NAVAL AIRBORNE ORDNANCE

Prepared by

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PREFACE

The purpose of this publication is to provide officers of the aviation organization of the Regular Navy and the Naval Reserve with technical information concerning representative aviation ordnance equipment. The level of presentation assumes familiarity with two Navy Training Courses—Aviation Ordnanceman 3 & 2, NavPers 10345-A, and Aviation Ordnanceman 1 & C, NavPers 10347-A.

This textbook is especially pertinent to the promotion-study program of the following categories of officers: 131X, 135X, 151X, 670X, 721X—CWO's, Ensigns, LTJG's, and LT's. It is intended to be used both for self-study purposes and as a text for an Officer Correspondence Course.

Although the presentation is slanted primarily toward the technical understanding of ordnance equipment, it includes some information concerning preparation for the administrative duties of the Aviation Weapons Officer. Organizations, procedures, and facilities for supplying and maintaining naval ordnance materials are described because an understanding of these phases of logistic support is important for officers whose duties are concerned with such material.

Those parts of the text which concern technical aspects of operation and maintenance of ordnance equipment should be considered as representative of recent equipments, though not necessarily the latest modifications. It must be remembered, also, that organizations, functions, and administrative responsibilities, as well as details of procedure, are subject to change. This publication, therefore, can serve only as a guide. The particular officer involved must by adequate in service training fit himself into the organization to which he is attached and increase his understanding and proficiency in the performance of his assigned tasks.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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CHAPTER 1

GENERAL ASPECTS OF NAVAL AIRBORNE ORDNANCE

GROWTH OF NAVAL AIRBORNE ORDNANCE

Battles on land, on sea, or in the air, with few exceptions, have been won by the side able to deliver the heaviest firepower with the greatest skill and over the longest ranges for any sustained period. These factors of firepower, skill, and range have proved important in all wars. It is not surprising that aircraft became a decisive weapon in World War II, since combat aircraft have extended the range of battle while carrying harder hitting weapons. Consequently, in time of war, the nation able to produce in quantity the longest ranging, hardest hitting weapons is almost certain to win, provided it has the ability to deliver the weapons with skill and accuracy.

In the lengthening of ranges, progress during World War II was tremendous. In the beginning ranges were still being measured in yards. The largest battleship's guns rarely exceeded 40,000 yards, and this figure was accepted to be the practical limit. However, in the Pacific theater of war, a new weapon, the carrier based attack aircraft, suddenly increased battle ranges to several hundred miles and became the dominating influence in the Pacific. Its first real test came in the Coral Sea in May 1942 when Japanese and United States forces, stood some 200 miles apart and launched air attacks. Much the same thing was repeated at Midway a few weeks later; thus, the armed aircraft, with ever-increasing range, became a major force in deciding battle outcome.

To make aircraft a decisive winning factor, more than outnumbering the enemy was needed. Ordnance experts believe that, basically, it was superior firepower and tactics which allowed United States aircraft to win practically every air battle during World War II. Although Japanese bombs and torpedoes were practically as destructive as our own, their aircraft guns and gunnery were inferior.

The Japanese aircraft guns could not match the caliber .50 Browning machinegun; Japanese aircraft were not equipped to carry as large a payload as our aircraft or to withstand the necessary "g" forces encountered during air battle maneuvers. As an example of our superiority in the two air engagements at Coral Sea and Midway, a total of 296 Japanese aircraft were destroyed by United States carrier aircraft. The score in the Coral Sea battle was 3 to 1 and almost 2 to 1 at Midway. As the supply of American aircraft increased, later actions had much higher ratios, reaching the figure of 22 to 1 in the famous Marianas battle (Marianas "turkey shoot").

With such decisive victories it was only natural that a new era in naval warfare should evolve around the carrier and around carrier-force airpower. It is here that the Aviation Weapons Officer finds himself in in dominant supporting role. Combat aircraft are only as good as their integrated firepower, and aircraft firepower depends largely upon the Aviation Weapons Officer's supervision of ordnance operations afloat and ashore.

CONTINUING RACE FOR FIREPOWER

It was early in World War I that lightly armed scouting aircraft, the only aircraft in use, initiated the race for air weapons powerful enough to dominate the air. During this period, the Germans stayed generally ahead in aerial gunnery, even though command of the air was never more than local on either side and never was essential to surface actions. The Nazis failed to profit by the ordnance lessons they should have learned from their predecessors in World War I. In 1940, although greatly superior in number (5 to 1 in overall figures), they lost the Battle for Britain by a score of 2 to 1.

With all due credit to the great value of early warning radar and the then new 100-octane gasoline, it is clear that the British victory was due largely to superior firepower delivered from excellent fighter aircraft by highly competent pilots. These British aircraft were the first with integrated armament, designed and configured solely to destroy enemy aircraft. Examples of United States naval air battles won because of superior pilots, aircraft, and firepower are numerous.

During the past 25 years aircraft and their armament have advanced in design and complexity in tremendous strides. In the 1940's a fighter aircraft's maximum speed was 300 knots and had a maximum altitude of 40,000 feet, while today's jet aircraft attain supersonic speeds with maximum altitudes of 90,000 feet or more. Aircraft gun designers have attempted to keep pace with the aircraft—the .30-caliber machinegun was replaced by the .50-caliber machinegun, which in turn was replaced by the present 20-mm aircraft gun. NOTE: Aircraft guns are practically obsolete for air-to-air combat.

Aircraft rockets have advanced from the 3-inch and 5-inch, 1,200 fps, singly carried types to such rockets as the 2.25 inch "Mighty Mouse," and the 5-inch "ZUNI," which have velocities of 2,200 fps and are carried in pods of 4 or more. Furthermore, the unguided rocket is gradually being replaced by the guided missile which has practically unlimited capabilities.

Meanwhile, a constant program of research and testing goes on with many other types of conventional ammunition in an attempt to use the latest techniques and adapt present types of conventional ammunition to the latest complex weapons systems. All of this is overshadowed by this country's arsenal of nuclear weapons. A current aircraft loaded with nuclear weapons can deliver as much destruction as the largest armada of aircraft was capable of delivering in World War II. A squadron of aircraft loaded with nuclear weapons can rain down enough destruction to cause unbelievable annihilation and a carrier air wing's capabilities could paralyze three-fourths of the world.

The enemy also has this countermassive retaliation capability. Therefore, the arms race is no longer for larger and more devastating weapons, but rather for aircraft capable of carrying a wide variety of weapons for many types of missions. Time required for aircraft reconfiguration is also important. Today's jet-powered aircraft, with their complex weapons systems, are ample testimony that the race for superior firepower continues.

LESSONS LEARNED FROM PAST WARS

Throughout the Pacific theater of World War II, Japanese naval aircraft, highly maneuverable but weaker in firepower and in protective armor, were more numerous than American naval aircraft. Yet, even in 1941-42, Japanese aircraft were being shot down at a ratio of 3 to 1. These victories were achieved by superior pilots using better constructed aircraft which were equipped with more advanced sighting methods. This resulted in more accurate delivery of the ordnance payload to produce an enemy kill. Thus, complete local dominance over an enemy who had superior numbers of highly maneuverable aircraft generally resulted.

Among the many lessons learned were the ones to capitalize on the mistakes of the Japanese. The enemy sacrificed protective armor, self-sealing gas tanks, aircraft construction, and semiskilled pilots for speed and maneuverability, whereas American aircraft were well constructed, had adequate protective armor, and contained self-sealing gas tanks. American victories could also be attributed to skilled pilots who knew their aircraft's capabilities and limitations, were trained in airborne ordnance delivery, and seasoned in aerial gunnery techniques. Also the United States went to unlimited effort to rescue a downed pilot; the enemy normally considered their pilots expendable.

The United States and her Allies were quick to capitalize on still other mistakes made by both the Japanese and the Germans. The enemy placed little or no value in captured equipment; whereas the Allies went to unlimited means to capture (intact whenever possible) enemy equipment such as aircraft, tanks, ammunition, vehicles, guns, camera equipment, etc. The captured material was promptly sent to test stations, research centers, laboratories, etc., where thorough tests, evaluations and analyses were performed. The results proved invaluable to military strategists who used this information to plan operations whereby they capitalized on the weaknesses found in the enemy's equipment.

The Korean campaign taught us a new type of limited war. The Pacific Fleet was engaged in around-the-clock strikes in North Korea, while the Atlantic Fleet stepped up their training exercises. Also in Korean air operations, new

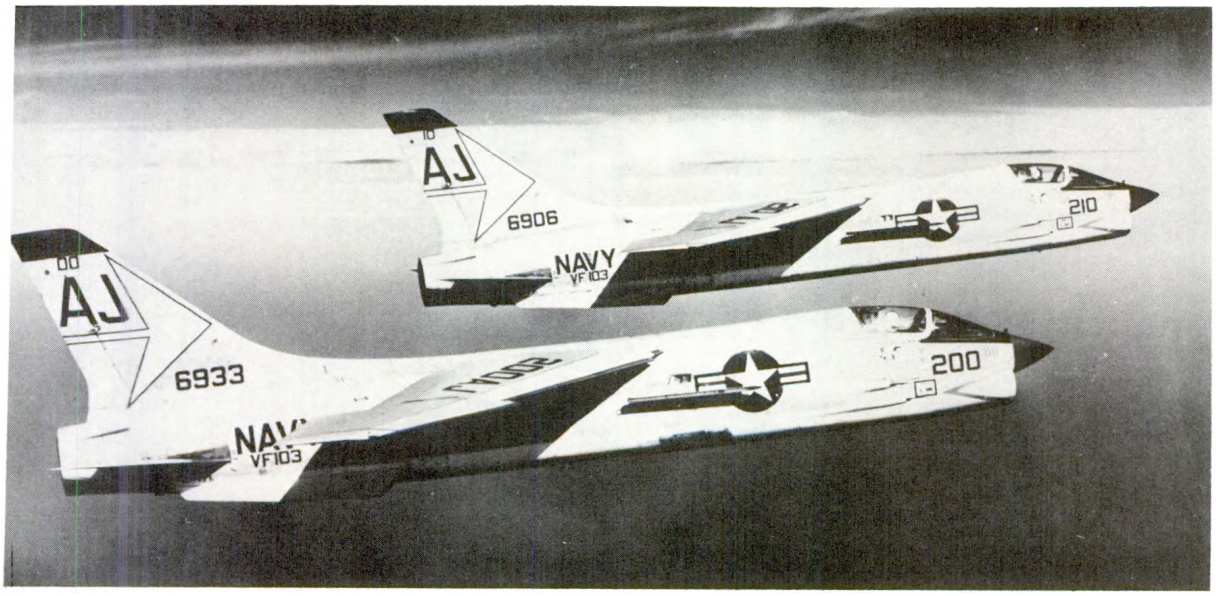


Figure 1-1. —F-8E Crusader.

impetus and emphasis were given to the interdiction (attack of supply lines) type of tactics. It developed into a concerted drive to destroy railroad rolling stock, trucks, bridges, and electric powerplants.

An interdiction type of air warfare requires detailed planning so that the attacks may be effective. For example, a plan aimed at railroads which does not also concentrate on trucking would not be worth the required time, aircraft, equipment, and personnel.

The operation must be planned so that the maximum crippling effect is obtained with a minimum effort. Not only is such an attack more effective, but it does not kill as many noncombatant personnel as does random bombing of industrial and urban areas.

AIRCRAFT TYPES

The current types of aircraft that the Aviation Weapons Officer will encounter can carry an array of weapons at speeds and altitudes that would astound the Aviation Ordnance Officer of World War II. Also, these aircraft require skilled personnel to properly install, adjust, and maintain their respective complex weapons systems.

A brief resume of current operational models of Navy aircraft, purposely shortened to include only the later models, is given in the following paragraphs. Older models of Navy aircraft are still in use on certain assigned missions, and information is usually readily available locally.

Fighter

F-8E.—The F-8E Crusader (fig. 1-1) is a single seat, supersonic, sweptwing fighter aircraft designed for carrier use. The variable-incidence wing, whose angle is changed for takeoffs and landings, is set high and well back on the fuselage. The horizontal tailplane, which is a small replica of the wing, is mounted well down on the fuselage tail.

The F-8E is similar to the F-8D and is an all-weather interceptor, capable of speeds approaching Mach 2. The F-8E contains a higher performance radar than the F-8D.

The armament capabilities include a gunnery system containing 20-mm Mk 12 Mod 0 guns; a missile system equipped with provisions for mounting and firing externally carried missiles; and a fire control system for directing gun, rocket, and missile firing.

In 1962, an F-8E was equipped with two pylon assemblies to carry a wide variety of missiles and bombs to test its suitability as an attack aircraft. The two pylons are capable of carrying twelve 250-pound bombs, four 500-pound bombs, two 1,000-pound bombs, two 2,000-pound bombs, two Bullpup (A or B) air-to-surface missiles, or 24 Zuni rockets.

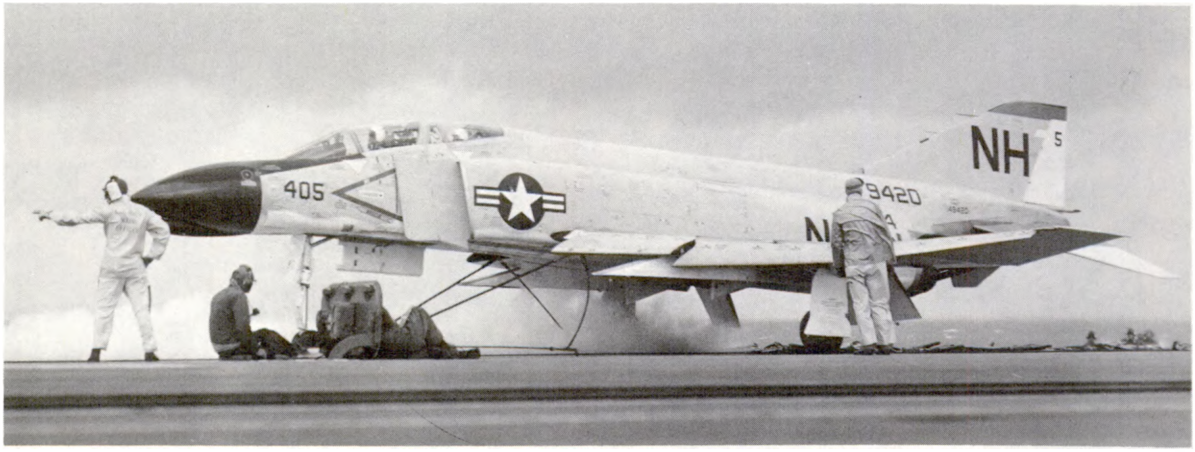


Figure 1-2. —F-4B Phantom II.

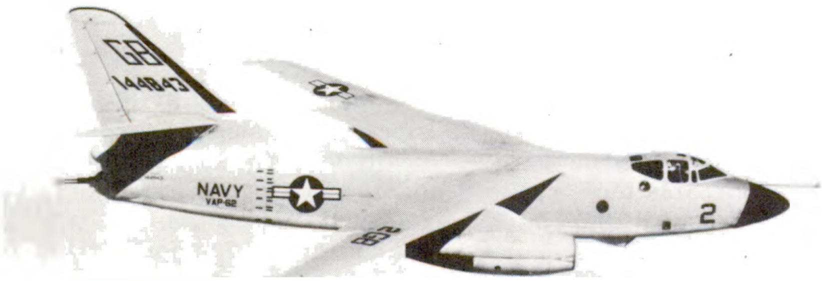


Figure 1-3. —A-3B Skywarrior.

The tests proved highly successful, and current F-8E are equipped with pylon assemblies to carry the full range of attack weapons.

F-4B. —The F-4B Phantom (fig. 1-2) is the successor to the F-3 Demon. The Phantom is capable of speeds in excess of Mach 2.6 and has operated at an altitude of approximately 99,000 feet. The F-4B is a two-seated, twin-engine, all-weather, fighter-attack bomber. Normal armament of the F-4B consists of four radar controlled missiles (Sparrow III) positioned in tandem pairs, two forward and two aft, in recessed cavities on the bottom of the fuselage. Two additional missile stations are provided by installation of the wing missile pylons. Each of these pylons is capable of carrying one radar controlled missile or two heat seeking (Sidewinder) missiles. Also, the F-4B is capable of carrying rocket packs and a variety of conventional or nuclear stores.

Attack

A-3B. —The A-3B Skywarrior (fig. 1-3) is a twin-jet sweptwing and swept-tail bomber whose primary mission is the attack and destruction of

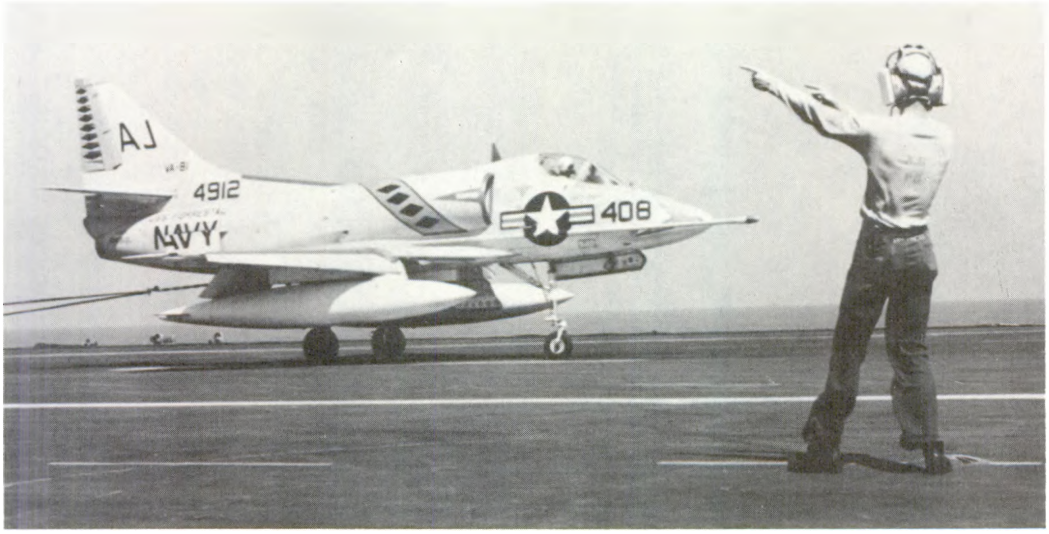


Figure 1-4. —A-4E Skyhawk.

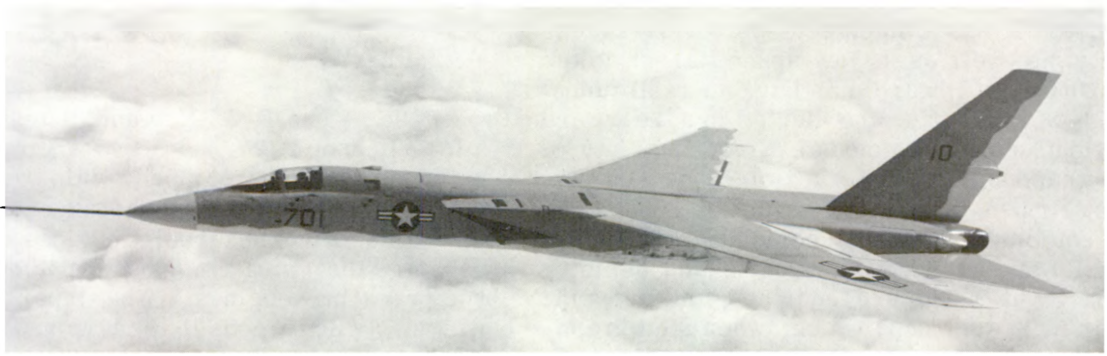


Figure 1-5. —A-5A Vigilante.

enemy ground and surface targets. Although designed chiefly as a nuclear bomber, the three-man crew is highly versatile and can be used for many other missions. It is capable of delivering virtually any weapon in the Navy's arsenal from an aircraft carrier or shore base. It can be identified by the high mounted wings, the huge vertical tail assembly, the cockpit located well forward in the fuselage, and the pointed nose. Though large for a carrier type aircraft, the A-3B is small in comparison with other aircraft in its class having a wingspan of approximately 72 feet.

A-4E. —The A-4E Skyhawk (fig. 1-4) is a single-seat, low-wing, jet, attack bomber. An outstanding recognition feature is its small size; it claims the distinction of being the only contemporary U. S. carrier-based aircraft compact enough not to require folding wings. The A-4E is capable of carrying nuclear weapons, rockets, and missiles in addition to other conventional weapons. Five bomb racks, two on each wing and one amidships, are capable of carrying 8, 200 pounds of nuclear or conventional stores.

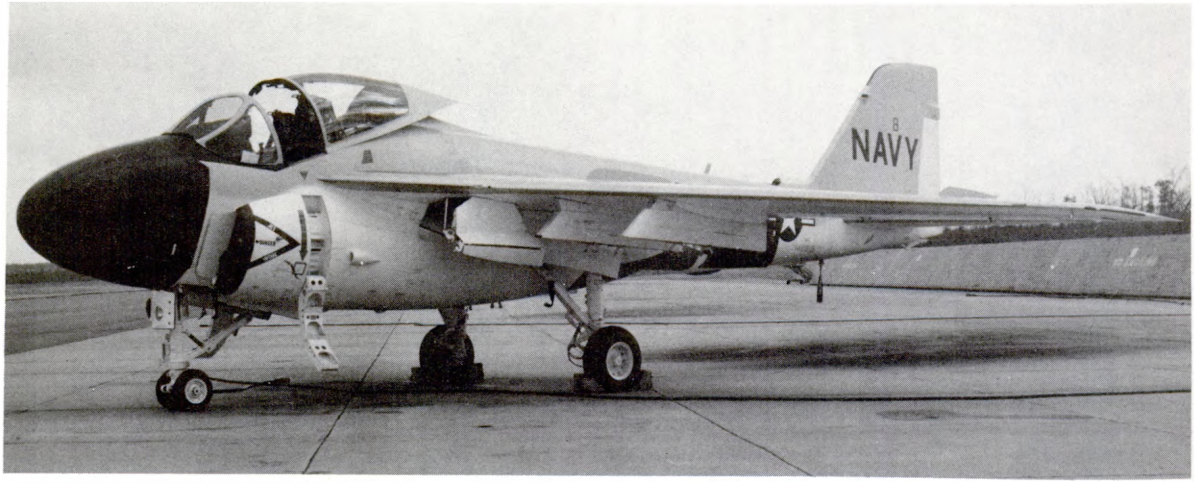


Figure 1-6. —A-6A Intruder.

A-5A.—The A-5A Vigilante (fig. 1-5) is a two-place (pilot and navigator/bombardier) carrier-based subsonic or supersonic attack bomber capable of carrying nuclear or conventional weapons in all weather and at low or high altitudes. It has a Mach 2.0—performance capability as well as a low-speed target loiter capability. Its linear bomb bay, an axial tunnel through which stores are ejected in a rearward direction, can accommodate a wide variety of naval weapons.

The first A-5A flew in August of 1958. The A-5A equipment includes a completely integrated inertial Doppler/radar navigation and bombing system. The wings are equipped with drooping leading edges and flaps which, when used in conjunction with spoiler-deflectors, provide low-speed flight characteristics. The long pointed nose, with the cockpit well forward, is set between two square-formed, jet-engine intakes.

A-6A. —The A-6A Intruder (fig. 1-6) is the Navy's newest attack bomber. It is a two-place (pilot and radar operator side by side) sweptwing aircraft. The A-6A is a versatile aircraft capable of subsonic speeds as well as extended range. Its extremely sensitive radar and detection equipment can detect targets under all weather conditions. The A-6A is designed for carrier use as well as for use on short runways. It is easily identified by the overall fuselage which has an expanded teardrop appearance with a thickening effect through the engine area, then progressively thins and tapers to the tail. The horizontal stabilizer is set slightly forward of a large vertical stabilizer, the leading edge of which slants aft at approximately a 40° angle. The A-6A is capable of carrying conventional as well as nuclear weapons.

Patrol Series

P-2H. —The P-2H Neptune, latest version in a long line of P-2's, is a two-engine, midwing, patrol aircraft, equipped with two additional turbojet engines to augment takeoff and combat performance. The turbojet engines are mounted beneath the wing in pods, outboard of the reciprocating engines. The tapered, straight wing has wingtip pods that carry radar and landing lights in addition to fuel. An enlarged crew space, a bulging cockpit canopy, a modified nose landing gear, redesigned wingtip pods, and a simplified multifunction control system are added features of the "H" model. Although designed primarily for ASW, the P-2H is also used for patrol, minelaying or torpedo-bomber duties. The P-2H is capable of carrying a large variety of ordnance loads, including rockets, depth charges, torpedoes, and nuclear weapons.

P-3A. —The P-3A Orion (fig. 1-7) is the latest U. S. Navy antisubmarine warfare aircraft. It is derived from the commercial Lockheed Electra. Designed to supplant the P-2H Neptune, the P-3A is capable of operating for extended periods of time at altitudes from sea level to 30,000 feet and above. It is equipped

Figure 1-7. —P-3A Orion.

with the latest electronic search devices as well as the latest navigation and communications equipment. Included is an advanced underwater detection apparatus and a magnetic anomaly detector in the tail. The P-3A is capable of speeds in excess of 460 mph. Standard cruising speed is approximately 380 mph. The P-3A can cruise using two inboard engines only. It has good endurance at low altitudes and carries a crew of 10. It is capable of carrying a large variety of ordnance loads, including rockets, depth charges, torpedoes, and nuclear weapons.

Antisubmarine Series

S-2C. —The S-2C Tracker (fig. 1-8) is a twin-engine high-wing ASW aircraft designed to search for, detect, and destroy enemy submarines under all weather conditions. The S-2C is the first U. S. carrier aircraft combining features for submarine search and attack in one aircraft. It utilizes radar, sonobuoys, and MAD equipments to detect an enemy submarine, and then uses torpedoes, depth charges, or rockets to destroy it. The Tracker has accommodations for a crew of four, and it is possible to interchange all crew positions in flight. A retractable radome is located under the rear fuselage behind the bomb bay. The S-2C is easily distinguished from its predecessors by an enlarged torpedo bay which accommodates a larger antisubmarine weapon.

The latest version of this aircraft, the S-2D, differs very little from its predecessors in external appearance; however, it has actually been modified extensively. The forward fuselage has been lengthened, the aft sections of the engine nacelles have been deepened for sonobuoy stowage space, and the wingtips have been rounded.

CARRIER TYPES

The two main classes of aircraft carriers that have billets for officers in the aviation ordnance

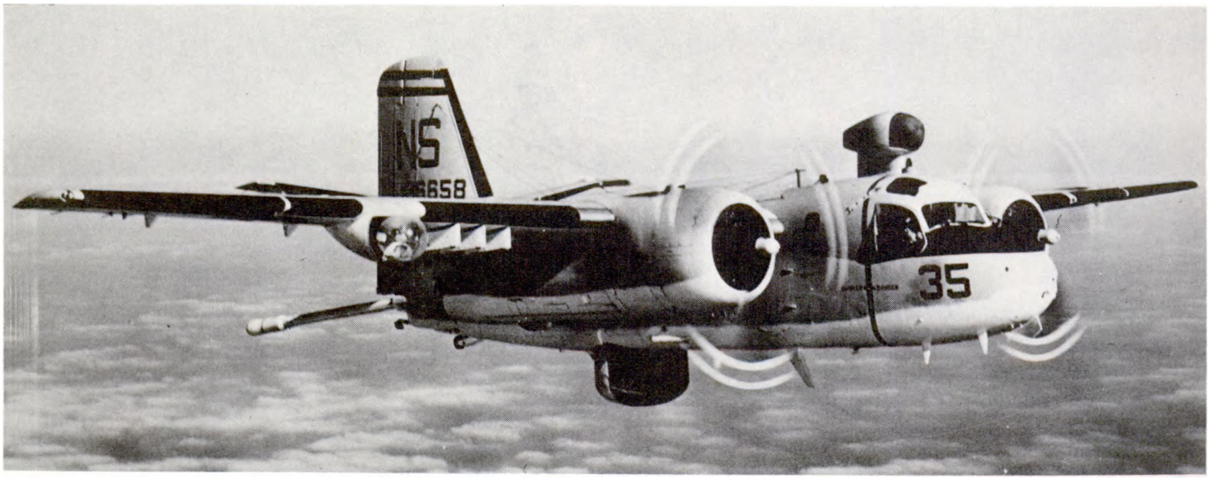


Figure 1-8. —S-2C Tracker.

field are the attack carrier (CVA) and the antisubmarine warfare support carrier (CVS). However, other classes of aircraft carriers are still operational with the fleet but have been relegated to specialized and supporting roles. A list of the present CVA and CVS classes of carrier is presented in table 1-1.

Attack Carriers

The present array of attack carriers consists of many classes but basically all have the same capabilities. Included in the pertinent data of present CVA's are the following features: angled deck, steam catapults, nuclear weapons capability, hurricane bow, and air conditioning.

The introduction of the angled deck has speeded flight operations considerably. With the use of the angled deck, launching and recovery of aircraft can take place at the same time.

Present classes of CVA's include the Enterprise class, Kitty Hawk class, Forrestal class, Midway class, and some of the Essex class. A brief discussion of the types of carriers and individual class data follows.

ENTERPRISE CLASS. —Of great significance to naval strategy is the first nuclear powered aircraft carrier, the USS Enterprise CVAN 65. (See fig. 1-9.) The Enterprise is equipped with four C-13 steam driven catapults with an energy potential of 60,000,000 foot-pounds. An aircraft weighing 78,000 pounds can be accelerated to 160 mph from a standing start in a distance of 250 feet. Aircraft can be launched at a rate of one every 15 seconds while using all four of its catapults. The four deck edge elevators provide rapid movement of aircraft. Nuclear power propulsion gives the USS Enterprise unlimited cruising ability.

FORRESTAL CLASS. —The USS Forrestal CVA 59, first of her class, was completed in October of 1955. (See fig. 1-10.) Since that time three sister ships, the Saratoga CVA 60, Ranger CVA 61, and Independence CVA 62 have joined the fleet.

KITTY HAWK CLASS. —The USS Kitty Hawk CVA 63 and the USS Constellation CVA 64 are essentially built along the Forrestal lines, but were developed into a separate class (Kitty Hawk class) because of their guided missile launching capabilities.

MIDWAY CLASS. —The Midway class carriers (Midway CVA 41, Franklin D. Roosevelt CVA 42, and the Coral Sea CVA 43) were completed in the first 2 years after World War II, but have undergone complete major conversions. They have received angled decks, steam catapults, and increased fuel capacities. The extensive changes enable these ships to handle the heavy, fast jets of today and any carrier aircraft in the near future. (See fig. 1-11.)

CVS Carriers

The CVS carrier class (fig. 1-12) was established in 1953. These carriers are antisubmarine warfare support carriers and are capable

Table 1-1. —Aircraft carrier class data.

Class	Carrier	Displacement full load	Overall length	Width	Speed	Complement
CVA (N) 65	Enterprise (CVAN 65)	85,800	1,102	252	35	4,600
CVA 63	Kitty Hawk (CVA 63) Constellation (CVA 64) American (CVA 66)	76,700	1,047	252	35	4,965
CVA 59	Forrestal (CVA 59) Saratoga (CVA 60) Independence (CVA 62) Ranger (CVA 61)	75,900	1,046	252	33	4,150
CVA 41	Midway (CVA 41) Roosevelt (CVA 42) Coral Sea (CVA 43)	62,000	968	210	33	3,354
CVA 19	Hancock (CVA 19) Ticonderoga (CVA 14) Lexington (CVA 16) Bon Homme Richard (CVA 31) Oriskany (CVA 34) Shangri-La (CVA 38) Intrepid (CVS 11)	42,600	899	192	33	2,800
CVS 10	Essex (CVS 9) Bennington (CVS 20) Yorktown (CVS 10) Hornet (CVS 12) Randolph (CVS 15) Wasp (CVS 18) Kearsarge (CVS 33) Lake Champlain (CVS 39)	38,500	888	192	33	2,800

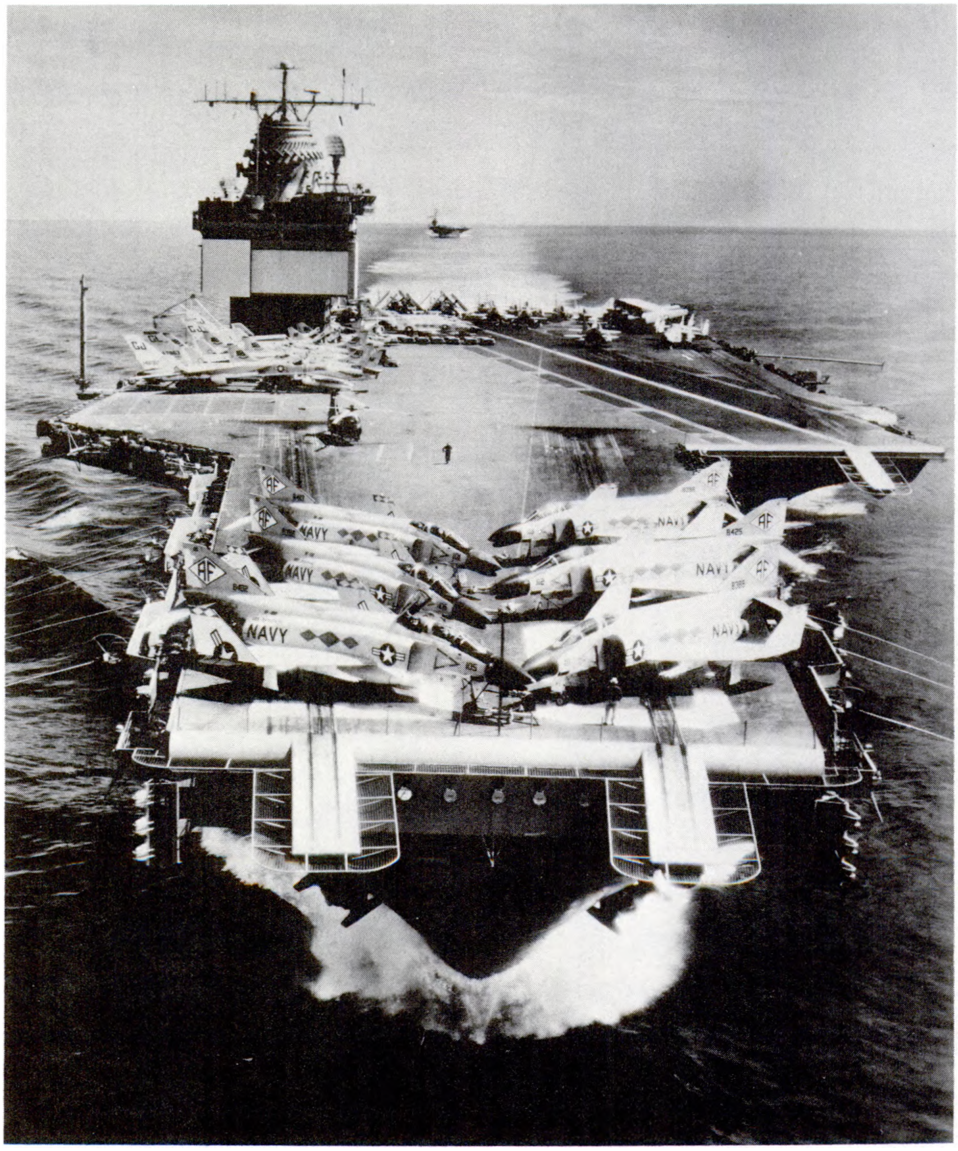


Figure 1-9.—USS Enterprise CVAN 65.

of supporting the new types of antisubmarine warfare aircraft. The CVS class of carriers are Essex class carriers that were built during World War II, some of which have not been modified as extensively as those reclassed as CVA's. The Essex class CVA's are being replaced by new carriers, and the Essex class carriers now designated as CVA's are being redesignated as CVS's.

Other carriers of a specialized nature have been developed and are being improved upon. These ships are to support the vertical envelopment phase of amphibious operation. The amphibious assault ship (LPH) is the key of the modern amphibious force. Companion ship to the LPH is the amphibious transport, dock (LPD).

The first LPH, the Thetis Bay, was converted from an escort carrier. Two Essex class carriers, the Boxer (LPH-4) and Princeton (LPH-5), have been converted to amphibious assault ships. Other LPH's, built from the

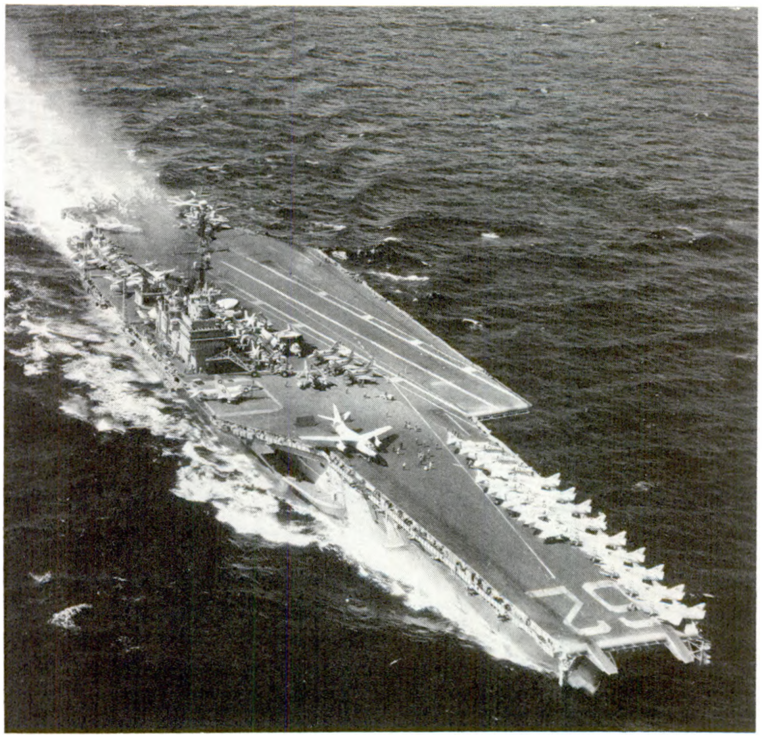


Figure 1-10. —Forrestal class, USS Independence CVA 62.

keel up for this specialized mission, include the Okinawa (LPH-3), and Guadalcanal (LPH-7), while still others are under construction. The first of new construction was the Iwo Jima (LPH-2). Examples of currently operational amphibious transport, docks (LPD's) are the Raleigh (LPD-1), Vancouver (LPD-2), and Lasalle (LPD-3), while several others are under construction or in the planning stage.

The Navy is composed of over 180 (870 total) different types of ships. They are divided according to mission into three distinctive categories—combatant ships, auxiliary vessels, and service craft. Figure 1-13 shows most of the different types of ships currently used in the Navy.

The policy of the Navy has been to adapt and modernize naval "hardware" to meet the needs of changing conditions. Ships, aircraft, and other equipment are continually being modified to give them greater capabilities.

Ships have a relatively long life span. They are modernized and converted whenever it is possible to do so.

Over 80 submarines have been converted to snorkel operations; however, such new submarines as the Nautilus and Seawolf indicate that these older submarines are far outmoded as to speed, range, and suitability for future use in warfare.

During tests and operations, the submarines Nautilus and Seawolf broke nearly every known submarine record, definitely proving nuclear power as a means of ship propulsion and paving the way for its trial in many other types of vessels. As of this writing, over 40 nuclear submarines have been launched or are scheduled to be launched in the near future.

Several old destroyers have been given special equipment for antisubmarine and radar picket work. However, new developments demand that new ships be produced that will provide a higher degree of combat effectiveness.

Programs are underway to keep up with the never-ending struggle of obsolescence.

FAST CARRIER TASK FORCES

As developed in World War II, the fast carrier task force represented a revolution in

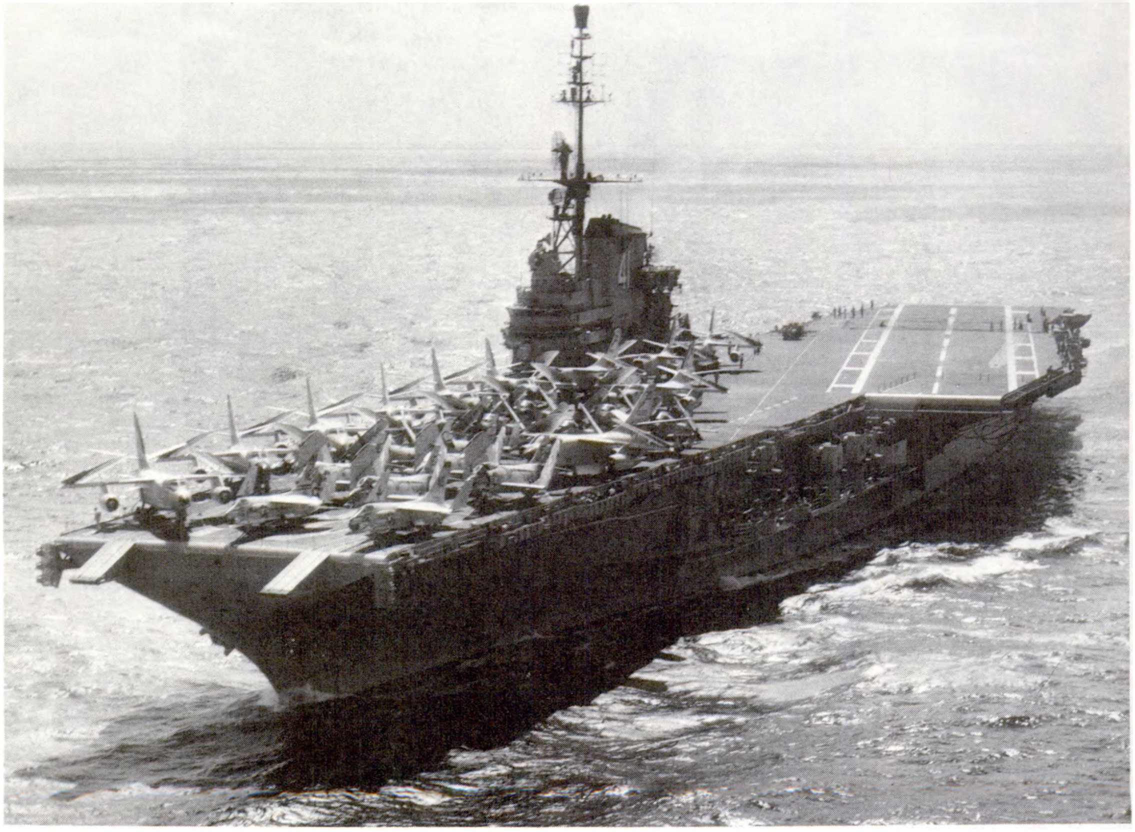


Figure 1-11. —USS Midway CVA 41.

naval warfare. The carrier task force, primarily American in origin and concept, was designed as a naval striking force which could gain and hold command of vital sea areas. It was the weapon that set the stage for amphibious warfare, creating the "area of immunity" which the amphibious forces needed to perform their missions.

Striking forces are task forces formed primarily to conduct strikes, sweeps, or raids. A strike is any naval operation which is planned to produce devastating damage to an objective. A series of strikes in combination against several enemy targets in a certain area is termed a sweep. A raid is a sudden attack, usually by a small force having no intention of holding the territory invaded. Types of task forces organized primarily for striking force operations are attack carrier striking forces, surface striking forces, and submarine striking forces. These forces may operate independently during the period of their organization, or they may operate in coordination with another force.

CARRIER TASK GROUPS

The basic tactical component of a carrier task force is the task group, composed of one or two carriers along with the necessary supporting ships. The commander of a task force includes in his operation orders breakdowns of the groups into units and further into elements, each with a particular mission or type of mission. Hence, a particular ship might be included in two or more of the groups, units, or elements. The commander thus attempts to provide for all probable tactical situations, but in the course of a battle, it might be necessary to make changes in some of the groupings.

Figure 1-12.—USS Bennington CVS 20.

A World War II task group, depending on the situation, was usually formed into a more or less compact formation with several carriers at the heart. The screening battleships, cruisers, and destroyers were arranged about the carriers in that order; i.e., in a descending order of firepower. This provided the carriers with maximum protection against aircraft, submarines, and gunfire. Today, however, each task group has only one or two carriers, for a single modern carrier with modern weapons can deliver a greater punch than could several World War II carriers armed with World War II weapons. This capability, plus increased range and speed of weapons systems coupled with improved communications capabilities, allows task groups to spread out over much larger areas. An added advantage from this type of dispersal is a reduction in possible losses from nuclear attack.

Compositions as well as formations of task groups have changed. The battleship has disappeared from the scene and guided missile ships, radar picket ships and submarines, and airborne early warning (AEW) aircraft have been added. Nothing remains of the precise circular formations of World War II. Instead, ships are scattered loosely, almost indiscriminately, over vast expanses. One could never determine which ship was the carrier by merely observing on a radarscope the arrangements of the formations. Heavy ships of the screen probably will remain relatively close to the carrier, but relative distances of the destroyers are much greater. Formerly a destroyer's primary job was screening against submarines; to this has been added the equally important task of acting as picket ship. The other picket ships and picket submarines and AEW aircraft are deployed in the directions from which

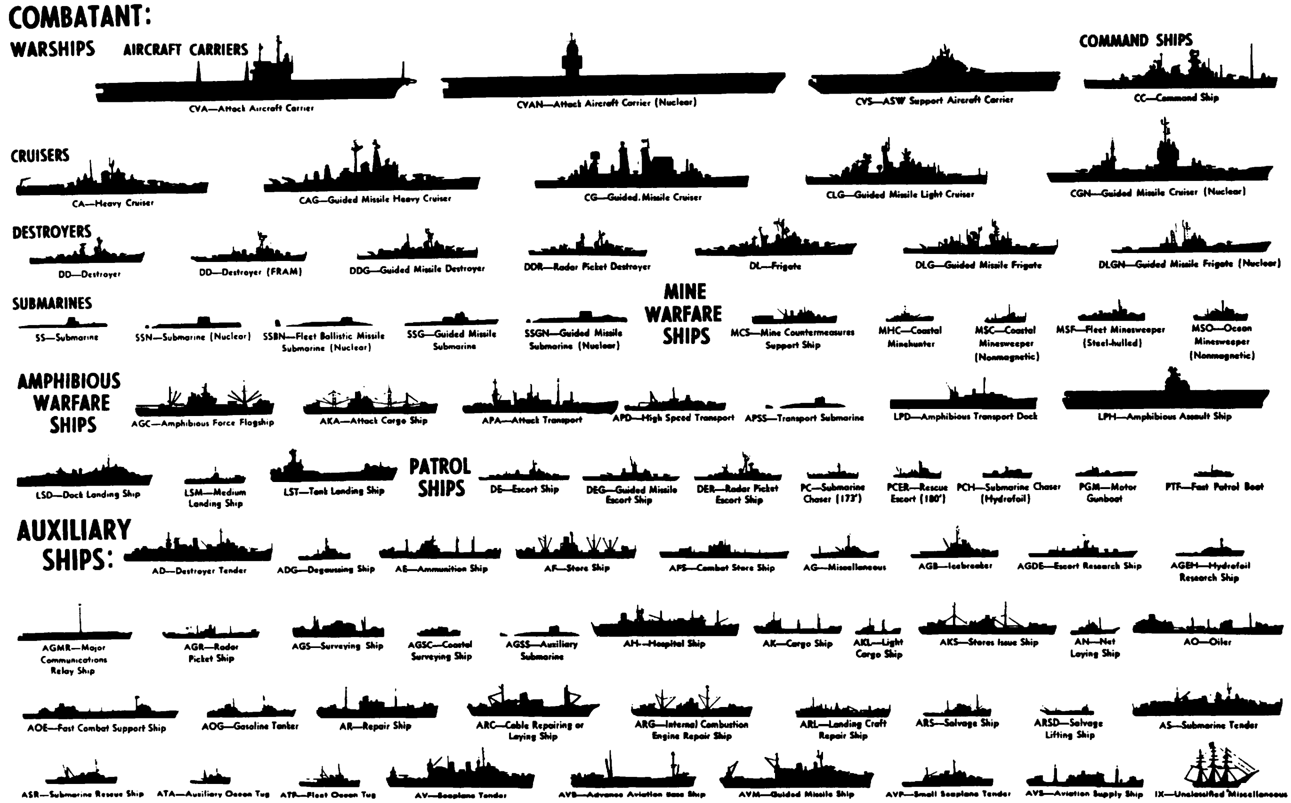


Figure 1-13.—The U.S. Fleet in silhouette.

an enemy might be expected to launch an attack. Such disposition increases the changes of spotting enemy activity, warning of which can be radioed to the task force, thus enabling it to make last minute preparations for defense and counterattack.

Air Strikes

Before an air strike is made, an attack plan is composed, and pilots participating in the strike are thoroughly briefed on the plan. Included in the briefing is all known information which might contribute to the success of the strike e.g., enemy strength, location or probable location of the enemy, recovery areas, weather conditions, location of friendly forces, and, if feasible, target priorities. Against an enemy possessing aircraft carriers, the usual procedure would be to cripple his carriers and destroy his aircraft. Then, with the enemy's airpower eliminated, attacks would be directed against other ships in the group. Priority of targets would depend on the existing strategic and tactical situation, but normally, ships with the greatest firepower would be attacked first. Methods of delivering the attacks and the weapons selected would depend on whether it was to be a day or night attack and on the weather conditions at the target.

In the event the United States was to employ nuclear weapons, a few aircraft or even a single aircraft might be utilized in a surprise attack. Against early warning systems, surprise would be a much more important factor than the brute force of the massed attacks of World War II, and the nuclear weapons would cause even greater destruction.

AIRBORNE ORDNANCE AND ARMAMENT SYSTEMS

Aircraft ordnance and armament equipment includes all offensive and defensive weapons and ammunition used by aircraft. This definition also includes such equipment as fire control and sighting systems, together with auxiliary devices for handling, maintaining, carrying, and firing (or releasing) airborne ammunition from naval aircraft.

Airborne ammunition includes all items of explosive ordnance and fuzes, including aircraft gun ammunition, bombs, rockets, torpedoes, mines, guided missiles, and nuclear weapons carried on aircraft.

Auxiliary equipment includes pyrotechnic and smoke tank equipment, together with training and target materials for rocketry, bombing, and other combat activities. Also included are the maintenance items used with the above material, and equipment for handling and loading ordnance at shore bases, on carriers, and on aircraft.

Airborne ordnance and armament equipment are the materials which convert aircraft from work vehicles into combat weapons. The items come in a wide variety, keeping pace with the expanding uses and capabilities of naval aircraft.

OPERATIONAL ORDNANCE AND ARMAMENT SYSTEMS

As in the past, current ordnance and armament systems are constantly changing. The marks and mods of equipment familiar to veterans of World War II are rarely found on current aircraft. However, most of today's ordnance and armament items had their beginnings and combat tests during wartime, as many of the current complex devices are essentially refinements and improvements of war proved equipment.

An armament system of today normally provides a means of carrying and delivering the various ordnance loads (bombs, mines, torpedoes, nuclear weapons, rockets, or guided missiles) that are adaptable to a particular aircraft. The selected conventional or nuclear weapon may be carried either internally (linear bomb bays or bomb bays) or externally on pylons, racks, launchers, missile launchers, or ejector launchers.

The related systems necessary for operation of an armament system may include a stores release and indicating systems, an electric fuze function control system or arming control system, an internal armament system, an external armament system, a sighting system, or a monitoring system. The entire armament system with multiple weapon concept is keyed together to produce the ultimate result—an enemy kill. A representative armament system is covered in chapter 5 of this text.

NAVAL AVIATION

Operationally, naval aviation has no separate mission or organization from the rest of the Navy. However, logistic and training problems of aviation have led to the establishment of separate echelons of command for administrative and logistical duties. Naval aviation is divided into four parts, similar in organization to the other major bureaus of the Navy. They are the Assistant Secretary for Research and Development, the Deputy Chief of Naval Operations (DCNO Air), the Naval Material Support Establishment, and the Bureau of Naval Weapons.

ASSISTANT SECRETARY OF THE NAVY

The Assistant Secretary of the Navy (Research and Development) is responsible for policy, management, and control of research, development, test, and evaluation matters.

DEPUTY CHIEF OF NAVAL OPERATIONS (AIR)

The Deputy Chief of Naval Operations (DCNO Air) implements the responsibilities of the Chief of Naval Operations with respect to the integration of naval aviation plans, programs, requirements, training, and safety, and the coordination of the Navy astronautic program.

NAVAL MATERIAL SUPPORT ESTABLISHMENT

The recent activation of the Naval Material Support Establishment ties the four major bureaus closer together. A military commander is now at the head of all Navy "producer" organizations. The four major bureaus affected by the recent realinement are the Bureau of Naval Weapons, Bureau of Ships, Bureau of Yards and Docks, and the Bureau of Supplies and Accounts.

BUREAU OF NAVAL WEAPONS

The Bureau of Naval Weapons (BuWeps) is the most recent bureau, having been established on 1 September 1959. It represents a merger of two former bureaus—Ordnance and Aeronautics. The decision to combine these two bureaus was based upon the necessity for the timely development and procurement of effective weapon systems and equipment, and for insuring full utilization of the professional and technical ability available to the Navy. The primary objective of this reorganization was to reduce the time between the expression of an operational requirement and the delivery to the combat forces of a fully developed and effective weapon or weapon system for service evaluation.

BuWeps is responsible for the research, development, design, test, operating standards, manufacture, alteration, repair, overhaul, material effectiveness, disposition, and salvage of all naval weapons. BuWeps is also responsible for all Navy and Marine Corps aircraft, airborne target drones, photographic and meteorological equipment, astronautic vehicles and supporting equipment, and for all pertinent functions relating thereto; and for the operation of air stations, naval stations, and air, rocket, and missile centers and test stations.

For more information regarding BuWeps role in the organization of the Department of the Navy, reference should be made to the pamphlet "The Department of the Navy, NavExos P-435" (latest revision). BuWeps Instruction 5450.27 spells out in detail its own functions and tasks pertaining to ammunition, ammunition components, and related material.

AVIATION WEAPONS OFFICER BILLETS

The recently adopted term Aviation Weapons Officer (in lieu of Aviation Ordnance Officer) may be confusing to some officers in the aviation ordnance field. Therefore, to avoid confusion the term Aviation Weapons Officer is used when speaking of the aviation ordnance field in general. However, when specific billets and duties are discussed the former title is used.

The billet of Aviation Weapons Officers increases in importance and responsibility concomitantly with the mounting complexity of armament systems installed in current naval aircraft. The mounting responsibilities evolve from more exacting aircraft maintenance techniques and operational problems required to be solved rapidly. The increasing number and complexity of electrical and electronic units being installed or scheduled for early installation on fleet aircraft, and the shortage of experienced aviation ordnance personnel have resulted in a greater workload for the Aviation Weapons Officer. To solve many of these problems, maximum effort should be directed toward efficient organization of the ordnance division and toward a well integrated training program for ordnance personnel.

The Aviation Weapons Officer of today has a grave continuing responsibility. Squadron commanding officers will undoubtedly count strongly and weigh thoroughly the Aviation Weapons Officer's answers given in regard to imminent pressing ordnance problems—a wrong or casual statement of fact could be disastrous. The Aviation Weapons Officer also has a deep responsibility to his men to instill in them an acute awareness of the importance of knowing a job and doing it with the utmost of their ability, to take pride in their work, and above all never bypassing or ignoring pertinent safety precautions.

The billets and duties of the Aviation Weapons Officer discussed in this text are based primarily on two billets as listed in the Manual of Navy Officer Billet Classification, NavPers 15839—the Aircraft Maintenance Ordnance Officer and the Squadron Weapons Officer.

AIRCRAFT MAINTENANCE ORDNANCE OFFICER

The responsibilities and duties of the Aircraft Maintenance Ordnance Officer are as follows:

1. Supervises and directs maintanance tasks on aircraft ordnance equipment and systems, nuclear weapons, and guided missiles as authorized.

2. Insures readiness of aircraft ordnance equipment; including guns, gunsights, bomb racks, ammunition handling equipment, and guided missiles and nuclear weapons flight and ground equipment where applicable.

3. Performs functional and ground tests of ordnance systems and accessories, insuring that adjustments are made; directs installation of authorized field changes; supervises removal, replacement, and minor adjustment and

repair of ordnance systems, components, and accessories.

4. Supervises assembly of gun and rocket packages; establishes methods for utilization of units, components, and systems; orders spares and replacement and maintains full equipment and parts allowance.

5. Insures proper equipment preservation; furnishes technical advice on discrepancies and failures; assigns aircraft to be armed and plans aircraft type loading as directed.

6. Supervises storing, handling, loading, and arming of aircraft ammunition, guided missiles, napalm bombs, rockets, torpedoes, high-explosive bombs, aircraft mines, and nuclear weapons where applicable.

7. Insures that all safety precautions and regulations are observed.

8. Assists in the preparation and submission of technical reports, and conducts on-the-job training.

SQUADRON WEAPONS OFFICER

The responsibilities and duties of the Squadron Weapons Officer are as follows:

1. Supervises and directs maintenance and material readiness of aircraft armament equipment.

2. Directs ordnancemen to inspect, repair, service, and perform routine maintenance of aircraft guns, gunsights, bomb racks, ammunition handling equipment, and guided missile and nuclear weapons flight and ground equipment where applicable.

3. Supervises and/or directs loading, arming, and testing of conventional bombs, aircraft guns, guided missiles, and nuclear weapons.

4. Directs procurement, maintenance, and stowage of ammunition.

5. Maintains adequate supply of ammunition in ready service lockers.

6. Conducts training classes for squadron ordnance personnel, including training on nuclear weapons and guided missile flight and ground procedures and techniques.

7. Provides technical library of armament publications for reference by division personnel.

8. Prepares gunnery performance charts for all pilots.

9. Directs preparation of required ordnance reports.

A quick glance at the responsibilities of the Aircraft Maintenance Ordnance Officer and the Squadron Weapons Officer will reveal many overlapping and similar duties. Therefore, throughout this text the words "Aviation Weapons Officer" will apply to both billets unless specifically stated otherwise.

In chapters 6 and 7 of this text, some of the many duties and responsibilities of the Aviation Weapons Officer in actual operational billets are discussed.

SOURCES OF INFORMATION

A well-informed Aviation Weapons Officer may acquire items of information pertaining to aviation ordnance from many sources. Some of the more pertinent publications are listed as follows:

Naval Weapons Bulletin.
Naval Aviation News.
Approach Magazine.
The Troubleshooter.
Orion Service Digest.
Service Information Summary (SIS).
Field Service Digest.
Line Officer (NavPers 15892).
JAG Journal.
ASO Bulletin.
Civil Service Journal.
Monthly Newsletter.
Fly Navy.
Recognition Journal.
FAA Aviation News.
Consumer Bulletin.
Electronics Information Bulletin.
Career Information Newsletter.
Chinfo Newsletter.
PDC Newsletter.
I & E Catalog.
Navy Management Review.
OIR Newsletter.
Navy Training Bulletin.
All Hands.
Defense Department Digest.
DESC Information Bulletin.

However, the best sources of printed information for the Aviation Weapons Officer are the applicable ordnance publications issued by the direction of BuWeps. These ordnance publications which are required reading, or of interest, to the Aviation Weapons Officer are listed in two important indexes, which are discussed in the following paragraphs.

NAVSANDA PUBLICATION 2002

NavSandA Publication 2002, Navy Stock List of Forms and Publications, Cognizance Symbol I Material, contains listings of certain BuWeps ordnance publications and detailed ordering instructions are provided therein. The following types of publications are available through the Navy supply system.

Ordnance Pamphlets (OP's).
NavOrd Charts (OC's).
Explosive Ordnance Disposal Bulletins (EODB's).
Naval Weapons Bulletins (NWB's).
RUDTORPE Digest.
Other miscellaneous publications.

NAVWEPS OP 0

NavWeps OP 0 is basically an index of two main types of ordnance publications; namely, Ordnance Pamphlets (OP's) and Ordnance Data (OD's). Ordering information pertaining to these and other ordnance types of publications is presented throughout the various sections of this index. The Aviation Weapons Officer should examine all sections of this index thoroughly.

OTHER SOURCES

Publications by the Department of Defense (DOD), other bureaus and activities of the Navy, Armed Forces, and commercial suppliers of the Armed Forces encompass the majority of a long list of printed matter that may be informative or valuable to the Aviation Weapons Officer. Some of the more pertinent ordnance publications are explained in chapter 3 of this text. Also pertinent instructions, manuals, pamphlets, publications, etc., are listed in appendix III of this text.

CHAPTER 2

AIRCRAFT MAINTENANCE ORGANIZATION

In order to maintain increasingly complex aircraft in their operating prime, various aircraft maintenance organizations and procedures have been employed throughout the Navy. Prior to and during early World War II, it was a general practice for every operating activity to have its own maintenance spaces, equipment, and a complement of maintenance personnel to accomplish all maintenance except overhaul. Due to variance in workload between squadrons, some shops were idle at times and could have been used by maintenance personnel from other squadrons on the same station to accomplish their work.

A combining of talents, efforts, facilities, and equipments for the accomplishment of common tasks was indicated. Through the process of evolution, combining of naval aircraft maintenance personnel and consolidation of maintenance facilities were effected on a Navy-wide basis when the Naval Aircraft Maintenance Program (NAMP) was established in 1958.

A notable increase in efficiency and effectiveness resulted from the NAMP. With the necessity for economy in the military services, this resulted in an investigation of the basic concept of maintenance and material management practices throughout the Department of Defense. With the idea toward standardization of procedures based on the most advantageous system, this concept has been filtered down through the services. For the Navy, the responsibility for development of the Standard Navy Maintenance Management System was delegated to the Deputy Chief of Naval Operations (DCNO) for Logistics.

THE STANDARD NAVY MAINTENANCE MANAGEMENT SYSTEM

OpNav Instruction 5420.48 of 15 January 1963 established the Maintenance and Material Management Project Group and a supporting Staff Working Group to recommend to DCNO (Logistics) action to achieve the following aims:

1. A standard for maintenance planning and control that will provide for the uniform accomplishment of planned preventive maintenance in all ships and aircraft squadrons of the operating forces.

2. A system for collecting, processing, analyzing, and distributing feedback information to line commanders and bureaus, enabling them to carry out their management functions in support of the operating forces.

OpNav Instruction 4700.16A of 1 August 1963 is the directive implementing action on the program. This instruction describes the broad approach to the basic objectives of the plan. It outlines the program required to coordinate the activities of the Bureau of Ships, Bureau of Naval Weapons, and Bureau of Supplies and Accounts, and to integrate these activities into the overall system. The plan of attack is divided into two parts, as follows:

1. Development and implementation of a Planned Maintenance System for the management of planned maintenance throughout the operating forces. It will emphasize maximum practical maintenance at the lowest (ship, squadron, and station) echelon.

2. Development and implementation of a uniform Maintenance Data Collection System, in support of the Navy Maintenance and Material Management Program, for ships and squadrons of the operating forces.

The Planned Maintenance System, as it pertains specifically to naval aviation, is an extension of the Maintenance Requirement Card (MRC) System developed in recent years on newer model aircraft. (The MRC system is discussed later in this chapter.) In general, the Planned

Maintenance System will accomplish the following objectives:

1. Develop documentation for preventive maintenance.
2. Develop uniform standards of maintenance planning, control, and recording.
3. Standardize maintenance management procedures throughout the operating forces.
4. Develop a standard format for recording and reporting maintenance.
5. Revise procurement specifications for new equipment and new systems to provide for adequate preventive maintenance documentation.
6. Include the evaluation of equipment maintenance requirements in fleet evaluations of equipments and systems.
7. Initiate the standard maintenance management system in all new ship construction.
8. Control preventive maintenance documentation throughout the operating forces.

The basic objective in establishing a Maintenance Data Collection System is to provide the required information and statistics as a basis for effective management of the Navy's maintenance and material resources. Its basic functions include data collection, data processing, and data analysis.

Functions performed in the data collection area will include the following:

1. Training personnel in the mechanics of implementing the provisions of the system.
2. Monitoring and evaluating activities, after the implementation of the system, to determine revisions and modifications required for conformity with Navy organization and procedures.
3. Altering time accounting and data collection forms as required to develop a standard system for data collection.

Functions performed in the data processing area will include the following:

1. Providing designated activities with the procedures and equipment required to process data.
2. Training key punch operators for necessary equipment.
3. Determining the data analysis methods to be used in the Navy Data Collection System.

The overall system will be implemented on a progressive basis. It will include all naval air activities by January 1965 and all surface forces by January 1966.

The Naval Aircraft Maintenance Program, in general, meets all the basic requirements of the Standard Navy Maintenance Management System. However, considerable modification in details will be made in order to adapt the system to universal use in the operating forces. The following discussion of the NAMP is correct as of the date of writing, and reflects changes anticipated through December 1964. However, revisions will continue to be made for years to come.

AIRCRAFT MAINTENANCE PROGRAM

In 1962, the NAMP was revamped and brought up to date with the issuance of BuWeps Instruction 4700.2 which incorporated under one cover the provisions of most directives pertaining to naval aircraft maintenance. The contents of this chapter are based on information contained in BuWeps Instruction 4700.2 (current series). This instruction is of benefit to all aviation maintenance personnel, and should be required reading for all Aviation Weapons Officers.

PURPOSE

The NAMP is designed to provide for maximum utilization of manpower, facilities, and material, and establishes a standard set of rules and guidance criteria for the accomplishment of all maintenance on naval aircraft and associated equipments. Adoption of standard maintenance practices by both fleet and shore commands is expected to greatly reduce the learning time for inexperienced and newly transferred personnel. Formal training in the Naval Air Technical Training Command is being concentrated and made more specific so that personnel assigned from schools to the operating forces or between major commands will possess a degree of familiarity with basic organization and methods not possible under nonstandardized procedures.

ORGANIZATION

The NAMP employs a standard organizational structure providing for controlled planning, direction, and logistic support, and uniform assignment of workload responsibilities to the several maintenance levels. The organizational structure of each individual activity conforms to this established standard but varies in direct proportion to the assigned level and scope of maintenance support to be provided.

Terminology concerning maintenance levels, such as class A, class B, etc., has been changed in the revision to BuWeps Instruction 4700.2, to the terminology adopted by the Department of Defense (DOD). For example, DOD terminology groups classes A and B under the heading "depot maintenance," C and D under "intermediate maintenance," and E and F under "organizational maintenance."

MAINTENANCE LEVELS AND RESPONSIBILITIES

The Department of Defense divides all aircraft maintenance into three distinct levels: depot maintenance, intermediate maintenance, and organizational maintenance. These three levels provide for a separation of the various maintenance tasks according to complexity, depth, facility and equipment requirements, personnel skills, and scope of support responsibility.

Depot Maintenance

Depot maintenance is that type of work that must be performed in an industrial type facility. Such facilities may be either military or commercial. This level of work includes overhaul and major repair and modification of aircraft, components, and equipments. It also includes the manufacture of designated aeronautical parts as system spares, and the manufacture of kits for the accomplishment of aircraft and equipment modifications. Support is servicewide.

Intermediate Maintenance

Intermediate maintenance is that type of work performed in centrally located facilities for the support of operating units within a designated area or at a particular base or station. This level of maintenance does shop type repair and test work on aircraft components and equipment from the supported units. Technical assistance, when required, is furnished to the supported operating units.

Organizational Maintenance

Organizational maintenance is work performed by the operating unit on a day to day basis in support of its own operations. Maintenance performed at this level includes line operation (servicing, preflighting, minor adjustments, etc., in preparation for flight), periodic inspections of aircraft and equipment, and the associated tests, repairs, and adjustments which do not require shop facilities. All such work is performed in facilities assigned to the operating units on either a joint or individual basis.

Selective Intermediate Maintenance

This level of maintenance is also included in DOD depot maintenance and consists of the major repair or overhaul of designated aeronautical items and the furnishing of specified technical and logistic services. This level of maintenance is performed by BuWeps designated O&R and aircraft maintenance departments of naval air stations, by certain Marine Corps maintenance organizations, and by designated naval stations supporting aviation activities. Selective intermediate functions may be assigned to activities supporting an entire logistic area or an organizational segment of the Marine Corps operating forces.

NOTE: The coverage on maintenance levels provided in this chapter is devoted primarily to the intermediate and organizational levels, as these are the basic levels to which BuWeps Instruction 4700.2 is directed. Activities performing these levels of maintenance are also the ones to which Aviation Weapons Officers will normally be assigned. An intermediate level maintenance department organization (which also applies to NARTU's) is illustrated in figure 2-1. An organizational level maintenance department organization (typical of a squadron) is illustrated in figure 2-2.

Organizational level maintenance for assigned and transient aircraft at naval air stations and naval air facilities is a responsibility of a division/branch of the operations department. (See BuWeps Instruction 4700. 2).

AIRCRAFT MAINTENANCE DEPARTMENT

The organization for aircraft maintenance departments provides firm lines of authority from the maintenance officer to personnel accomplishing the work for which the department is responsible. The term "department" is used in this text as a general term which applies fully to all maintenance activities having a department head. (In cases of maintenance activities assigned as divisions to other departments, the term "division," designating the next echelon, is used in place of department. Branches become sections and sections become units.)

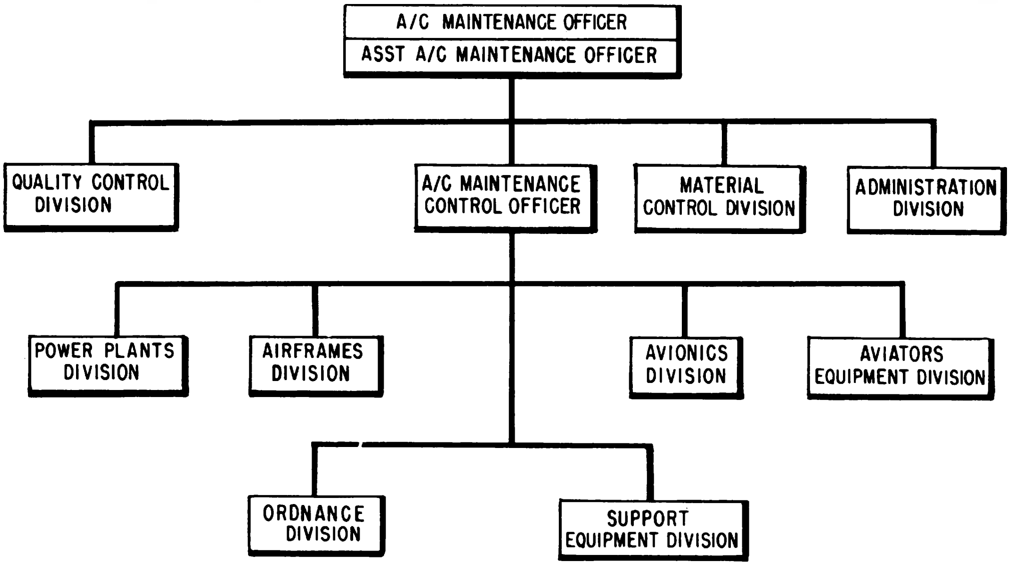


Figure 2-1.—Intermediate level maintenance department organization.

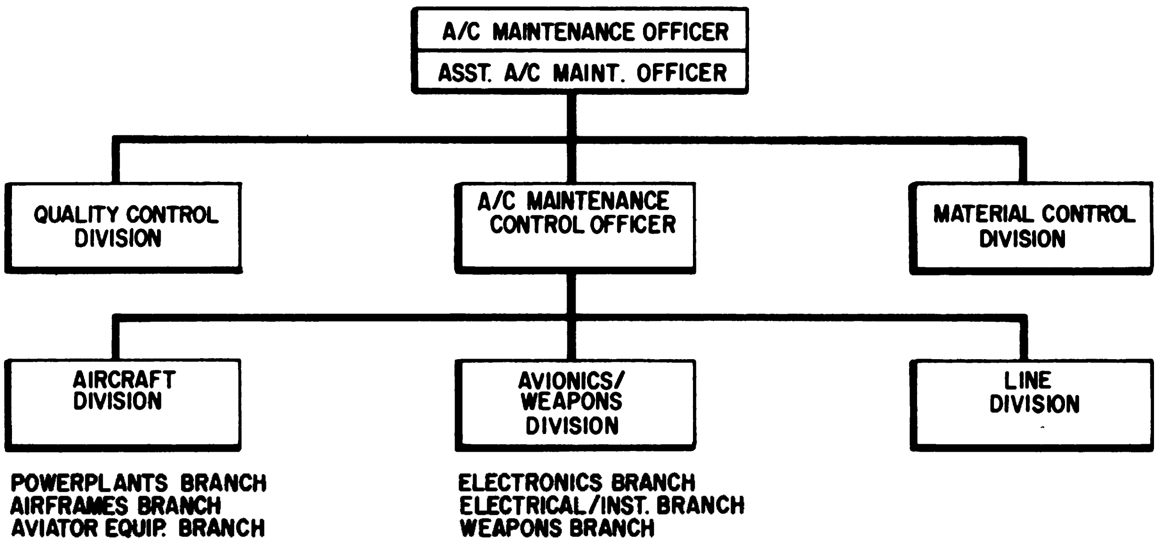


Figure 2-2.—Organizational level maintenance department organization.

All major segments of the department reporting directly to the department head are called divisions. Divisions are subdivided into branches. Basic structures for aircraft maintenance organizations are presently undergoing trial and evaluation. Consequently, some changes, variations, or deviations to present structures are anticipated. Therefore, the Aviation Weapons Officer should consult the latest changes to BuWeps Instruction 4700.2 and other applicable instructions for up-to-the-minute basic structures of maintenance organizations and allowable deviations.

The aircraft maintenance department supports naval operations by the upkeep of assigned and supported aircraft and associated support equipments to the level and depth of maintenance required. Specific functions include the following:

1. Periodic maintenance and routine inspection and servicing of aircraft, associated support equipment, and aeronautical material and components including the necessary disassembly, cleaning, examination, repair, modification, test, inspection, assembly, and preservation.
2. Special work in compliance with technical directives or local instructions.
3. Correction of discrepancies.
4. Assurance of high quality of all work.
5. Maintenance of records and technical publications.
6. Maintenance and custody of tools and other organizational equipment.
7. Training of assigned personnel.
8. Conduct of maintenance and ground handling safety programs.

STAFF DIVISIONS

Staff elements are incorporated into the organizational framework for aircraft maintenance activities for the purpose of providing services and support to the production elements. A discussion of some of the more important functions of the staff divisions is contained in the following paragraphs. A more detailed discussion of these divisions and their responsibilities is contained in BuWeps Instruction 4700.2 (current series).

Quality Control Division

The quality control concept is fundamentally the prevention of the occurrence of defects. This concept embraces all events from the start of the maintenance operation to its completion. Achievement of quality control depends on prevention, knowledge, and special skills.

Prevention is based on the concept that it is necessary to preclude maintenance failures. In the true sense, this principle extends to safety of personnel, to maintenance of equipment, and to virtually every aspect of the total maintenance effort. Prevention is concerned with the regulation of events, rather than being regulated by them.

Knowledge is derived from factual information. It introduces the practices of data collection and data analysis as means of acquiring this knowledge.

Special skills, not normally possessed by production personnel, are required in a staff of personnel trained in the techniques of data analysis and supervision of the quality control program.

The quality control program provides a systematic and efficient process for gathering and maintaining information on the quality characteristics of products and on the source and nature of defects, and their immediate impact on the current operation. It permits decisions to be based on facts rather than on intuition or memory. It further provides comparative data which will be useful long after the details of the current occasion have been forgotten. The proper functioning of quality control requires the delegation of authority and the assumption of responsibility for action. Its main objectives are to pinpoint problem areas in maintenance which can aid in the following achievements:

1. Improve the quality, uniformity, and reliability of the total maintenance effort.
2. Improve the work environment, tools, and equipment used by the production personnel.
3. Eliminate unnecessary man-hour and dollar expenditures.
4. Improve the training, work habits, and procedures of maintenance personnel.
5. Improve the quality and value of reports and correspondence originated by the activity.
6. More effectively disseminate pertinent technical information.
7. Establish realistic material and equipment requirements in support of the maintenance effort.
8. Effectively support the Malfunction Reporting Program.

Teamwork must be achieved before benefits can be obtained from a quality control program. To be effective, quality control functions must blend with the interests of the entire organization. Each individual in the department must be permitted to use an optimum amount of judgment in the course of his daily work, since his judgment plays a vital part in the quality of his work. Quality control techniques supply each person, from the worker to the commanding officer, with information on actual quality achieved. This information provides a challenge to the individual to improve the quality of his work.

The quality control division provides the department head with the quality status of work accomplished, points up areas that need particular attention, and develops more realistic inspection requirements. Primary functions performed by this division are as follows:

1. Reviews all incoming technical publications and directives affecting the department to determine their application to quality control.

2. Prepares or assists in the preparation of maintenance instructions to insure that proper direction and emphasis is given to implementing quality control.

3. Maintains the technical library for the department. Insures that each shop receives all publications applicable to their work areas, and that these are current and complete. Maintains a master file of Component Repair Data Sheets for aircraft models supported.

4. Reviews publications and directives, such as Armament Material Bulletins, Armament Material Changes, Periodic Maintenance Requirements Manuals, etc. Prepares and submits to BuWeps or other cognizant authority recommendations for revision of these documents.

5. Establishes qualification requirements for quality control inspectors and collateral duty inspectors. (Quality control inspectors are those personnel permanently assigned to the quality control division as inspectors. Collateral duty inspectors are those personnel permanently assigned to a production division who have a secondary or collateral duty assignment to inspect work accomplished within their assigned production division.) Reviews the qualifications of personnel nominated for these positions and endorses nominations to the department head. Maintains a record of all designated inspectors.

6. Reviews work orders, inspection sheets, and "yellow sheets," and notes unnecessary and/or recurring discrepancies requiring special action.

7. Obtains and utilizes appropriate inspection equipment, such as lights, mirrors, magnifying glasses, dye penetrant kits, tensiometers, pressure gages, carbon monoxide testers, etc.

8. Periodically accompanies collateral duty inspectors on assigned inspections and rechecks their qualifications.

9. Insures that established standard procedures are observed for conducting ground tests and preflight, special, and periodic inspections. Checks the performance of this work to insure that the desired quality level is obtained.

10. Insures that all work guides, checkoff lists, checksheets, flight test forms, etc., used to define or control maintenance operations, are complete and current.

11. Insures that each test pilot and/or aircrew is briefed prior to test flights so that the purpose and objectives of the flight are clearly understood.

12. Reviews all FUR entries, explanations, and descriptions, to insure that they are accurate, clear, concise, and comprehensive.

13. Insures that the configuration of aircraft, aircraft components, and support equipment is such that all essential modifications have been incorporated. This responsibility necessitates review of appropriate logbooks.

14. Spot checks equipment received for use, returned for repair, or held awaiting repair, to insure its condition, identification, packaging, preservation, and configuration are satisfactory and, when applicable, that shelf life limits are not exceeded.

15. Performs inspections of maintenance equipment to insure compliance with calibration and safety instructions.

16. Performs technical inspections of all maintenance equipment and facilities to insure compliance with fire and safety regulations, the existence of satisfactory environmental conditions, and proper qualification of equipment operators and drivers.

17. Provides for the continuous on-the-job training of all inspectors in the techniques and procedures pertaining to the conduct of inspections.

18. When directed, provides technical task forces to study trouble areas and submit recommendations for corrective action.

19. Maintains adequate records and data on discrepancies to enable establishment of trends with the specific objective of determining when discrepancies in any area are increasing.

20. Maintains liaison with contractor, Naval Aviation Engineering Service Unit (NAESU) representatives, Bureau of Naval Weapons Fleet Readiness Representatives (BUWEPSFLTREADREPS), and other available field technical services. Establishes and maintains liaison with other maintenance activities and rework points, in order to obtain information on ways for improving maintenance techniques, quality of workmanship, and quality control procedures.

Material Control Division

In order to maintain an effective aircraft maintenance program, a cooperative working relationship between production and supply personnel must exist. Without an adequate material and supply program, effective maintenance of a complex weapons system cannot be accomplished. The material control division is responsible for the establishment and functioning of the supply program.

The material control division provides material support to the department by accomplishing the following functions:

1. Plans, requisitions, and expedites the flow of material needed to support the workload.
2. Maintains liaison with the supporting supply department on maintenance material matters to insure that material needs of the maintenance department are satisfied.
3. Compiles and analyzes maintenance usage data.
4. Coordinates its actions with the quality control division for determining the quality and condition of material and spare parts received Ready for Issue (RFI).
5. Furnishes technical advice and information to the supply department on the identity and quantity of supplies, spare parts, and materials necessary to accomplish the assigned workload.
6. Establishes standard operating procedures which will insure the inventory of tools and the adequate accountability of material and equipment.
7. Initiates surveys in the event of loss, damage, or destruction of accountable items of material and/or equipment.
8. Keeps the aircraft maintenance officer advised of the overall supply situation as it affects the department.
9. Verifies requisitions for AOCP (Aircraft Out of Commission for Parts) and ANFE (Aircraft Not Fully Equipped) materials; and maintains, by aircraft serial numbers, current AOCP and ANFE status.
10. Recommends and controls cannibalization in accordance with applicable directives when such action is deemed advisable and in the best interest of the operation.
11. Performs Cost and Allotment Record Accounting, charting, and budgeting of costs.
12. Records and reports custody materials.
13. Returns prospective RB/RE material and locally repaired RFI material to supply.
14. Monitors the operation of toolrooms, and maintains support equipment allowance lists.
15. Obtains, controls, and reports authorized allowances of material.
16. Inventories aircraft upon receipt and transfer. Insures that inventory log entries are made, authenticated, and corrected.
17. Establishes an Aeronautical Material Screening Unit (applies to intermediate level maintenance activities only). Two categories of personnel are used in screening units—administrative personnel and technical personnel. The screening of material must be in accordance with the procedures promulgated by the aircraft maintenance officer.

Administration Division

The administration division pertains to intermediate level maintenance activities only, and accomplishes the following specific functions:

1. Establishes and controls a central reporting and recordkeeping system for all maintenance reports and correspondence.
2. Implements all directives concerning distribution, retention, and disposition of records, reports, and logs.
3. Provides clerical and administrative services for the department.
4. Receives and controls department correspondence.
5. Reproduces as necessary and distributes incoming messages and other data.
6. Maintains all correspondence and reports files for the department except for those special reference files maintained by each division or branch.
7. Supervises and coordinates department administrative responsibilities with other departments or divisions as required.
8. Conducts liaison with the administration department regarding maintenance department personnel matters.
9. Distributes personal mail to department personnel.
10. Makes proper distribution of all nontechnical information and publications.
11. Publishes and distributes approved locally issued maintenance directives, procedures, reports, and studies.
12. Controls classified material required by the department.

13. Supervises the department's man-hour accounting system.

14. Establishes and coordinates the department training requirements. Obtains necessary school quotas to support these requirements.

15. Assigns spaces to the various divisions and establishes the responsibility for security and cleanliness of such spaces.

16. Assumes responsibility for the cleanliness and security of vacant or unassigned aircraft maintenance spaces.

17. Arranges department participation in joint inspections of facilities assigned to tenant activities, especially incident to the departure of a tenant activity.

NOTE: In activities where organizational maintenance is the highest level of aircraft maintenance performed, the organization (fig. 2-2) does not provide for a separate administration division. In such activities the functions of the administration division are the responsibility of the assistant aircraft maintenance officer.

Maintenance Control Office

The aircraft maintenance control officer is responsible for the production effort of the department. Among his general responsibilities are those of establishing and exercising control and coordination of actions of the production divisions. Such control and coordination insures prompt movement of aircraft, parts, and materials and promotes harmony and cooperation. In discharging assigned responsibilities, the aircraft maintenance control office does the following:

1. Receives work requests from supported activities, and plans and schedules the accomplishment of the work.

2. Plans and schedules assigned aircraft through all phases of maintenance.

3. Initiates work orders to the production divisions for scheduled and unscheduled maintenance as required, assigning priorities and completion times.

4. Performs progress checks on work assigned.

5. Maintains the aircraft status board and keeps cognizant divisions informed of the status of aircraft.

6. Maintains a "Worksheet of Daily Transactions Reflecting Non-Ready Hours" as set forth in the Aircraft Accounting System, OpNav Instruction P5442.2A.

7. Prepares necessary aircraft parking plans and movement schedules.

8. Maintains aircraft logs (except inventory logs) in accordance with current directives.

9. Insures that Maintenance Instructions (CAMI, SAMI, and TIMI) are prepared when required, and provides the necessary control to insure compliance by cognizant divisions.

10. Maintains master files of completed work orders and maintenance instructions.

PRODUCTION DIVISIONS

The production divisions of an operating squadron performing maintenance functions include the aircraft division, avionics/weapons division, and line division. (See fig. 2-2). For maintenance activities performing intermediate level maintenance, the production divisions comprise the LOX, powerplants, airframes, avionics, ordnance, aviator equipment, photographic, and support equipment divisions. This organization is shown in figure 2-1.

Support Equipment Division

The support equipment division performs the following functions:

1. Initiates action to obtain the authorized allowance of support equipment, including items for subcustody to tenants.

2. Performs intermediate level maintenance on all support equipment for which the department is the authorized custodian. (The user performs organizational level maintenance.)

3. Performs component repair of items which have been removed from support equipment. Separate facilities are not established when they exist in the shops division.

4. Institutes a vigorous preventive maintenance program on all items of support equipment.

5. Administers the program for subcustody of support equipment to other divisions of the maintenance department and tenant activities.

6. Initiates requests to the maintenance control office for unscheduled work as required.

The support equipment division is applicable to those activities operating under an organization conforming to that illustrated in figure 2-1. In operating squadrons, when responsibilities relative to operation and maintenance of ground support equipment are extensive, the commanding officer is authorized to establish a ground support equipment branch. After considering the application of the ground support equipment being maintained, he assigns this branch to the appropriate production division.

Aircraft Division

The aircraft division (organizational level maintenance activities only) consists of the airframes, powerplants, and aviator equipment branches. This division accomplishes the following functions:

1. Coordinates and completes periodic maintenance and inspections.
2. Performs organizational level maintenance tasks as authorized in the airframes, powerplants, and aviator equipment areas.
3. Continuously advises the aircraft maintenance control officer of the status of work progress.
4. Insures cleanliness of hangar and assigned spaces.
5. Nominates personnel for assignment as collateral duty quality control inspectors.
6. Initiates requests for material required for the accomplishment of assigned tasks.
7. Assumes custody for tools and support equipment assigned to the aircraft division.
8. Interprets applicable directives and prepares (in draft form) maintenance instructions to implement such directives.
9. Recommends changes in techniques to promote maximum ground safety, safety of flight, and operational readiness of aircraft.
10. Initiates requests to the maintenance control office for unscheduled work.
11. Provides troubleshooters and aircrew members, as required, and exercises technical supervision over such personnel.
12. Expedites the accomplishment of assigned work through the continuous evaluation of methods and procedures, and incorporates new techniques as appropriate.

Avionics/Weapons Division

The avionics/weapons division (organizational level maintenance activities only) accomplishes the following functions:

1. Assigns personnel required to accomplish scheduled periodic maintenance and inspection of assigned aircraft. (The aircraft division is responsible for the coordination and completion of periodic maintenance and inspections.)
2. Performs organizational level maintenance tasks in the avionics and ordnance areas.
3. Advises the aircraft maintenance control officer of the status of work progress.
4. Assumes custody and accountability for assigned tools and support equipment.
5. Initiates requests for material required for the accomplishment of assigned tasks.
6. Nominates qualified individuals for assignment as collateral duty quality control inspectors.
7. Interprets applicable directives and prepares (in draft form) maintenance instructions to implement such directives.
8. Recommends changes in methods and techniques to promote optimum ground safety, safety of flight, and operational readiness of aircraft.
9. Initiates requests to the maintenance control office for unscheduled work.
10. Provides troubleshooters and aircrew members as required.
11. Expedites the accomplishment of assigned work by continuous evaluation of methods and procedures, and incorporates new techniques as appropriate.

AIRCRAFT INSPECTION SYSTEM

Inspections, varying in scope, purpose, and frequency, are performed on naval aircraft to insure that assigned aircraft are retained in a serviceable condition.

MAINTENANCE INSPECTIONS

Maintenance is the function of retaining material in, or restoring it to, a serviceable condition. Types of inspections which are performed by activities responsible for the maintenance of naval aircraft are as follows:

1. Acceptance Inspections. A minimum acceptance inspection consists of an inventory of installed material and loose gear, configuration verification, functional test of appropriate emergency systems, and a thorough daily inspection. Accepting activities may elect to increase the depth of inspection if the aircraft conditions warrant.
2. Daily Inspection. Daily inspections are accomplished between the last flight of the day and the next scheduled flight, if no more than

72 hours elapse between the inspection and the next scheduled flight If more than 72 hours elapse between the inspection and next flight, the inspection must be repeated. This inspection is basically a combination of requirements for checking equipment that requires a daily verification of satisfactory functioning, plus requirements that prescribe searching for and correction of relatively minor problems to preclude their progression to a state that would require major maintenance to remedy. Other items which require inspection more frequently than is prescribed for intermediate inspections are also included on the daily inspection and are accomplished along with the daily inspection on the day they become due.

3. Preflight Inspection. The preflight inspection consists of checking the aircraft for flight preparedness by performing visual examinations and operational tests to discover defects and maladjustments that, if not corrected, would cause accidents or aborted missions.

4. Intermediate Inspection. The intermediate inspection is a limited overall examination of the condition of the aircraft. The inspection includes certain requirements that are also applicable to the daily or preflight inspection and requirements that must be applied at periods occurring more frequently than major inspections.

5. Major Inspection. The major inspection is a thorough and searching inspection of the aircraft. This inspection includes certain requirements that are also applicable to the daily, preflight, and intermediate inspections.

6. Special Inspection. A special inspection is an inspection which either does not have a prescribed interval for inspection and depends upon occurrence of certain circumstances or conditions, or has an interval other than the standard inspection cycle.

7. Pilot's Aircraft Inspection. This inspection is accomplished as directed by the controlling custodian and BuWeps Instruction 4700.2.

Of the foregoing inspections the most extensive as well as time consuming are the intermediate and major periodic inspections. The appropriate intermediate or major inspection is conducted on the expiration of a specified calendar interval. When aircraft are inspected under this system, the workload planning operation is simplified and the scheduled maintenance in process is automatically stabilized. Because of this, naval aircraft are inspected on the calendar inspection system.

The first inspection interval subsequent to Navy acceptance of a new aircraft under this inspection system commences on the date of acceptance. An intermediate inspection is performed at the completion of the first interval of service with subsequent inspections performed in the sequence prescribed by the applicable Periodic Maintenance Requirements Manual.

Since all standard rework processes include the equivalent of a major inspection, the first inspection interval subsequent to standard rework commences on the date of accomplishment of the flight test following rework. After the first interval following standard rework, an intermediate inspection is required. Subsequent inspections are performed in the sequence prescribed in the applicable Periodic Maintenance Requirements Manual.

During special rework, the rework activity performs the next inspection if it falls due while in rework. Periodic inspections subsequent to special rework, therefore,continue in the sequence prescribed in the applicable Periodic Maintenance Requirements Manual. All periodic inspections accomplished by rework activities are noted in the Aircraft Log Book and the Aeronautical Equipment Service Record.

CALENDAR INSPECTIONS

Aircraft are inspected on the calendar interval authorized by current BuWeps instructions or on an adjusted interval as specified by the controlling custodian. The calendar intervals are computed on the basis of 52 weeks.

The calendar inspection system is placed into operation by dividing the number of aircraft assigned into the authorized inspection interval and programing work accordingly. For example, a 12-aircraft squadron operating a model aircraft that is assigned a 13-week inspection interval could induct an aircraft into check every week for 12 successive weeks, and then leave 1 week with no induction, as illustrated in figure 2-3.

All periodic inspections are computed from induction date to induction date, regardless of the number of days consumed performing the inspection.

To meet unusual situations, a period of plus or minus 1 week, or portion thereof, may be applied to the authorized calendar inspection interval; however, each deviation must be approved by the commanding officer or the officer in charge (not delegated) and applies only to the immediate inspection due. Successive deviations, if required, are computed from the date on which the inspection would have been due if the preceding deviation had not been granted.

To eliminate peaks and valleys in the workload, the overall pattern of inspections of all aircraft should be one of alternating intermediates and majors. Induction of new and reworked aircraft into an established calendar inspection schedule may require repeating or performing an otherwise unnecessary inspection

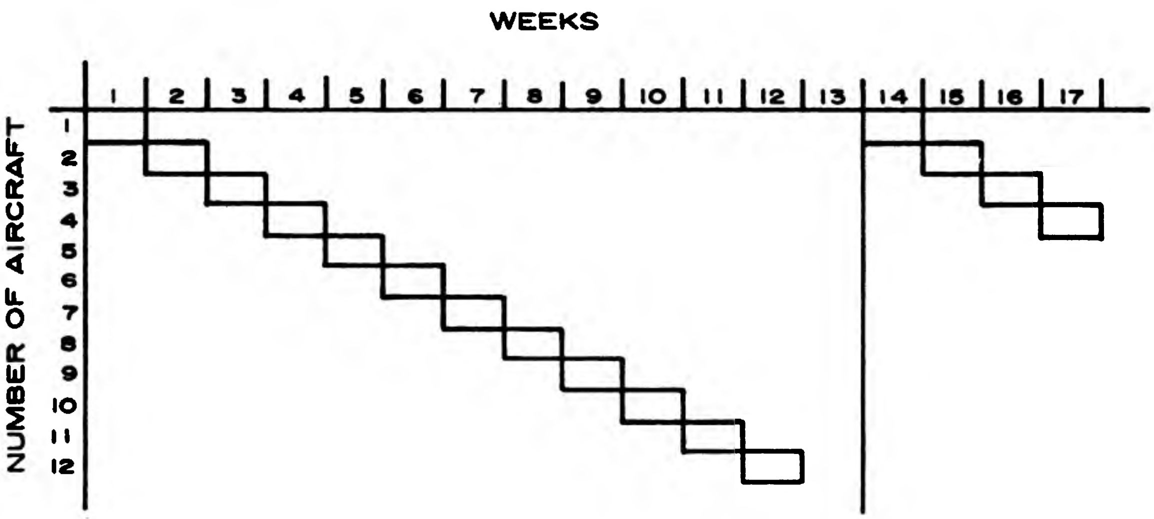


Figure 2-3. —Typical 12-aircraft squadron on a 13-week inspection interval.

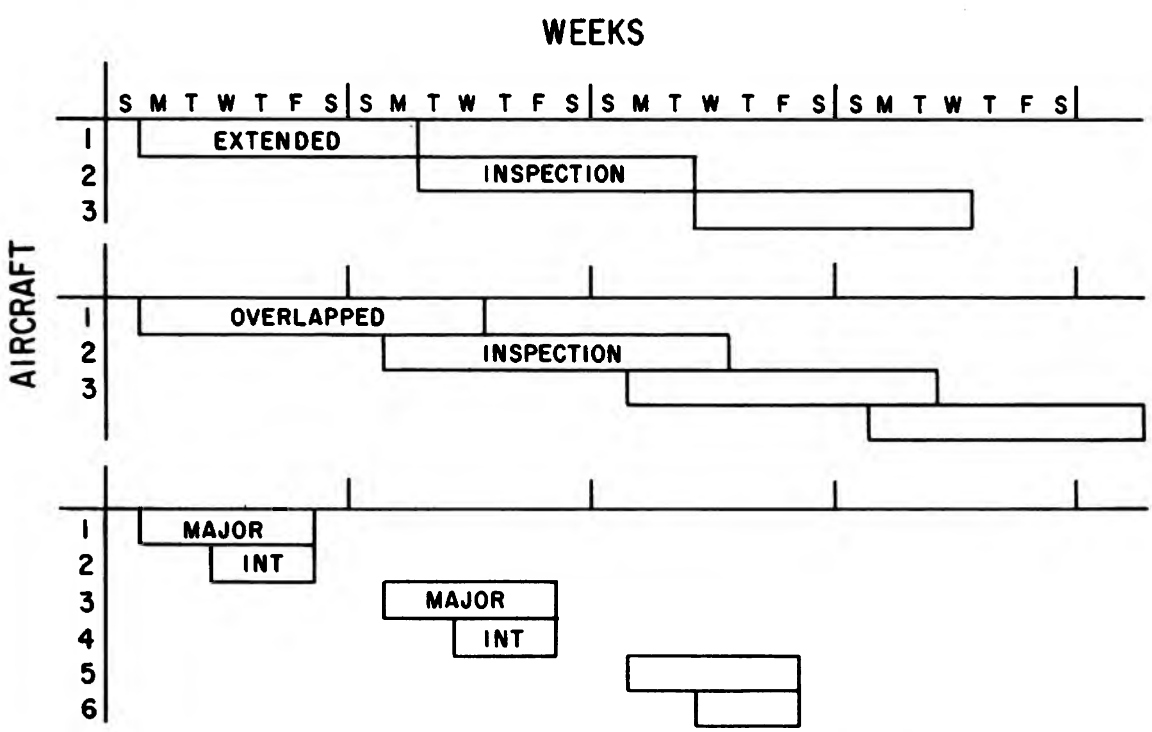


Figure 2-4.—Examples of induction date scheduling.

to insure that the scheduled workload pattern remains one of alternating intermediate and major inspections. (See figure 2-4 for some examples of induction into the inspection cycle.) Newly received aircraft are required to be firmly established in the calendar inspection schedule within a period not to exceed one inspection interval.

Reporting custodians are authorized under current instructions to increase the depth of any inspection but not to decrease it. Whenever the depth of an inspection is increased to meet unusual or special circumstances, the inspection is recorded only as the type which was due in accordance with the programed sequence. Special periodic inspections to an appropriate depth may be ordered by the reporting custodian whenever excessive utilization during the operating interval is considered to have impaired the material reliability or integrity of the aircraft. Such inspections are in addition to programed requirements and in no way affect the requirement for the accomplishment of the next regularly scheduled inspection.

Special inspections specified in the applicable Periodic Maintenance Requirements Manual are performed concurrently with scheduled calendar periodic inspections when the time authorized for the special inspection is not exceeded. When the time interval will be exceeded during the calendar period inspection interval, the special inspection is accomplished as part of the scheduled daily inspection falling nearest to the requirement.

Scheduled replacement of lifetime components is normally accomplished during the inspection falling nearest the hourly limitation. To facilitate maximum replacement in accordance with the foregoing, a deviation of plus or minus 10 percent of the stated operating time is permissible. When the hourly limitation plus or minus 10 percent does not coincide with a calendar inspection, the replacement is usually performed during the scheduled daily inspection nearest the hour limitation.

LIMITATIONS

Reporting custodians of aircraft are required under existing directives to submit a report to the controlling custodian on each aircraft that reaches a specified number of flight hours between inspections. The number varies with the aircraft model.

Controlling custodians evaluate the information received and take whatever action might be indicated. This action may include the adjustment of the calendar inspection cycles for individual reporting custodians in such a manner that the aircraft involved will be inspected on a more frequent basis.

MAINTENANCE FORMS AND RECORDS

Effective accomplishment of aircraft maintenance requires thorough familiarity with numerous maintenance forms and records. Some of these are discussed in other chapters of this text. Those discussed in the following paragraphs are Maintenance Instructions, Work Order and Work Accomplishment Records, Aeronautical Material Work Orders, Work Requests, aircraft status boards, and test flight forms used in post-maintenance flight tests.

MAINTENANCE INSTRUCTIONS

NavWeps Form 4710/8 (fig. 2-5) is available for use of maintenance administrators as the standard form for the interpretation and/or amplification of technical directives and maintenance requirements received from higher authority or to implement local instructions. It is usually prepared by the cognizant division; however, it may be drafted by any division designated by the aircraft maintenance officer. A review of the draft should be conducted by the quality control officer as well as the maintenance control officer prior to approval by the aircraft maintenance officer.

The Maintenance Instruction must be prepared carefully, with attention to the precept that it is the instrument by which the division officer directs his men. Command directives in the form of messages are often so brief that they need considerable amplification and background information to be understandable at the working level. On the other hand, directives in letter form may be received that have been prepared for all aviation activities and are lengthy and detailed. Only parts of these directives may be applicable locally, and they need condensation and selection to adapt them to local conditions. Three purposes for which the Maintenance Instruction may be used are as follows:

1. Work of a one-time nature, which requires the issuance of a Single Action Maintenance Instruction (SAMI).

A)

MAINTENANCE INSTRUCTION
NAVWEPS FORM 4710/8 (5-62)

☐ TECHNICAL INFORMATION ☒ SINGLE ACTION ☐ CONTINUING ACTION

ORIGINATING ACTIVITY	DATE	MAINTENANCE INSTRUCTION NO.
VF-102	20 Nov 1964	SAMI 62-53

SUBJECT

Modification, Missile Wing Unlock Mechanism (on missile pylon).

REFERENCE

F-4B Aviation Armament Change (F4H Aircraft Service Change) No. 58

APPLICATION

Applicable F-4B aircraft in custody of VF-102

ACTION

1. Install F-4B Airframe Change in accordance with instructions contained in F4H Aircraft Service Change No. 58.
2. Man-hours; 1 man: 2 hours.

WHEN TO BE DONE

Routine action - next intermediate inspection or as directed.

MATERIAL REQUIRED	MATERIAL ORDERED ON REQUISITION NO.
Kit 4, F4H-ASC-58, Stock No. R1510-1-F4H-C96(4 per a/c)	

WORK RESPONSIBILITY	LOG BOOK ENTRY (ENTRIES) REQUIRED
Ordnance	☒ YES *(State entry required)* In Technical Directives Section of NavAer-418 ☐ NO

SUBMITTED BY *(Signature of Division Officer)*	APPROVED BY *(Signature of Maintenance Officer)*
E. B. Cloud E. B. Cloud, Lt., USN	I. M. Moore I. M. Moore, CDR, USN

(See instructions on reverse)

Figure 2-5.—Maintenance Instruction, NavWeps Form 4710/8. (A) Front page.

(B)

This section to be used in case of single action

BUNO OR SERIAL NO.	DATE COMPLETED
148265	3/4/63
148272	3/11/63
148365	4/8/63
148378	4/29/63
148396	4/22/63
149404	5/11/63
149413	4/5/63
149445	7/15/63
148413	9/16/63
148370	
149423	

INSTRUCTIONS

Check appropriate box for Technical Information, Single Action or Continuing Action Maintenance Instruction.

Enter name of the squadron or activity preparing Instruction.

Enter date Instruction is prepared.

Enter number for identification and filing purposes. Separate sets of annual consecutive numbers shall be established for Technical Information, Single Action and Continuing Action Maintenance Instructions.

Enter brief, accurate description of the general action required.

Enter identification number and title of the directive that is the basis for this Instruction.

Enter models of aircraft or nomenclature of equipment affected.

Enter a complete, concise set of instructions for the performance of the action required. If the instructions are lengthy and involved, reference may be made to the requiring directive for information, in which case it must be attached to and made a part of the Instruction.

Enter when the specified action is to be taken; in what situation; following what occurrence; in connection with what other work; or a calendar deadline, as appropriate.

Identify material required to comply with this Instruction by part number and nomenclature.

If material must be ordered, enter the requisition number. If material request is not necessary, so indicate.

Enter division or divisions responsible for performance of the required action.

Check appropriate box. If a log book entry is required, a verbatim entry shall be provided for the guidance of the person making the entry. The SAMI or CAMI shall show location in log book of such entry.

Enter signature of the division officer who prepared the Instruction.

Enter signature of the Maintenance Officer or his assistant signifying his approval of the content and preparation of the Instruction.

"BuNo or Serial No." and "Date Completed" columns are used only in the case of Single Action Maintenance Instructions. The former will indicate each individual aircraft or piece of equipment subject to the required action, and the Records and Reports Division will use the latter for entering the date of completion of the action to provide a control for planning and record purposes.

NAVWEPS FORM 4710/8

Figure 2-5. —Maintenance Instruction, NavWeps Form 4710/8. (B) Back page.

2. Work that may recur at intervals, for which a Continuing Action Maintenance Instruction (CAMI) is issued.

3. When the need arises to disseminate technical information within the activity, a Technical Information Maintenance Instruction (TIMI) is issued.

Single Action Maintenance Instruction

When work ordered is such that it will be completed on one aircraft or piece of equipment by carrying out the instructions set forth, and will not require further action at any time or in any situation on that aircraft or piece of equipment, it is properly the subject of a SAMI; for example, an Airframe Change on all bureau numbers of a certain model of aircraft.

Continuing Action Maintenance Instruction

A CAMI is issued when the work ordered may be required to be repeated at intervals on the same aircraft or piece of equipment due to elapsed time or as a result of the peculiarities of some particular piece of equipment.

Technical Information Maintenance Instruction

A TIMI may be prepared when a directive or situation dictates that technical information be promulgated within the activity. When it is necessary to disseminate information, such as techniques and local policy, which does not direct the accomplishment of specific work at

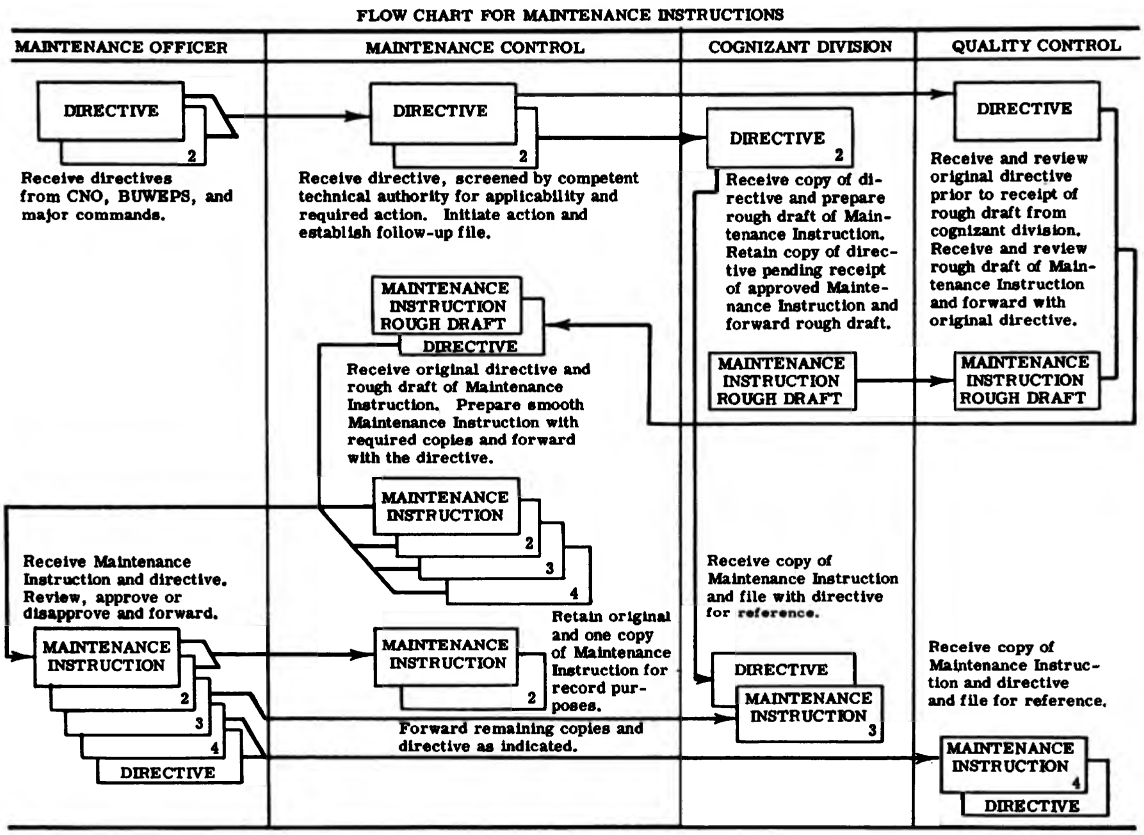


Figure 2-6.—Flow chart for Maintenance Instructions.

defined intervals but which is sustaining in nature, a TIMI may properly be issued; for example, procedures and techniques for aircraft fueling.

A separate numbering system is set up for each type of Maintenance Instruction (SAMI, CAMI, or TIMI) for file control purposes and, in the case of SAMI and CAMI, for cross-reference on work orders. Each supporting work order merely carries the serial number of the Maintenance Instruction rather than a repetition of the work description. Detailed instructions for preparing the Maintenance Instruction are printed on the back of the form. It is essential that central control of all directives from higher authority be maintained and that local working documents be prepared which will accurately interpret such directives in terms understandable to the workers. Figure 2-6 shows a flow chart for Maintenance Instructions.

WORK ORDER AND WORK ACCOMPLISHMENT RECORD

A Work Order and Work Accomplishment Record (WOWAR), NavWeps Form 4710/5, is prescribed and provided for use of aircraft maintenance activities to facilitate the direction and control of the maintenance operation as well as to record the accomplishment of completed work. The form further provides information which may be used for developing accurate job time estimates for scheduling purposes. These forms are provided in unit sets comprising an original and three copies, each having a different color. The original is white; the copies are pink, yellow, and green.

This form and procedures related to its use represent an improvement in the line of communication between the staff and production divisions of the aircraft maintenance department. The preparation and completion of the form is described in BuWeps Instruction 4700.2. Figure 2-7 (A) illustrates the front of the WOWAR form and figure 2-7 (B) illustrates the back. A flow chart which depicts the use of the WOWAR is shown in figure 2-8.

AERONAUTICAL MATERIAL WORK ORDER

An Aeronautical Material Work Order, NavWeps Form 4710/6 (fig. 2-9), is provided for the use of aircraft maintenance activities to facilitate the direction and control of component and equipment repair as well as to record the accomplishment of completed work. The form further provides information which may be used for developing accurate job time estimates for scheduling purposes. This form is not used to direct the removal of an item from or replacement of an item on an aircraft. Work Order and Work Accomplishment Record form is properly used for this purpose. The Aeronautical Material Work Order has been specifically devised so that it may be originated from any one of three organizational elements within a maintenance activity. These elements are as follows:

1. Workload scheduling in the maintenance control office.
2. Any division or shop to direct and control work within that division or shop.
3. The material control division when directing component repair maintenance.

Detailed instructions for preparing the Aeronautical Material Work Order are contained on the back of each form. The form is prepared in duplicate so that the originator may retain a copy for control purposes.

WORK REQUEST

NavWeps Form 4710/7 (fig. 2-10) has been provided for use as a work request form. The Work Request is originated by a maintenance activity when requesting specific work beyond its capability from a supporting activity. The supporting activity reviews the request and approves or disapproves. If the request is approved, a work order is issued and the requesting activity is notified when the work is completed. If the request is disapproved, the reason therefor is entered on the Work Request and it is returned to the originator. Detailed instructions for preparing the Work Request are printed on the back of the form.

AIRCRAFT STATUS BOARD

This board is maintained to provide a visual presentation of current status information on all aircraft assigned to an activity. The aircraft status board, such as the one depicted in figure 2-11, should be of suitable size and material to display sufficient information so that interested personnel can quickly ascertain the essential facts.

(A)

WORK ORDER & WORK ACCOMPLISHMENT RECORD
NAVWEPS FORM 4710/5 (5-62)

VF 102
(Activity)

WORK ORDER NO. 64-B601

ROUTE TO:

ASSIGNMENT AND AUTHORIZATION

TYPE A/C	SIDE NO.	BUNO	DATE/TIME	ACTION DIVISION/SHOP	WORK AUTHORIZED *(Signature)*
F-4B	AF 12	148413	5/10 1340	AO SHOP	E. B. Winkler AOCM

WORK ORDER DATA

A/C STATUS	PRIORITY	FLIGHT TEST	YELLOW SHEET—SIGNATURE REQUIRED
☒ DOWN ☐ UP	☒ ROUTINE ☐ URGENT ☐ DEFERRED	☐ YES ☒ NO	☐ YES ☒ NO

DISCREPANCY AND/OR WORK DESCRIPTION

1. Jettison circuit to Aero 27A bomb rack operates intermittently
2. perform periodic check of Aero 27A bomb rack.

SPECIAL INSTRUCTIONS, REFERENCES OR DIRECTIVES

1 Clean, lubricate, repair or replace components as required
2 Request operational check on next flight

Pilot reported satisfactory operation 5/11/64 0935

ASSIST DIVISION/SHOP	DATE/TIME	MAN-HOURS	SIGNATURE

Figure 2-7. —Work Order and Work Accomplishment Record. (A) Front page.

(B)

TECHNICAL DATA

PARTS REPLACED (Nomenclature)	SERIAL NUMBERS OLD PART	SERIAL NUMBERS NEW PART	REASON FOR REPLACEMENT	FUR (No.)
none				

WORK ACCOMPLISHMENT RECORD

WORK ACCOMPLISHED (In detail)

1. disassembled ejector mechanism
2. Cleaned, inspected, lubricated and reassembled.
3. Performed routine tests and operational checks as prescribed in NavWeps 01-245FDB-2-7

ACTION DIVISION/SHOP	WORK ACCOMPLISHED BY (Signature)	DATE/TIME	MAN-HOURS	SUPERVISOR'S SIGNATURE
	R.W. Smith AO3	5/10 1730	1-6	M.F. Arenbaugh AOCS

INSPECTOR

R. S. Brown AO1 (Signature) — 5/10 1740 (Date/Time)

YELLOW SHEET

☐ SIGNED OFF ☐ NOT REQUIRED

AIRCRAFT NOT READY DATA (Notify Maintenance Control)

DATE/TIME	SUPPORT EQUIP.	ADMP	ANFE
START			
END			

ADMINISTRATIVE ACTION
(Circle "action" item in each block and initial when complete)

STATUS BOARD	FLIGHT TEST	WEIGHT & BALANCE	FUR INITIATED	LOG BOOK ENTRY
POST (NOT REQ'D)	COMPLETE (NOT REQ'D)	COMPLETE (NOT REQ'D)	COMPLETE (NOT REQ'D)	(NOT REQ'D) AIRCRAFT / ENGINE / ACCESSORY & COMPONENT

OTHER ACTION (Specify)

Operational check on next flight

NO FURTHER ACTION REQUIRED E. B. Winkler AOCM. (Signature)

NAVWEPS FORM 4710/5 (5-62) (BACK)

Figure 2-7. —Work Order and Work Accomplishment Record. (B) Back page.

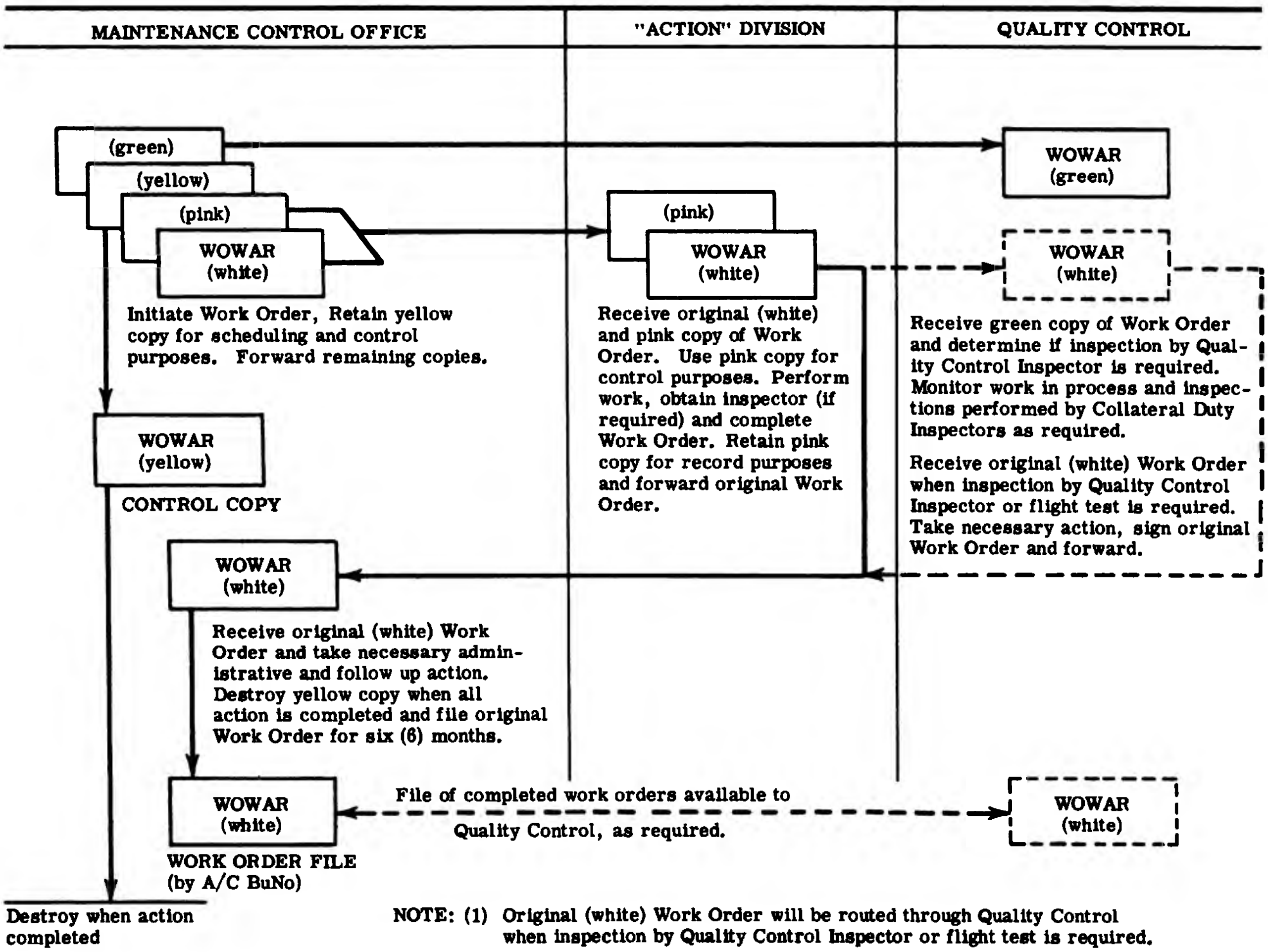


Figure 2-8.—Flow chart for Work Order and Work Accomplishment Record.

(A)

AERONAUTICAL MATERIAL WORK ORDER
NAVWEPS FORM 4710/6 (5-62)

VF 74
(Activity)

WORK ORDER CONTROL NO. 482

ASSIGNMENT AND AUTHORIZATION

ORIGINATOR	ACTION DIVISION/SHOP	DATE/TIME	SIGNATURE
☐ MAINTENANCE CONTROL			
☐ MATERIAL CONTROL DIVISION			
☒ DIVISION Avics/Weps	Ordnance	2/8/64 1100	R. S. Brown ADCS

WORK ORDER DATA

COMPONENT/ EQUIPMENT IDENTIFICATION	NOMENCLATURE Missile Jettison Switch assembly	SERIAL, PART OR TYPE NUMBER 146

DISCREPANCY AND/OR WORK DESCRIPTION

1 Fuse F3 in Jettison circuit blows repeatedly

JOB PRIORITY		DEADLINE	ESTIMATED MAN-HOURS
☐ ROUTINE	☒ URGENT	2/3/64 1530	2.0

WORK ACCOMPLISHMENT RECORD (*Also see Technical Data on reverse*)

WORK ACCOMPLISHED - IN DETAIL

1. Replaced shorted capacitor C12
2. Replaced fuse F3

WORK COMPLETED (*Date/time*)	(*Man-hours*)	INSPECTOR'S SIGNATURE	
2/3/64 1430	1.5	C. W. Jones AOC	☒ CERTIFIED RFI
ACCOMPLISHED BY (*Signature*) A. D. Barbour AO2		DIVISION/SHOP SUPERVISOR (*Signature*) R. S. Brown ADCS	

ADMINISTRATIVE ACTION

ACCESSORY AND COMPONENT SERVICE RECORD ENTRY	☒ NOT REQUIRED	☐ ENTERED	(*Date*)	(*Signature*)
FUR/EFR	☒ INITIATED ADB	☐ COMPLETED		☐ NOT REQUIRED

OTHER ACTION (*Specify*)

MATERIAL DISPOSITION (*Specify*)	NO FURTHER ACTION REQUIRED
To be replaced in Buno 148413	G. W. Gerber AO1 (*Signature*)

Figure 2-9.—Aeronautical Material Work Order, NavWeps Form 4710/6. (A) Front page.

(B)

INSTRUCTIONS

ASSIGNMENT AND AUTHORIZATION - The "originator" enters the activity name, assigns a work order control number, and identifies the originator by checking the appropriate box. The originating authority also enters the "Action" Division/Shop, the date and time the work order is issued, and an authorizing signature.

WORK ORDER DATA - The "originator" enters the nomenclature and the serial, part or type number of the material and briefly describes the discrepancy or work required. If the work order does not accompany the material, the location of the job should be indicated. The "originator" may also indicate a "job priority" and "deadline", if applicable, as well as an estimate of the man-hours required to complete the work.

WORK ACCOMPLISHMENT RECORD - The man completing the work enters a detailed description of the work accomplished, the completion date and time, and the total man-hours expended, and signs under "Accomplished by". Space is provided for the signature of a designated inspector and an indication if the material has been certified "Ready for Issue" (RFI). Space is also provided for the signature of the Division/Shop Supervisor.

ADMINISTRATIVE ACTION - This section is self-explanatory and is completed by the "originator." The purpose of this section is to insure that all administrative action is completed prior to certification of "No Further Action Required."

TECHNICAL DATA

(This section is self-explanatory and, if applicable, is completed by the man assigned to the job.)

PARTS REPLACED *(Nomenclature)*	PART/REF. SYMBOL NO. OLD PART	PART/REF. SYMBOL NO. NEW PART	REASON FOR REPLACEMENT	FUR/EFR NO.
CAPACITOR C12			SHORTED	FUR 113
FUSE F3			BLOWN	

WORK ACCOMPLISHMENT RECORD *(Cont'd from front)*

WORK ACCOMPLISHED - IN DETAIL

NAVWEPS FORM 4710/6 (5-62 (Back))

Figure 2-9. —Aeronautical Material Work Order, NavWeps Form 4710/6. (B) Back page.

(A)

WORK REQUEST
NAVWEPS FORM 4710/7 (5-62)

TO: AMD SANFORD	DATE: 6 JUNE 1964
ORIGINATING ACTIVITY: VAH-5	WORK REQUEST NO.: 6-64

JUSTIFICATION FOR WORK REQUESTED: BEYOND CAPABILITY OF ORGANIZATIONAL MAINTENANCE ACTIVITY. A-3B AVIATION ARMAMENT CHANGE N° 164 DIRECTS INCORPORATION BY CONTRACTOR MODIFICATION TEAM.
SQUADRON DEPLOYMENT PRECLUDES USE OF SQUADRON FACILITIES.

LOCATION OF JOB: HANGAR N-36

FOR FURTHER INFORMATION CONTACT (Name and telephone number): M.F. ARENBAUGH AOCS EXT 635	REQUESTED COMPLETION DATE: 1 July 1964

WORK REQUESTED
(Give complete, accurate, and detailed description of desired work. Attach sketch if necessary.)

Supervise and administer incorporation of a-3B Aviation Armament Change No. 164 in EA-3B BuNo. 146449e.
(copy of Change attached.)

REQUESTING ACTIVITY WILL FURNISH MATERIAL AS FOLLOWS:	REQUESTING ACTIVITY WILL FURNISH ASSISTANCE AS FOLLOWS:
(1) R 1510-1-A3D-C164 CHANGE KIT	3 MEN PILOT (OFFICER) PLANE CAPTAIN AVIATION ORDNANCE SPECIALIST

SIGNATURE (Maintenance Officer of Supported Activity): A. N. Smith CDR USN.

☒ APPROVED ☐ DISAPPROVED	REASON FOR DISAPPROVAL:	SIGNATURE (Maintenance Officer of Supporting Activity): J. N. Jones CDR USN.

DATE STARTED	DATE COMPLETED	DATE REQUESTING ACTIVITY NOTIFIED	WORK ORDER NUMBER ASSIGNED
9 JUNE 1964	28 June 1964	28 June 1964	324

Figure 2-10.—Work Request, NavWeps Form 4710/7. (A) Front page.

(B)

NAVWEPS FORM 4710/7 (5-62) (Back)

INSTRUCTIONS

Supported Activity

TO: Enter name of supporting activity.

DATE: Enter date Work Request is prepared.

ORIGINATING ACTIVITY: Enter name of activity originating Work Request.

WORK REQUEST NO:

JUSTIFICATION FOR WORK REQUESTED: Enter justification for Work Request.

LOCATION OF JOB: Enter where job is physically located at originating activity, or the location at the supporting activity to which the job will be delivered, if known.

FOR FURTHER INFORMATION CONTACT: Enter name and telephone number of person having complete information on the work requested.

REQUESTED COMPLETION DATE: Enter date work must be completed.

WORK REQUESTED: Enter complete, accurate and detailed description of the work to be accomplished.

REQUESTING ACTIVITY WILL FURNISH MATERIAL AS FOLLOWS: Enter stock number and nomenclature of material which will be furnished by the originating activity for completing the job.

REQUESTING ACTIVITY WILL FURNISH ASSISTANCE AS FOLLOWS: Enter the assistance which will be furnished by the originating activity for completing the job.

SIGNATURE: Enter signature of the Maintenance Officer.

Supporting Activity

APPROVED: Enter X in box if the Work Request is approved.

DISAPPROVED: Enter X in box if Work Request is disapproved.

REASON FOR DISAPPROVAL: If Work Request is disapproved, enter reason for disapproval.

SIGNATURE: Enter signature of the Maintenance Officer.

DATE STARTED: Enter date work is started.

DATE COMPLETED: Enter date work is completed.

DATE REQUESTING ACTIVITY NOTIFIED: Enter date requesting activity is notified that the work has been completed.

WORK ORDER NUMBER ASSIGNED: Enter work order number assigned to the job.

Figure 2-10.—Work Request, NavWeps Form 4710/7. (B) Back page.

AIRCRAFT STATUS BOARD (Sample)

SQUAD. NO.	MODEL	BUNO	UP or DOWN	STATUS CODE	ENGINE HOURS (since overhaul)	ENGINE HOURS (since check)	A/C HOURS (since check)	NEXT PERIODIC INSPECTION		MONTHS IN SERVICE	REMARKS
								TYPE INSPECTION	DUE DATE		

Figure 2-11.—Aircraft status boards.

The size and location of the board will vary with the employment and operating conditions of the particular activity; however, it remains the responsibility of the maintenance control office to maintain the board in a current and up to date status. Additional columns and subcolumns for rapid reference may be employed to indicate the status of selected components and functional systems as well as replacement times or dates on selected items. When items which have established replacement intervals are selected for the status board, the time at which replacement is required can be effectively displayed by entering in the component column the replacement interval (or the time remaining on the item) plus the aircraft or engine time when the item was installed. Thus, replacement is required when the aircraft or engine time equals the time entered in the component column. For a more effective display, the figure in the component column may be entered in red as the replacement time or date approaches.

POST-MAINTENANCE FLIGHT TESTS

The control and accomplishment of test flights may be a necessary and an integral part of a maintenance process. Test flights are those flights performed to determine if the airframe, powerplant, accessories, and items of equipage are functioning in accordance with predetermined requirements while subjected to the intended operating environment. Such flights are conducted when it is not feasible or possible to determine safe and/or required functioning by means of ground or shop tests. (Refer to BuWeps Instruction 4700.2 (latest series) for a listing of conditions that require flight tests.)

AIRCRAFT LOGS AND PROCEDURES

All activities which have reporting custody of Navy or Marine Corps aircraft have the responsibility to maintain the logbook and associated records for their assigned aircraft in a proper and up to date status. Detailed instructions for the preparation and maintenance of these logs and records are contained in BuWeps Instruction 4700.2. In most activities the responsibility for maintaining the logs and records can best be discharged by assigning the responsibility to one capable individual. In small activities, it may be assigned as a collateral duty.

AIRCRAFT LOG BOOK

The Aircraft Log Book is a hard cover, looseleaf ring binder containing separators and page insert forms. Each separator and page insert is a form number NavWeps 13090 and is identified by individual dash numbers. The following is a list of the forms used by each section of the logbook and a brief description of each:

1. General Information. This form title is self-explanatory. A summary of the information included is as follows:

a. Origin of logbooks. Upon Navy acceptance of an aircraft, the original accepting activity initiates the Aircraft Log Book. "Original Accepting Activity" is defined as the cognizant Bureau of Naval Weapons Representative or, when delivery is made at a point other than a contractor's plant, the Navy Representative. In addition to basic entries required by current instructions, the original accepting activity is required to accurately record the status of all Airframe Changes and other directives concerning the aircraft, and continue the record as long as the aircraft remains in its custody.

b. Custody of logbooks. The logbook is kept in the office of the station or unit to which the aircraft is assigned. When the aircraft is transferred, the logbook is brought up to date prior to forwarding with the aircraft to the new station or unit. If the aircraft is flown to the new activity, the logbook is transferred in the custody of the ferry pilot.

c. Entries in the logbooks. All entries are printed in ink or typewritten and are made under the supervision of the maintenance officer of the activity to which the aircraft is assigned. Entries include records of transfers, rework, repairs, engine changes, flights, and other pertinent information.

d. Disposition of logbooks. The logs for experimental aircraft, those considered to be of historical value, and those involved in accidents resulting in death, injury, or substantial damage to other than government property are forwarded to the U. S. Naval Records Management Center, Alexandria, Virginia, when the applicable aircraft is stricken from the Navy list. Logs and records of destroyed aircraft are disposed of locally if the aircraft do not fall into one of the foregoing categories. Aircraft which are sold or transferred to other than Navy custody usually have their logs transferred at the same time to the new custodian.

e. Ordering logs and forms. Additional forms for each section of the logbook may be requisitioned from the nearest aeronautical publications supply point using the Publication and Forms Order Blank, NavAer 140.

2. Guarantee Information. Guarantee periods for aircraft and component parts are effective for a specified length of time from the date of original acceptance by the Navy. It is the responsibility of the original accepting activity to fill in the information required by this part of the log. This page contains either the required information or the notation "No Guarantee" in accordance with instructions on the form.

3. Description and Preliminary Remarks. It is the responsibility of the original accepting activity to fill in the information required by this part of the log. This includes model, bureau number, manufacturer, general data (fuel capacity, oil capacity, engine model, and propeller model and type), and other pertinent remarks.

Entering of subsequent changes, additions, or deletions is the responsibility of the activity performing the modifications. The authenticating signature is that of the commanding officer (or his representative) of the activity accepting or modifying the aircraft.

4. Custody and Transfer Record. It is the responsibility of aircraft custodians to enter the information required by this section of the log. Proper aircraft accounting requires that the correct date of transfer and the authority for transfer be accurately recorded.

5. Aircraft Flight Log. Recorded in this section is information relative to every flight of the aircraft. Space is provided to enter the date, duration, flight code, types of landings, and status changes. The log is closed out at the end of each month and each time that the aircraft is transferred to a new reporting custodian. A red line is drawn immediately under the last flight entry prior to a periodic inspection. This provides a rapid reference to the time since the previous periodic inspection.

6. Inspection Record. The purpose of this record is to record all inspections performed on the aircraft during each service tour with the exception of routine preflight and daily inspections. Information contained is the type of inspection performed, the authorization, date completed, by whom performed (activity), and a certifying signature.

7. Record of Rework. This section of the logbook contains the permanent record of the type rework performed on the aircraft, the dates, and the activities performing the work. When an aircraft is transferred to an Overhaul and Repair, modification, or contractor activity for overhaul, repair, reconditioning, conversion, modification, modernization, interim rework, or progressive maintenance, the logbook must accompany the aircraft and must be brought up to date as necessary by the activity performing the work. This applies even though there is no change in reporting custodian.

8. Technical Directives. This section of the logbook is of paramount importance, in that it is mandatory that all cognizant personnel be completely familiar with instructions and procedures concerned with the accounting and logging of technical directives. Lack of understanding and failure to follow instructions have resulted in numerous faulty entries, extra and time consuming correspondence, and actual grounding of aircraft pending corrective action.

The term "technical directives" covers a wide field. Certain of these directives have a place in the Aircraft Log Book; others do not. For those directives requiring logbook entries, definite procedures for accounting have been established. The chart on the instruction page for technical directives (NavWeps 13090/4) is intended to be used as a guide and reference for the logging of technical directives in all parts and sections of the Aircraft Log Book and the associated records.

Another valuable reference for use in determining whether a specific action requires a logbook entry is the Aircraft Directives Configuration List for the particular activity. BuWeps Instruction 13050.1 (latest series) establishes and implements a system for providing this list to reporting custodians of aircraft. It is a listing of BuWeps and fleet-issued maintenance directives, by aircraft type and engine model. The directives included in the system are all those that require a logbook entry, or that SHOULD require a logbook entry because they direct a modification, alteration, inspection, etc., that should be logged even though the directive may fail to specify logging it.

The Technical Directives page is initiated and maintained in accordance with the following:

a. Basic Information. Complete aircraft model designation, type of directive, and aircraft bureau number are entered on each page.

b. Number. Enter the directive number in this space. All numbered directives must be accounted for in sequence; therefore, numbered spaces must be reserved for those not received.

c. Status. Enter the appropriate status code (INC, NINC, NA, NIS, C). INC - Incorporated: Indicates that the specified change or modification has been completely incorporated. NINC - Not incorporated (a temporary entry made in pencil): This code is used to indicate directives that have been issued but not yet incorporated. NA - Not applicable: Directives that do not apply to the particular aircraft model or bureau number. NIS - Not Issued: Directives that have not been issued, will not be issued, or have not been received. This entry is made in pencil unless it is known that the directive will not be issued, in which case a permanent entry may be made. C - Canceled: Directive has been canceled.

d. Category. Enter "I," "U," or "R" as applicable to indicate if incorporation action is Immediate, Urgent, or Routine.

e. Description. This space is used to enter a brief identifying description of the directive.

f. Compliance. The name of the activity complying with the directive and the date of compliance are entered here.

g. Signature. Authenticating signature. All entries must be individually signed off. Bracketing of several entries for a single signature is not authorized under current instructions.

h. Revisions. When revisions are issued to technical directives, the revision letter or letters are entered in this column on the same line containing the basic entry. The complete log entry for the revision is then entered on a "REVISIONS" Technical Directive page.

9. Preservation-Depreservation Record. This form is considered self-explanatory. It is retained as a permanent part of the record. Columns are provided for showing preservation date, represervation due date, type of preservation, date depreserved, directive complied with, reason for inactivity, preserving activity identification, and authenticating signature.

10. Replacement of Airframe Assemblies, Accessories, and Major Components. This section is the maintenance replacement record for parts, assemblies, accessories, and major components associated with the airframe. (This form is also used as a part of the Aeronautical Equipment Service Record to record the replacement of such items associated with the particular aeronautical equipment.)

It is impracticable to include a definite list of such items in a training manual inasmuch as requirements vary according to the aircraft model. Sound maintenance practices and flight safety considerations will dictate the items, other than mandatory, that should be recorded in this section. It is emphasized that replacement of items properly associated with equipments that require an Aeronautical Equipment Service Record is recorded in the applicable Part VIII of those records.

11. Operating History. This section provides for the recording of significant historical information concerning the aircraft. The activity performing the rework completes this record as appropriate upon completion of each service tour of progressive/airline maintenance period or cycle.

12. Miscellaneous. This section of the logbook is used by operating activities to record significant information affecting the aircraft for which there is no other place provided in the logbook. This type of information may include abnormal flight characteristics, peculiar troubles of an undetermined nature, damage to aircraft, historical data, and authorizations for service tour extensions. Current instructions prohibit the use of this section to record information properly belonging in other sections of the logbook.

13. Installed Explosive Safety Devices. This section of the log contains a record of all explosive safety devices which are currently installed in the aircraft. A partial list of such devices includes lap belt cartridges, initiators, canopy removers, and ejection seat cartridges or devices. Expendable ammunition and stores and fuzes are not intended for inclusion in this record. However, information concerning the cartridges or devices used to expel stores may be entered in this section at the option of the commanding officer. Like all other sections of the logbook, this record is required to be maintained in a current status by reporting custodians.

Space is provided in this record for data such as type of device installed, Mark number, Mod number, Lot number, purpose or location, the activity installing the device, the date, the expiration date (for determining service life), and the removal date.

AERONAUTICAL EQUIPMENT SERVICE RECORD

The Aeronautical Equipment Service Record is a nine-part, looseleaf log contained within a separate cover and punched for insertion in the Aircraft Log Book ring binder. This record is prescribed for use with aircraft powerplants, propellers, and airborne auxiliary power units. When used as a propeller log, it is prepared using the propeller hub as the basic equipment and must accompany the hub throughout its service life.

The Aeronautical Equipment Service Record is initiated by the activity originally accepting the equipment for the Navy. The records are subsequently maintained by the activity having custody of the equipment. Maintenance of this record is similar to that required for the Aircraft Log Book. Although the record is maintained in the maintenance office by the Aviation Maintenance Administrationman (AZ), much of the information that must be incorporated comes from the individual shops. General familiarity with the contents of the log and the record by Aviation Weapons Officers and by chief and first class petty officers in all aviation ratings will be a valuable aid in the development of the spirit of cooperation so vital to the overall maintenance effort.

The Aeronautical Equipment Service Record consists of the following:

1. The cover (NavWeps Form 13090/30).
2. Part I - Guarantee Information and Basic Information (NavWeps Form 13090/31). This part contains information similar to that contained in the first two sections of the Aircraft Log Book previously covered.
3. Part II - Custody and Transfer Record.
4. Part III - Equipment Operating Log. This form is generally self-explanatory; however, a few remarks may be helpful as an aid in preparation and maintenance. For instance, it should be remembered that "Military" time refers to reciprocating engines and "Afterburner" time refers to gas turbine engines. The form provides for logging of equipment operating time on a per flight, daily, weekly, or monthly basis except that ferry and test flight times are logged separately. This form provides an additional column without a heading which may be used for logging any special information.
5. Part IV - Inspection Record. The discussion of this form in the section on Aircraft Log Books also applies to the preparation and maintenance of this form when used as Part IV of the Aeronautical Equipment Service Record.
6. Part V - Record of Rework. This is also a dual usage form and is to be maintained in accordance with those instructions which apply to the Aircraft Log Book.
7. Part VI - Technical Directives. The recording of technical directives in the Aeronautical Equipment Service Record is largely limited to "bulletin" type publications. The form used for such recordings is the same as that used in the Aircraft Log Book. Separate pages are used for each type directive and all applicable directives are recorded.
8. Part VII - Preservation-Depreservation Record. This part of the Aeronautical Equipment Service Record is another of the forms that is also used in the Aircraft Log Book. The purpose and the maintenance of this form

when used as part of this record are basically the same as for the Aircraft Log Book.

9. Part VIII - Replacement of Assemblies, Accessories, and Major Components. Part VIII is another of the forms that is also used in the Aircraft Log Book. This part of the record is screened for information and discarded at time of rework, and a new Part VIII is initiated.

10. Part IX - Miscellaneous. Part IX is used in the Aeronautical Equipment Service Record for recording pertinent information for which no other place has been provided. Such information includes special test data, abnormal characteristics of equipments, significant damage and/or repair, and authorization for extension of operating intervals.

SUPPLEMENTAL LOGBOOK RECORDS

Although some of the records mentioned in the following paragraphs have no direct relationship to the Aviation Weapons Officer's duties, they are included in order to give a complete picture of logging and reporting procedures. As has been stated previously, an appreciation of the entire logging and reporting system is helpful in developing cooperative working relationships between the aviation ordnance shop and other maintenance units.

Accessory and Component Service Record

This record is used for both accessories and components, and is to be maintained when required by the Bureau of Naval Weapons. It is used to record complete maintenance history, installation, and usage data. It is maintained as part of the Aircraft Log Book or the Aeronautical Equipment Service Record as long as the accessory or component is installed. When the item is removed from the aircraft or equipment, this form must accompany the part.

An accessory service record must be initiated for an aeronautical accessory when it is determined that all of the following conditions exist:

1. The accessory is subject to time-interval replacement (other than at overhaul of the aircraft or equipment).
2. The accessory is subject to rework.
3. The accessory performs a complete major function.
4. The function critically affects the performance of the aircraft or equipment.

The assignment of accessory records to any items not meeting all of the above conditions is determined separately in each instance. Individual accessory service records are initiated for each airframe accessory when specified in particular Accessories Bulletins.

Each Accessory and Component Service Record contains the basic information (nomenclature, Federal Stock Number, serial number, manufacturer, etc.), installation data, removal data, technical directives, and overhaul and significant repair.

The "Return Material Documents Envelope," Form NavAer 5138, is used for the protection of accessory service records incident to all shipments of individually packaged accessories.

INVENTORY LOGS AND RECORDS

In order to maintain an unbroken chain of custodial responsibility incident to the transfer and acceptance of naval aircraft, the Standard Inventory Log was developed to be used as an instrument of transfer. In the interest of standardization among the armed services, the Aircraft Inventory Record has been designed by the Department of Defense for this purpose. Inventory records are being prepared, instead of inventory logs, for future new production aircraft.

With remote exceptions, no aircraft may now be transferred or accepted without an inventory log or record. On these occasions an inventory of the aircraft and its equipment must be accomplished, based on the items of equipment and material contained in the applicable log or record.

Although the log and record serve the same purpose, there are some minor differences in their format and categorical listings. In general, the determination as to whether items are, or are not, subject to listing in these publications without regard as to whether they are contractor or Government furnished and contractor or service installed, is governed by the following:

1. Items essential to the execution of the designated missions of the aircraft, such as armament, electronics, photographic equipment (excluding cameras other than for primary missions), and special instruments, are included.

2. Items of equipment which are rigidly fixed and considered to be a basic or integral part of the airframe, such as engines, propellers, wheels, tires, and brakes, are excluded. In the case of the Aircraft Inventory Record, standard instruments are also excluded.

3. Special equipment items essential to the safety or comfort of the crew, such as bedding, liferafts, Thermos bottles, crash axes, and portable fire extinguishers, are included. Comparable items which are personal issue or furnished on squadron allowances are excluded.

4. Loose equipment delivered with the aircraft, such as covers, mooring kits, and jack pads, for which stowage provisions have been incorporated in the aircraft, are included.

5. Items subject to pilferage or readily convertible to personal use, such as clocks, Thermos jugs or bottles, bedding, and first aid kits, are included. Comparable items which are personal issue or furnished on squadron allowances are excluded.

The Standard Inventory Log is subdivided into groups of equipment; e.g., instrument and navigation equipment, armament equipment, and electronic equipment. The components are listed in alphabetical sequence and according to their location in the aircraft, with the exception of the electronics equipment, in which case all components of an equipment are listed in one place regardless of their location in the aircraft. Stock numbers are also supplied for individual items, and are used for ready reference when replacements are required.

The Aircraft Inventory Record includes a sectional breakdown diagram of the applicable aircraft. This diagram consists of a side elevation and/or the plan view of a wing, or in the case of twin-boomed or flying wing aircraft, the perspective view.

To facilitate inventorying, the sections of the diagram are identified by letters, the letter "A" being assigned to the foremost section, "B" to the next, and so on, generally to the rear of the aircraft. The letter "R," as part of the item number, denotes items mounted on the exterior of the fuselage, and the letter "F" denotes items to which access is gained from the fuselage. Subdivisions of sections may be identified by a lowercase letter such as "Aa," "Ac," etc.

The equipment list portion of the record is divided into sections, each of which lists the items pertaining to a particular section of the aircraft, as indicated on the sectional breakdown diagram. Within each section, individual items are numbered as nearly as possible in the sequence of their physical location in the aircraft without regard to their relation to specific equipment. Stock numbers are not supplied as part of the equipment listing in inventory records.

One Standard Inventory Log in general is issued as applicable to one aircraft model and designates material and equipment peculiar among the various applicable versions and bureau numbers. The Aircraft Inventory Record is issued as applicable to one aircraft for a specific bureau number.

Blank columns are provided on the inventory pages of the log and record, in order that transferring and receiving activities may jointly inventory and indicate the quantity of each item ascertained to be on board the aircraft at the time of transfer. A "Receipt Endorsement Log" in the Standard Inventory Log, and a "Certificate and Record of Transfer" in the Aircraft Inventory Record are provided so that transferring and receiving activities may sign, indicating by column applicability, the items on board the aircraft.

Upon the transfer of an aircraft, representatives from the transferring and receiving activities jointly inventory and record, in the appropriate column, the quantity of each item which is ascertained to be on board the aircraft at the time of transfer. When a ferry pilot or a naval vessel is involved in the transfer, two inventories are made, one prior to the ferry flight or embarkation, and one upon completion. In the former instance, the ferry pilot or vessel is to be considered the receiving activity, and in the latter instance the transferring activity.

A Report of Inventory Form supplied with the Standard Inventory Log, or the Shortages Form (DD 780-2) in the Aircraft Inventory Record, is generally prepared in triplicate, listing missing items with appropriate remarks. The original signed copy of the form is retained by the transferring activity and filed as a permanent record of transfer.

The second copy of the form is left in the Standard Inventory Log or Aircraft Inventory Record, as the case may be, and delivered along with the log or record to the activity receiving the aircraft.

A third copy of the report or shortages form is forwarded to the cognizant major operating command of the transferring activity for information and any appropriate action deemed necessary.

In the case of missing items, the transferring activity makes every effort to locate the missing items or to withdraw from stores the replacement items necessary to complete the inventory. If it is impossible to locate or supply the missing items, the notation "Missing items are not available" is placed in the Report of Inventory Form in the Standard Inventory Log or the Shortages Form in the Aircraft Inventory Record. An explanatory statement signed by the transferring representative is placed with this form, indicating the authority for these shortages. On the basis of this statement, the receiving activity may fill the shortages from stock and account for them in the normal manner.

When an aircraft is abandoned or disposed of by scrapping, the inventory log or record may be destroyed by the activity disposing of the aircraft. When the aircraft is transferred to other U.S. agencies, the log or record is transferred also. When sold to a private party, the inventory log or record is forwarded to BuWeps immediately after consummation of the sale and should include the signatures of the last custodian (seller) and the purchaser. In order to provide the buyer with inventory information, the log or record may be duplicated, provided that it includes no classified information.

TRAINING

The proper training of ordnance maintenance personnel is a necessity, and is an important responsibility of the Aviation Weapons Officer. An inspection of a well-run, efficient, ordnance shop would undoubtedly reveal a flexible training program, with competent instructors. The competent instructor should utilize each opportunity to instruct unskilled ordnance personnel in the varied tasks that may be assigned. This training may be accomplished by many methods such as lectures, movies, training aids, group discussions, on-the-job training, etc. Due to limited facilities, however, most maintenance training at the ordnance shop level is either by the lecture method or on-the-job training method.

An approved department/division/branch master training syllabus is usually made available for use by the Aviation Weapons Officer (or his delegated training assistant). If this training syllabus is not available, a shop training program should be initiated. The master outline can be varied to meet any training need of an individual shop provided the minimum requirements of the master training syllabus are met. The appropriate corrected syllabus should then be submitted (via proper channels) for approval, coordination, and publishing by the maintenance administration officer. Coordination of lectures with other divisions/branches is of the utmost importance because of limited classrooms, training aids, movie projectors, etc., and overlapping subjects, such as first aid, survival, NBC warfare, etc.

The majority of practical inservice ordnance maintenance training is either formal or informal training. Each is explained in the following paragraphs.

FORMAL TRAINING (INSERVICE)

Formal training is conducted in the classroom through lectures, supplemented by required reading. Lectures should be implemented with available visual training aids. An approved published schedule should include a listing for each lecture, the time, the location of the classroom, the names of those men who are to attend, the subject, and the name of the instructor. (NOTE: A typical lecture format is shown in chapter 11 of BuWeps Instruction 4700.2.)

Instructor assignments, which are normally collateral duties, should be made sufficiently in advance to allow for adequate preparation of the lesson. Assignments should be based on the ability of the individuals, but an effort should be made to insure that as many men as practical are given assignments. Personnel given instructor assignments should be familiar with the contents of the Manual for Navy Instructors, NavPers 16103-C (or current revision). This text discusses those essential areas of knowledge and procedures which furnish instructors with a basis on which to build skilled instructor techniques.

Working with the ordnance chief or senior AO, the Aviation Weapons Officer should select a competent, enthusiastic training petty officer.

The petty officer who is selected for the ordnance branch training should prepare a training syllabus form and a required reading record form for each man. These forms should be similar to those shown in figures 2-12 and 2-13. He is also responsible for informing the maintenance administrative officer of the lectures needed for the ordnance branch and the personnel required to attend these lectures. This is of primary importance to the maintenance administrative officer as he needs this information for coordinating and scheduling lectures for the entire department.

Figure 2-12 lists several subjects that may be considered suitable for the preparation of training lectures. This is not a complete listing nor are all of the items listed mandatory.

Required Reading

Certain directives and publications as directed by higher authority are routed for dissemination as maintenance information. The leading AO's initials on such a routing slip indicates to the branch/division officer that the material was read and initialed by all applicable AO personnel and that the directive was incorporated in the standing required reading file. Each division/branch officer should maintain an active and a standing required reading file for his shop. The active file contains items of maintenance information, and such other information as the division/branch officer wishes to disseminate. The standing file contains material that has been read and initialed by all personnel presently assigned and is kept on file for the indoctrination of new men. Figure 2-13 or its equivalent is used to maintain records on each man's progress in required reading. If no copy of a directive is available for the reading file, a cross-reference sheet is filed in its place indicating where it can be found. Records are kept on the progress of each man in his required reading. Newly assigned men should read and initial both the active and standing required reading material. Files are reviewed at least once monthly and obsolete material removed therefrom.

INFORMAL TRAINING (INSERVICE)

Informal inservice training, better known as "on-the-job" training, is the practical instruction of men in the performance of maintenance tasks by means of demonstration and imitation under personal supervision in the shop or on the operating line. Nearly every maintenance task undertaken presents an opportunity for on-the-job training.

The experienced men of the squadron are utilized as fully as possible in instructing, demonstrating, and imparting their skills to the less experienced personnel. Under this system, the trainee has the opportunity to actually do the job under the supervision of an experienced petty officer. The only equipment required is the job itself. A vital ingredient, of course, is that the individual doing the instructing have an interest in the job and the skill to do it well. The striker or trainee will learn something by seeing the job done, and he will gain experience by having a chance to participate in its accomplishment.

The nature of this type of training makes a regular scheduling impractical. Actually, it is done at every opportunity and can be regulated by effective use of a training syllabus. The syllabus is prepared under the guidance of the aircraft maintenance officer with content and scope commensurate with practical factor requirements of rated and striker personnel. A record of on-the-job training given is made to division/branch officers at regular intervals so that a close watch may be made on individual progress. Final attainment of satisfactory levels of skill are recorded. These records will point out need for training in special areas as well as for review by higher authority.

TRAINING SYLLABUS
NAVWEPS FORM 1510/2 (5-62)

NAME		RATE		SERVICE NUMBER	
O'DELL, J.C.		AO2		325-61-79	

LECTURE	TITLE	INST.	DATE	GRADE	ENTRY BY
L1	SQUADRON ORGANIZATION	SPERA	1-6-64	S	SPERA
L2	SAFETY PRECAUTIONS	GIBSON	1-8-64	S	"
L3	GENERAL FAMILIARIZATION-P2E	BOCCIA	1-11-64	S	"
L4	A/C INSPECTIONS AND PROCEDURES	SPERA	1-15-64	S	SPERA
L5	ARMING AND DEARMING PROCEDURES				
L6	A/C BOMBS AND FUZES				
L7	A/C ROCKETS				
L8	A/C MINES AND TORPEDOES				
L9	ORDNANCE HANDLING EQUIPMENT	CHAMPLIN	3-1-64	S	SPERA
L10	A/C ORDNANCE EQUIPMENT				
L11	PYROTECHNICS				
J12	PYROTECHNICS BREAKOUT AND HANDLING	CHAMPLIN	4-4-64	S	SPERA
J13	ROCKET ASSEMBLY				
J14	BOMB BREAKOUT AND ASSEMBLY				
J15	MINE AND TORPEDO LOADING				
J16	LOADING A/C ROCKETS	PENROD	2-1-64	S	SPERA
J17	LOADING A/C BOMBS	PENROD	2-8-64	S	"
J18	RETRO EJECTOR, OPERATION OF:				
J19	SONOBUOY DISPENSERS				
L20	SMALL ARMS				
L21	SAMI, CAMI, AND TIMI				
L22	ORDNANCE AIRCREW SYLLABUS				
L23	GUIDED MISSILES				
L24	SPECIAL KNOWLEDGE LECTURES				
	1. NUCLEAR WEAPONS				
	2. NUCLEAR WEAPONS TESTING				
	3. NUCLEAR WEAPONS TESTERS				
	4. NUCLEAR WEAPONS LOADING				
	5. AIRCRAFT CONFIGURATION				
L25	PUBLICATIONS				
QUAL.	1. ORDNANCE AIRCREW CHECK				
QUAL.	2. ORDNANCE AIRCREWMAN				
QUAL.	3. AIRCREWMAN				

Figure 2-12. —Training syllabus.

REQUIRED READING AND MAINTENANCE INFORMATION RECORD
NAVWEPS FORM 1510/1 (5-62)

DIVISION
SHOPS DIVISION
ORDNANCE BRANCH

NAME	RATE	SUBJECT: DEPT ORGANIZATION	WATCH DUTIES	LIBERTY AND LEAVE POLICY	SAFETY PRECAUTIONS	SAMI'S	CAMI'S	TIMI'S	DEPT DIRECTIVES				
DAVIS, J. R.	AOCS	3/15	3/15	3/15	4/2	3/16	3/16	3/16	3/17				
WILLOW, A. A.	AO1	3/18	3/12	3/18	3/16	3/20	3/20		3/12				
JOHNSON, R. A.	AO2	3/12	3/12	3/12	3/20	3/18	3/18	3/24	3/13				
JACKSON, F. L.	AO2	3/1	3/4	3/5	3/18								
FIGNUT, G. R.	AO3	3/6	3/10	4/1	3/18	3/22	3/22	3/22	3/25				
DOARE, W. T.	AOAN	3/4	3/10	3/10	4/2				3/14				

Figure 2-13.—Required reading and maintenance information record.

Short of full-time apprentice training, on-the-job training is the best way to enable men to become qualified mechanics and technicians. It can also be used as a supplement to and part of an apprentice training program. The degree of success in on-the-job training depends on the degree of recognition by each individual of his responsibility to his outfit to impart his knowledge and skill to the man who is trying to learn.

MAN-HOUR ACCOUNTING

Man-hour accounting is performed with guidelines as set forth in BuWeps Instruction 4700.2. However, these guidelines previously were not used by all activities in a standardized program, but were used on the local level as an aid for better overall manpower usage and requirements.

Man-hour accounting is now undergoing extensive change and has been redesignated as man-hour reporting. At the present time, man-hour reporting under the Standard Navy Maintenance Management System is undergoing evaluation for use by the Navy.

During the evaluation period the data generated by the air wings and maintenance activities will be used to devise machine processed reports. These reports will be used to determine which reports and records now kept by the operating forces of the Navy can be replaced by machine processing. The overall system should result in increased man power utilization.

It is anticipated that several revisions will be required in the man-hour reporting prior to its final acceptance by the Navy. As data is analyzed it may be determined that more detail of a different format is required, thus creating the need for a revision.

Since man-hour reporting is in a period of evaluation and the program is not firm, the Aviation Weapons Officer should refer to BuWeps Instruction 4700.2 (latest revision).

MALFUNCTION REPORTING

The purpose of the Bureau of Naval Weapons Malfunction Reporting Program (MRP) is to enable BuWeps and its contractors to rapidly perform both statistical and technical analyses of equipment failures and to take steps to insure that more reliable equipment is developed. The major aspects of the program are the collecting, compiling, and analyzing of service experience with naval aeronautic materials to determine areas of immediate failures and trends of impending failures, and to coordinate efforts to correct material deficiencies and improve flight safety, operational utility, and logistic support for operating aircraft.

In its present form, the MRP emphasizes reporting of all failures occurring on aircraft (and their special support equipment) which are currently in production. For all other aircraft, general and special support equipment, and general aeronautical material, reliability reports are submitted on the following occasions only:

1. In all situations in which flight safety is affected.
2. In any situation which seriously affects aircraft availability.
3. When a part is retained for, or released to, a contractor or an Overhaul and Repair department for investigation.
4. When a government furnished equipment item is rejected by a government inspection activity.

For aircraft currently in production, the program calls for reporting of each unscheduled maintenance action, failure, malfunction, removal and replacement, or rejection of materials, parts, or assemblies installed in or received for installation in the aircraft, associated material, and support equipment.

The report form used in the MRP is the Failure, Unsatisfactory, or Removal Report (FUR), NavWeps Form 13070/3. The form is available in both the single sheet and as a set. In determining which form to use, a general guideline is: If a replacement part is required, use the set. The first sheet of the set is exactly the same as the single copy. The difference between the two is that the set has the supporting documents required by supply activities for requisitioning material replacements, and disposing of the defective material which has been replaced. Figure 2-14 shows a completed FUR form.

Instructions for filling out the FUR are found in the BuWeps Instruction 13070.1 (latest series). This instruction should be read and used by all maintenance personnel concerned with submitting FUR's.

NOTE: The film (#KN-10,007) entitled "BuWeps Malfunction Reporting Program," Report Symbol BUWEPS 13070-3

1. Reporting Activity	2. Report Ser. No.	3. Date Of Trouble	4. Installed In Aircraft/Arrest. Gear/Catapult/Support Equipment — Model	Buno or Ser. No.	5. Aircraft Logbook Time
VAH-1	3579	9-19-64	A-5A	149295	00250

	Model / Part No.	Nomenclature	Serial No.	Other	
System, Set Equipment Or Engine	6. Model Designation And Model No.: AN/ASQ-56	7. Nomenclature: CNI	8. Serial No.: 101	9. Time Meter Read./Logbook Time or Events (if applicable) — Hour meter: 1000; Logbook hrs.; Starts; Landings	
Unit, Component Accessory, Assembly Or Equipage	10. Manufacturer's Part No.: 522-1066-004	11. Nomenclature: AM - 2310/ASQ	12. Serial No.: SM-42	13. Mfr's Code No.: 13499; 14. Contract No.: NOW61-0574	15. Time Or Events — Hrs.: 200; Starts; Ldg's
Subassembly (Electronic) Or Primary Part Failure (Non-electronic)	16. Manufacturer's Part No.: 542-4996-005	17. Nomenclature: RF & Injection	18. Serial No.: 024	19. Mfr's Code No.: 13499	20. Location (if applicable): 5A6
Supply Identification Item(s) Returned	21. Federal Stock Number	22. (RM, MR copies only)	23. Quantity	24. (RM, MR copies only)	25. (RM, MR copies only)

Reason For Report (Check one) — 26. Removal Or Maintenance Action Required As A Result Of:

1 [X] Failure/Suspected Failure Or malfunction 2 [ ] Damaged due To improper Maintenance/Operation/Test 3 [ ] Damaged or Defective On receipt 4 [ ] Damaged Accidentally 5 [ ] Scheduled/Directed Removal, high time Overage, excess To requirements

27. Item overhauled by

DESCRIPTION OF TROUBLE

(If box 1, 2, 3, or 4 was checked in space 26, complete spaces 28 through 31. If box 5 was checked in space 26, leave spaces 28 through 31 blank.)

28. First Observed/Occurred During

1 [ ] Flight operations—Land based; 2 [X] Flight operations carrier based; 3 [ ] Pre-flight; 4 [ ] Daily; 5 [ ] Conditional; 6 [ ] Calendar; 7 [ ] Overhaul/PAR; 8 [ ] Shop maintenance bench test; 9 [ ] Special directed inspection; 10 [ ] Normal operation of support equip., catapults, arresting gear, mirror landing sys. only.

29. Symptoms—How Discovered — Item: 16

A [ ] Excessive vibration; B [ ] High fuel consumption; C [ ] High oil consumption; D [ ] Incorrect display; E [X] Inoperative; F [ ] Interference/Binding; G [ ] Intermittent operation; H [ ] Leakage; I [ ] Low performance; J [ ] Metal in oil; K [ ] Noisy; L [ ] None noticed; M [ ] Out-of-balance; N [ ] Overheating; O [ ] Pressure out-of-limits; P [ ] RPM out-of-limits; Q [ ] Surging/Fluctuates; R [ ] Temperature out-of-limits; S [ ] Torque out-of-limits; T [ ] Unstable operation; U [ ] Visible defect; V [ ] Other (Amplify)

30. Part Condition

007 [ ] Arced; 780 [ ] Bent; 135 [X] Binding; 429 [ ] Blistered/Peeled; 070 [ ] Broken/Cracked; 900 [ ] Burned/Burned out; 120 [ ] Chafed/Galled; 130 [ ] Changed value; 910 [ ] Chipped/Nicked; 999 [ ] Circuit defective; 160 [ ] Connections defective; 818 [ ] Contacts Burned/Pitted; 170 [ ] Corroded; 200 [ ] Dented; 201 [ ] Distorted/Stretched; 148 [ ] Eroded; 250 [ ] Frayed/Torn; 001 [ ] Gassy; 381 [ ] Leaking; 730 [ ] Loose; 004 [ ] Low GM or emission; 750 [ ] Missing; 008 [ ] Noisy; 450 [ ] Open; 790 [ ] Out-of-adjustment; 439 [ ] Plugged/Clogged; 576 [ ] Ruptured/Split/Blown; 935 [ ] Scored; 585 [ ] Sheared; 196 [ ] Shorted/Grounded; 422 [ ] Soldering defect; 660 [ ] Stripped; 018 [ ] Tested OK—Did not work; 389 [ ] Unknown (Cannot disassemble); 020 [ ] Worn—Excessively; 099 [ ] Other (Amplify)

31. Cause Of Trouble

A [ ] Design deficiency; B [ ] Faulty maintenance (Quality Control); C [ ] Faulty manufacturing (Quality Control); D [ ] Faulty overhaul (Quality control); E [ ] Faulty preservation/Packaging; F [X] Foreign object; G [ ] Fluid contamination; H [ ] Installation environment (Location in weapons sys.); I [ ] No failure-replaced to improve sys. performance; J [ ] Operator technique/Adjustment; K [ ] Other parts primary cause; L [ ] Undetermined (Cannot disassemble); M [ ] Weather conditions; N [ ] Wrong part installation; O [ ] Other (Amplify)

32. DISPOSITION OR CORRECTIVE ACTION: Select appropriate code(s) from list below and enter in boxes at left to indicate disposition or corrective action taken with respect to each of the items entered in spaces 6, 10, and 16.

Space 6 [H]; Space 10 [K]; Space 16 [J]

Replaced And Returned To Supply — Code	Reason	Code	Corrective Action
A	Hold 90 days	H	Used as is
B	Lack of repair facilities	I	Adj./Realign./Serv./Repaired in place
C	Lack of repair parts	J	Removed-Adj./Realign./Serv./Repaired-reinstalled
D	Lack of Tech. Pubs.	K	Removed-repaired-made RFI
E	Lack of personnel	L	Removed-tested Ok-made RFI
F	Beyond assigned maintenance level	M	Removed-scrapped
G	Other—(Defective on receipt, high time, directed removal, excess to requirements, etc.)	N	Surveyed
		O	Released for investigation and replaced (Indicate custody in space 35)

33. Maintainability Information

	Hours	Tenths
Man-hours to locate trouble Space 10		5
Man-Hours to locate trouble Space 16		5
Man-hours to repair/replace/adjust	1	5
Actual time A/C was undergoing repair	2	5
Total time aircraft not flyable due to this malfunction	3	0

ACCESSIBILITY: S [X] Satisfactory; U [ ] Unsatisfactory (Amplify)

SPECIAL: 1 [X] Frequent trouble item; 2 [ ] Can be installed wrong (Amplify)

34. Component/Assembly, Subassembly Replaced With: Mfr's Part No. / Serial No. / Mfr's Code No.

35. AMPLIFYING REMARKS (Furnish additional information concerning failure or corrective action not covered above. Do not merely repeat information checked above. Specify any severe operating conditions, such as hard landings, wheels-up landings, severe maneuvers, etc.)

Binding because of foreign material.

36. Report Is: 0 [ ] FUR 1 [X] AMPFUR 2 [ ] Urgent AMPFUR 3 [ ] Flight Safety AMPFUR 4 [ ] Follow up report

Signature: W. N. Kaste — Rank/Rate: AOCM — Date: 9-19-64

Associated Parts Repaired Or Replaced (Do not list any item reported above)	37. Part No. (Non-electronic parts) Or Part Ref. Designator (Electronic parts)	38. Part Name, Tube Type, Semi-Conductor Type Or Description	39. Mfr's Code No.	40. Failure Code (From space 30)	41. Disposition (Code from space 32)
	541-4674-002	Spur gear	13499	135	I

42. Activity Repaired By: VAH-1 — Signature: O. K. Phillips — Rank/Rate: AOCS — Date: 9-19-64

FAILURE, UNSATISFACTORY OR REMOVAL REPORT NAVWEPS FORM 13070/3 (10-62) — (Mail this copy to NATSF) — FUR

Figure 2-14. —FUR, NavWeps Form 13070/3.

shows the proper preparation of the Failure, Unsatisfactory, or Removal Report, NavWeps Form 13070/3.

Aircraft Discrepancy Report

The Aircraft Discrepancy Report (Report Symbol BuWeps 13070-4) is used to indicate areas in immediate need of increased attention during production and rework of aircraft. It provides a direct method for reporting inherent minor or continuing discrepancies in quality and workmanship, in order to insure acceptable standards of quality in the end product. The report is required on all new aircraft and on aircraft received either from Overhaul and Repair activities or from civilian contractors who are performing extensive maintenance on aircraft. This method of reporting is not to be used in lieu of FUR's prepared in accordance with BuWeps Instruction 13070.1 (latest series).

The report is to be completed during the acceptance inspection, but in no case later than 30 days after receipt of the aircraft. When no discrepancies are found, the word "NONE" is to be entered in the "Description of Discrepancy or Failure" column. This report is not to be used to report equipment shortages, ferry or shipping damage, deterioration during pool storage, or other discrepancies that do not directly pertain to the quality of rework or manufacture. Enough detail should be provided to permit an objective analysis of each discrepancy. If the space provided for reporting discrepancies is not sufficient, supplemental sheets may be attached as required.

Detailed instructions regarding the submission of this report are found in BuWeps Instruction 4700.2 (latest series).

CHAPTER 3

AVIATION ORDNANCE MANAGEMENT

One of the greatest assets that an Aviation Weapons Officer (Aviation Ordnance Officer) can possess is a thorough understanding of ordnance management and administration. Regardless of the billet to which the Aviation Weapons Officer may be assigned, high proficiency in management and administration is an invaluable asset in his day-to-day endeavors.

Within the field of aviation ordnance, no one division/branch officer can be expected to have immediate answers to all the questions and problems that arise during the course of day-to-day operations. However, knowing the proper procedures to obtain the required information to resolve the various problems encountered contributes much to the efficiency of the division.

This chapter discusses some of the directives, pamphlets, miscellaneous publications, procedures in naval correspondence, and other information to assist the Aviation Weapons Officer in carrying out his duties in the management field.

PUBLICATIONS

The Aviation Weapons Officer's (Ordnance Branch Officer) duties require him to use publications, logs, records, and reports associated with ordnance administration. He must also be familiar with the proper procedures for the procuring, using, and accounting of the various publications utilized in the maintenance of aviation ordnance equipment. Unless these details are quickly mastered by the Aviation Weapons Officer, his value to the ordnance branch and his ability to instruct the personnel under him are limited.

Experience has shown that many Aviation Weapons Officers are not familiar with all of the publications dealing with their numerous assigned duties. The great volume of publications associated with each assigned duty makes it practically impossible for any one person to become thoroughly familiar with all of them.

Aviation Weapons Officers should make it their explicit duty to become familiar with certain publications dealing directly with their work—particularly those dealing directly with their duties as instructors and administrators. Other publications dealing with secondary phases of their work should be obtained and be readily available for quick reference.

Each ordnance activity should establish and maintain a publications library. It should contain a complete set of current publications properly filed and readily available to interested personnel. The importance of the library is evidenced by the fact that it receives a grade during annual inspections. Some of the applicable publications issued periodically which provide current information pertinent to the ordnance branch are discussed in this chapter.

NAVY DIRECTIVES SYSTEM

The Navy Directives System, SecNav Instruction 5215.1A, provides a uniform plan for issuing and maintaining directives. Directives consist of written matter which prescribes or establishes policy, organization methods, or procedure; require action; or contain information essential to the effective administration or operation of activities concerned.

Instructions are directives of a continuing nature and remain in effect until subsequently canceled. Notices are directives of a one-time nature or directives which are applicable for a brief period of time (usually 6 months or less). Each notice contains a provision for cancellation, on which a specific date is stated for record purposes.

Standard Subject Classification Numbers

The Navy-Marine Corps Standard Subject Classification System, SecNav Instruction P5210.11, provides a single, standard subject scheme This classification system is used for classifying Navy and Marine Corps documents by subject through the Department of the Navy. SecNav Instruction P5210.11 contains a list of standard subject classification numbers and a list of name-title subject classification codes. Except at activities with an exceptional large volume of correspondence, files normally are established by subject classification numbers. However, files may be established by name-title codes or a combination of both. These classification numbers/codes and their use are discussed in the following paragraphs.

For the purpose of identification and filing, standard subject classification numbers classify Navy correspondence and directives under 13 major series groups. These major series groups are further subdivided by the use of the last 3 digits in the major series. The 13 major series groups consist of the following.

1000 Series—Military Personnel.
2000 Series—Communications.
3000 Series—Operation and Readiness.
4000 Series—Logistics.
5000 Series—General Administration and Management.
6000 Series—Medicine and Surgery.
7000 Series—Financial Management.
8000 Series—Ordnance Material.
9000 Series—Ships Design and Ships Material.
10000 Series—General Material.
11000 Series—Facilities and Activities Ashore.
12000 Series—Civilian Personnel.
13000 Series—Aeronautical Material.

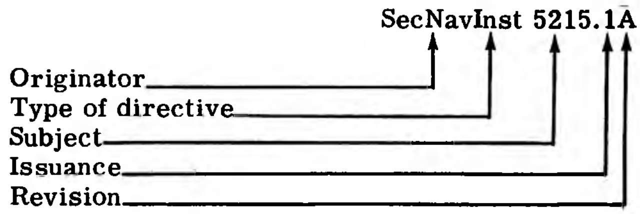
The 13 major subject groups are subdivided into primary, secondary, and sometimes tertiary breakdowns as follows:

4000 Indicates the major subject group—Logistics.
4400 Indicates the primary breakdown—Supply Control.
4440 Indicates the secondary breakdown—Inventory Control.
4441 Indicates the tertiary breakdown—Allowances.

Each office identifies the directives which it originates by the following:

1. The originator's abbreviation.
2. The type of directive.
3. The subject classification number.
4. A consecutive number, preceded by a decimal point (applies to instructions only).
5. A consecutive letter, indicating the revision.

The following example is an identifying symbol assigned to an instruction issued by the Office of the Secretary of the Navy:



Consecutive numbers are assigned to instructions having the same subject classification number to show the order of issuance. For example, the subject number of contract financing is 7810. An originating office would assign numbers to the first, second, and third instructions which it issues on contract financing as follows: 7810.1, 7810.2, 7810.3, respectively. The number 7810.1A would indicate the first revision of the instruction 7810.1.

Notices are not assigned consecutive numbers because of their one-time nature or brief duration. The subject classification number assigned as the file number of a letter is not assigned a consecutive number.

The security classification of Confidential or Secret instructions and notices is indicated by prefixing the subject number by 0 for Confidential and by 00 for Secret. Publication type directives are indicated by prefixing the subject number with the letter P.

Name-Title Subject Classification Codes

Name-title codes (alphabetic or alphabetic-numeric codes) are provided for names and titles frequently used by the Department of the Navy. These codes may be used for classifying and filing documents by name or organizational designation except that they are not to be used in assigning subject numbers to directives. Included are symbols for fleet organizations, the United States Government, foreign governments, commerical enterprises and firms; classes of personnel; types of naval activities; and official symbols for classes and types of aircraft, vessels, and guided missiles.

The first letter of the name or title code designates the larger organizational group, and the second or third letters designates a further breakdown of the larger group. For example, "NA" designates naval air stations. The "N" is for the Naval Shore Establishment and the "A" for air stations.

An Arabic numeral added to the letter symbol further subdivides the code. For example:

FF Fleets, Forces, Types, Areas and Sea Frontiers
FF1 U.S. Fleet
FF2 U.S. Tasks Fleets

BUREAU OF NAVAL WEAPONS PUBLICATIONS

All publications issued by the authority of the Chief of the Bureau of Naval Weapons are listed in the Navy Stock List of Forms and Publications, NavSandA Publication 2002. This stock list is a 13-section catalog which lists all forms and publications used throughout the Naval Establishment which are stocked and issued by the Forms and Publications Supply Office. The 13 sections listed by number and title are as follows:

Section I, Information and Stock List Index.

Section II, Forms.

Section III, BuPers Publications and Allied Items.

Section IV, BuMed Publications.

Section V, EXOS Publications and Allied Items. (NOTE: These are publications originating in the Executive Office of the Secretary of the Navy.)

Section VI, BuShips Publications and Allied Items.

Section VII, BuDocks Publications and Allied Items.

Section VIII, BuWeps Publications and Allied Items.

Section IX, OpNav, Communications, Tactical Doctrine and Allied/NATO Publications.

Section X, OpNav Publications and Allied Items.

Section XI, BuSandA Publications and Allied Items.

Section XII, Publications of the Department of Defense and of other Government Agencies.

Section XIII, Graphic Laminated Placards.

Some of the sections previously mentioned are subdivided into two or more parts. For instance, Section VIII of NavSandA 2002 is divided into four parts A, B, C, and D. The subdivisions are as follows:

1. Part A contains a list of BuWeps ordnance publications.
2. Part B contains a list of ordnance supply office (Illustrated Parts Breakdown) publications.
3. Part C contains a numerical listing by code numbers and latest issued date of available aeronautic technical manual type publications. The date indicates the date of either the basic book, latest change, or revision.
4. Part D contains a listing and latest issue date of aeronautic letter type publications such as aviation armament changes, bulletins, and others that do not pertain to aviation ordnance.

In any aeronautic technical library an index to all available current publications should be maintained. This need is satisfied in aircraft maintenance activities by separating Parts C and D from Section VIII of NavSandA Publication 2002 and binding them together with three other indexes issued by BuWeps to form a 4-part index. The other three parts of the Naval Aeronautic Publications Index (NAPI) are the Equipment and Subject Applicability List, the Aircraft Application List, and the Directives Application List.

The Equipment and Subject Applicability List (NW 00-500A) is an alphabetic-numerical listing of aeronautic equipment and indicates publications (by code number) that are applicable to each items of equipment. The part or model number is listed next to the equipment name to make identification easier. Publication numbers appear more than once in this index inasmuch as complete equipment systems and their respective major components are listed separately. This list is used when attempting to determine what manuals or other directives are available on a particular item of equipment, and only the model, type, or part number of the item is known.

The Aircraft Application List (NW 00-500B) contains a listing of all currently available technical manuals grouped according to their application to an aircraft. This part of the index does not contain letter type publications, and all manuals are listed in numerical order by publication code number only.

A list of the basic numbering categories is provided in the introduction at the front of the book. This list may be used in determining the general type of equipment covered in a publication. For determining the specific item of equipment covered by a listed publication number and for the title of the publication, reference should be made to the numerical section of the NAPI (Part C, NavSandA Publication 2002).

The Aircraft Application List is especially handy for determining what manuals are available for a particular model of aircraft. Included under each model is a complete listing of applicable manuals. This listing includes all allowance lists; armament manuals; machinery, tools, test equipment manuals; etc., pertaining to that particular model aircraft.

The Directives Application List (NW 00-500C) is a relatively recent addition to the NAPI. It serves the same purpose for letter type technical publications (less Instructions and Notices) as the Equipment and Subject Applicability List does for manual type publications. All aircraft models are grouped under one of 10 series listed in the table of contents. Turning to the selected series, one finds a listing of the active BuWeps Technical Directives with respect to their application to aircraft models. Directives for different configurations of the same model aircraft are listed separately for each configuration.

Updating of the Naval Aeronautic Publications Index is accomplished by the monthly issuance of cumulative supplements except for the Aircraft Application List and the Directives Application List which are revised by a semiannual reissue. Supplements are issued between reissues for NavSandA Publication 2002 and the Equipment and Subject Applicability List. Both supplements list all directives which have been issued or canceled since the last reissue. Reissues of the first three parts of the NAPI occur semiannually in March and September and for the Directives Application List, in January and July.

(NOTE: During the last of fiscal year 1964, supplements were not issued monthly, but were issued every other month for NavSandA Publication 2002 and quarterly for NW 00-500A. Whether or not this represents a permanent change in policy is unknown at the time of this writing.)

Publications dealing primarily with the operation and maintenance of aircraft and related equipment within the Naval Establishment originate from BuWeps. For clarity of discussion, these publications are divided into two categories—aeronautic and ordnance. This division by subject matter should not be interpreted as a title of a group of publications. The aeronautic and ordnance publications most frequently used by the Aviation Weapons Officer are discussed in this chapter.

Aeronautic Publications

TECHNICAL MANUALS.—The basic sources of technical aeronautic information are the technical manuals (formerly called handbooks) issued by BuWeps. Letter publications usually supplement the information contained in aeronautic technical manuals.

Code numbers assigned to technical manuals consist of a prefix and a number series of three or four parts. The prefix may consist of the letters NavAer (NA), NavWeps (NW), AN, TO, or CO. NavAer manuals were published by the Bureau of Aeronautics before the establishment of BuWeps. However, all manuals printed since the establishment of BuWeps are printed with the NavWeps prefix.

MAINTENANCE INSTRUCTIONS MANUALS.—Maintenance Instructions Manuals (formerly called Handbooks of Maintenance Instructions) provide information concerning the location, function, operation, removal, installation, testing, adjusting, and troubleshooting of components. Maintenance methods recommended are concerned with procedures such as those which can be performed by an operating squadron.

The Bureau of Naval Weapons prepares Maintenance Instructions Manuals for each type of aircraft. These manuals provide invaluable aid in locating equipment components and interconnecting cables in the aircraft, for either inspection purposes or troubleshooting.

Before attempting any new task on an aircraft, such as removing and replacing a missile launcher, the Maintenance Instructions Manual for that particular aircraft should be consulted. By proper use of this manual, (following the prescribed procedures) possible damage to equipment may be prevented and much time may be saved.

In the past, these manuals have been arranged so that the pertinent sections could be removed and kept available in the shop. More recently, these manuals are being issued as separate publications under individual identifying numbers. This should facilitate the use of the manual by maintenance personnel.

EQUIPMENT MANUALS.—The Bureau of Naval Weapons prepares Operation and Service Instruction Manuals (formerly called Handbook of Operating Instructions and Handbook of Service Instructions) for various armament equipments which require such instructions; aircraft technical manuals meet the requirement in many cases. The Operation and Service Instruction Manuals are sometimes combined in one manual; however, they are often issued as two separate manuals. Operation Instruction Manuals cover the operation of specific equipments and the necessary checks and adjustments required for optimum performance. These instructions are written from the equipment operator's viewpoint and are divorced from the operating instructions contained in the aircraft manuals.

ILLUSTRATED PARTS BREAKDOWN.—The Illustrated Parts Breakdown (IPB) contains detailed illustrations and listings of the components and parts of the equipment for which it is issued. The main value of this manual is its usefulness when ordering parts for replacement purposes, which is discussed in chapter 4 of this text.

In addition to the IPB for each equipment, there is an IPB for the entire aircraft. This breakdown is useful for the same purposes as the equipment IPB's.

OVERHAUL INSTRUCTION MANUAL.—The Overhaul Instruction Manual provides detailed information for overhauling the armament equipment and/or component. This includes such procedures as disassembly, cleaning, repair, recalibration, testing, and any other steps necessary for complete overhaul. The manual also includes a tabulated list of test equipment recommended for overhaul. It is issued primarily to overhaul activities because the nature of the work described is beyond the capacities and facilities of field maintenance activities.

TECHNICAL MANUALS FOR AIR-LAUNCHED GUIDED MISSILE SYSTEMS.—These manuals contain valuable information on the various missile systems, which are rapidly being revised at the present time. Some of the information found in these manuals include scheduled maintenance instructions, periodic check and test procedures, loading and unloading procedures, and illustrated parts breakdown. The Navy Stock List of Forms and Publications, NavSandA 2002, should be consulted for the type of manual desired and the latest issue. The Aviation Weapons Officer is responsible for having available the proper manuals that his squadron will need for a particular type missile.

FLIGHT MANUAL.—The flight manual is published by the authority of BuWeps. Although published primarily for the pilot and aircrewman, it is the most readily available source of information on both normal and emergency operations of the aircraft. The manual gives complete operating instructions for operational systems of the aircraft covered.

SPECIAL WEAPONS CHECK LISTS.—Special weapons check lists are published for each model of aircraft having nuclear weapons capabilities. One Mk and Mod special weapon is covered in each set of coded lists. Specific information found in special weapons check lists include material requirements, inspections, wiring checks, loading checks, postloading checks, pre-takeoff, inflight, unloading checks, and many other items. Each set of lists is arranged in sequence, giving a step-by-step procedure required to safely load, deliver, or off-load the weapon. Steps should not be memorized but performed in the order listed. Further coverage of special weapons check lists is afforded in chapter 12 of this text.

REVISIONS.—Revisions are prepared and distributed when it becomes necessary to modify any manual. When properly entered in the manual, the revisions serve to keep the manual an official source of the latest information applicable to the equipment. The available manuals and the revisions are listed in NAPI and NavSandA Publication 2002 and their supplements. By making periodic checks of these, it is possible to determine which revisions are current and should be included in the manual.

Ordnance Publications

Ordnance publications were formerly prepared under the cognizance of the Bureau of Ordnance. However, they are now prepared and distributed under the authority of BuWeps. Some BuOrd publications are still current and will remain in effect until canceled, revised, or superseded by an appropriate BuWeps publication.

NAVWEPS OP 0 (INDEX OF ORDNANCE PUBLICATIONS).—With the issuance of the 33rd revision of NavWeps OP 0, a complete new format of this index is being tested. It is visualized that this sectionalized arrangement will prove more usable, more informative in regards to ordering publications, and easier to revise.

OP 0 now consists of several separate parts. Each part contains related material and is capable of being revised or expanded independently of the remaining parts. This flexibility is expected to be an asset in keeping this publication current.

Part 1 is the Ordnance Pamphlet (OP) section. The initial tabulation is a "numerical locator" which indicates the status of all OP numbers allotted to 1 October 1963. All current publications available from the Naval Supply Depot, Philadelphia, are listed in the "Cog I" section. Title, current revision, latest change, and cognizant technical desk are listed. Publications are not to be ordered from the cognizant technical desk. Titles of obsolete publications are not listed. The numerical locator should be checked to determine if a publication is obsolete and if there is a superseding publication. A section cross-referencing OP's and their related OSO (Ordnance Supply Office, Mechanicsburg, Pa.) prepared IPB's (Illustrated Parts Breakdowns) is included in Part 1. IPB's prepared by OSO use an independent numbering system unrelated to the OP numbering system. Under preparation publications and their estimated completion dates are listed in a separate section.

Part 2 is the Ordnance Data (OD) section. The arrangement is similar to that of Part 1.

Part 3 is a series of indexes. This revision of OP 0 has an index of NavOrd charts, an index of Department of the Army publications used by the Navy and two special indexes. An index of publications related to surface missile systems and an index of publications related to mine systems are included with the intention of including additional special indexes of this type in the future.

Part 4 is a subject index of OP's and OD's listed in OP 0. During the testing period, NavWeps OP 0 (33rd revision) reports of errors or inaccuracies will be appreciated and should be forwarded to the Commanding Officer, U.S. Naval Weapons Services Office Code 100, U.S. Naval Base, Philadelphia, Pa., 19112.

NAVWEPS ORDNANCE PAMPHLETS (OP's).—These basic publications, serially numbered without regard to subject content or date of publication, deal with specific ordnance equipment, or subjects within the field of ordnance. Equipment OP's usually provide description information and instructions necessary for the operation, service, and maintenance of specific ordnance equipment.

NAVWEPS ORDNANCE DATA (OD's).—These publications are serially numbered in the same manner as OP's. They contain test, inspection, installation, description, maintenance, and operation data on components of ordnance equipment within the technical field. In the field of administration, OD's are published for publications allowance lists, equipment lists for specific ships, and the Index to Navy Ammunition Stock.

NAVWEPS ORDNANCE CHARTS (OC's).—NavWeps Ordnance Charts can be either drawings or diagrams. They are usually used as visual aids during a course of instruction. The majority are prepared as large wall charts, utilizing multiposition views or blowups to aid both the student and instructor.

NAVWEP'S ORDNANCE LETTER PUBLICATIONS.—Ordnance letter type publications in various categories are published and distributed under the cognizance of BuWeps in the form of minor changes to OP's, OD's, NavOrd Lists, etc. However, the main types of ordnance letter publications are the instructions and notices distributed by the Navy Directives System.

In order to improve the availability and effectiveness of ordnance publications, BuWeps has established a system for updating of Ordnance Pamphlets (OP's) and Ordnance Data (OD's) on a periodic basis. Feedback from forces afloat, from training activities, and from maintenance activities is an essential element in keeping these technical manuals up to date.

NAVY WARFARE PUBLICATIONS

Naval Warfare Publications (NWP's) are tactical publications which describe doctrines and procedures as prescribed by the Chief of Naval Operations.

NWP 0 describes the entire doctrinal publications system. Charts explaining in detail the interrelationships among these publications, and detailed indexes of their contents are found therein.

Due to the classification of most NWP's, they are only mentioned in this text. The type of billet to which the Aviation Weapons Officer is assigned will determine the extent he will use NWP's.

Section IX of the Navy Stock List of Forms and Publications (NavSandA Publication 2002), lists the numerous current OpNav Communications, Tactical Doctrine and Allied/NATO Publications (which include NWP's) that are published and available to needed activities. Section IX does not give the complete title to the various NWP's, Naval Warfare Information Publications (NWIP's), etc. However, each type of publication is normally available and may be ordered as needed by individual activities. OpNav Instruction P05605 is a classified published requirements list of COMTAC Publications (Certain Communication Tactical Doctrine, Allied and/or NATO Publications) for the naval shore activities.

Requisitioning procedures for COMTAC publications are as follows:

Prepare and submit a DOD Single Line Item Requisitioning System Document (DD Form 1348 or DD Form 1348m) in accordance with Navy Standard Requisitioning and Issue Procedures. Check the requisition restriction code "RR" column in the Section IX. If a requisition restriction code is indicated, submit a DD Form 1348 or 1348m direct to CNO. (Do not submit direct to stock points as this will delay issues.)

Operating Forces use the current OpNav Instruction's P05605 series as the basic instructions and procedures for the distribution, procurement, and disposition of COMTAC Publications. Naval shore activities use this stock list in conjunction with the current OpNav Instruction's P05605 series in ordering COMTAC material.

The type of information that can be found in NWIP's include command functions, mission, tasks, and organization, capabilities of the type unit, standard operating procedures, advanced base operations, and other information. Most of these publications are highly classified.

Various fleet publications and the "short titles" that are more commonly used are listed in table 3-1. Although some of these publications may never be used by the Aviation Weapons Officer, they are shown for representative types.

Table 3-1. —Fleet publications.

Title	Short title
Navy Warfare Publications:	
Shipboard Procedure	NWP 50A
Antiair Warefare	NWP 32A
Replenishment at Sea	NWP 38A
Naval Warfare Information Publications:	
Battle Control	NWIP-50-1A
Naval Weapons Selection-Ships	NWIP-20-2A
Naval Gunfire Support in Amphibious Operations	NWIP-22-2
Fleet Exercise Publications:	
ASW Exercise	FXP-1
AC Exercise	FXP-2
Gunnery Exercise	FXP-3A
Allied Tactics Publications:	
Allied Naval Maneuvering Instructions	ATP-1A Vol I
Allied Spotting Procedure for Naval Gunfire Support	ATP-4

MISCELLANEOUS PUBLICATIONS

Some of the important miscellaneous Navy publications issued periodically, which provide current information pertinent to many phases of the Aviation Weapons Officer's duties are discussed in the following paragraphs.

Naval Weapons Bulletin

The bulletin is a Confidential publication issued quarterly by BuWeps. The first bulletin issued in each calendar year lists all articles printed in the bulletin the preceding year. It is published to keep the Naval Establishment informed of the progress of certain aviation and ordnance projects likely to be of general interest (including new developments). Many of the latest ordnance innovations are detailed in the bulletin. These innovations may range from suggestions in using present equipment to those furnishing background information on advanced developments and concepts which might be useful for future planning.

Naval Aviation News

The News is published by the Chief of Naval Operations and BuWeps. It is a monthly magazine of general and specific interest to all aviation ratings in the Navy. There is usually a section of this magazine devoted to aviation ordnance alone. Current developments as well as helpful hints regarding work with aviation ordnance equipment are contained in this section.

All Hands

All Hands (NavPers-0) is a Bureau of Naval Personnel Bulletin. It is published monthly by the Bureau of Naval Personnel and contains information of general interest to all naval personnel.

Naval Training Bulletin

The Naval Training Bulletin (NavPers 14900), is published quarterly and contains valuable information on training techniques and methods as well as other interesting articles on training problems. It also includes a catalog of the latest published NavPers training publications and correspondence courses.

Approach

Approach is published monthly by the U.S. Naval Aviation Safety Center and is distributed to all naval aeronautical organizations. It should be read by all Aviation Weapons Officers for the most accurate information currently available on the subject of aviation accident prevention.

Mech

Mech is published annually by the U.S. Naval Aviation Safety Center and reviews the maintenance and servicing mishaps that occurred on aircraft during the year. This publication gives excellent coverage, by aircraft type and by shop or system, of the various maintenance errors that occur annually.

NAESU Digest

The Naval Aviation Engineering Service Unit (NAESU) each month prepares and publishes the magazine Digest of U.S. Naval Aviation Electronics. The digest contains information on electrical and electronic equipment relative to operation, maintenance, installation, and supply.

This is an excellent source of information dealing with new equipment and presents new ideas on older equipment. It gives the latest procedures for reducing test, calibration, and alinement time of equipment now in use as these methods are developed by NAESU and other activities. In general, it is, as the name suggests, a digest of all the latest information pertaining to work in electronics. It should be on the "must" read list for all Aviation Weapons Officers and always available as a ready reference for the crew.

Army Publications

Other publications from which valuable information and instructions may be gained are Department of the Army publications. Examples of these are such publications as Technical Manuals, Technical Bulletins, Field Manuals, etc.

The BuWeps Index of Ordnance Publications OP 0 also lists Department of the Army publications that are stocked by the Naval Supply Depot for issuance to the various naval activities and may be beneficial to the Aviation Weapons Officer.

NAVY CIVILIAN PERSONNEL INSTRUCTIONS (NCPI'S)

The Aviation Weapons Officer will sometimes during his career work either in close proximity to civilian employees or have civilians working under his purview. A high degree of proficiency in civil service management can improve his cooperation and coordination in management function.

The Aviation Weapons Officer who has civil service employees working under his supervision will have many personnel problems that are normally not encountered in the fleet. However, the main objective is the same regardless of the individuals being supervised—to see that the job is performed efficiently and economically. In the case of civil service employees, the Aviation Weapons Officer can best accomplish this by having a broad knowledge of the civil service policy, rules, and regulations that govern civil service employees.

The three basic authorities for NCPI's are as follows:

1. Article 0785—States the laws that govern the civilian supervisors.
2. General Order No. 5—Assigns responsibilities to civilian executive assistants.
3. SecNav Instruction 5430.7E—Delegates responsibilities to the Under Secretary of the Navy which include supervision and

administration of civilian personnel. He is also head of the Office of Industrial Relations (OIR)

NCPI-1, NAVEXOS P-122 Administration of Navy Civilian Personnel Instructions, provides all supervisors and employees with overall instructions for administration of civilian personnel within the Department of the Navy. These Instructions are issued to achieve the following objectives:

1. Assure uniformity throughout the Navy in applying and interpeting laws, executive orders, Comptroller General decisions, and Navy Department policies and procedures.
2. Provides in a single book serial order, overall instructions, policies and procedures relating to administration of civilian personnel.
3. Assures like treatment to all civilian personnel in the Navy.

Some of the more pertinent NCPI's that may concern the Aviation Weapons Officer in the performance of his routine duties are listed in table 3-2.

Table 3-2. —Listing of NCPI's.

NCPI No.	Subject
1	Administration of Navy Civilian Personnel Instructions.
211	Veteran Preference.
340	Promotions.
410	Training.
430	Performance Appraisals and Ratings.
450	Incentive.
512	Position Classification.
630	Absence and Leave.
713	Government Nondiscriminatory Employment Policy.
721	Employee Organization.
750	Disciplinary Offenses and Penalties.
830	Retirement and Social Security Benefits.

CLASSIFICATION AND SECURITY

Since much of the Aviation Weapons Officer's work requires the use of classified matter, an understanding of proper safeguards, dissemination, and control of such matter is essential.

It is the responsibility of every officer and man in the Navy to safeguard military information. The Aviation Weapons Officer must be especially vigilant since he works with classified material in his everyday duties.

The Department of the Navy Security Manual for Classified Information, OpNav Instruction 5510.1B (or latest revision) is the controlling guide in safeguarding classified information. However, there is no adequate substitute for continuous day-to-day practice in the proper methods of handling classified material. NOTE: OpNav Instruction 5510-49A is also a guide for the handling and control of classified matter. It is based on the requirements set forth in OpNav Instruction 5510.1B.

CLASSIFICATION OF DOCUMENTS

Matter which requires classification in the interests of national defense is assigned the lowest classification category appropriate thereto in accordance with the Department of the Navy Security Manual for Classified Matter. Classified matter, including extracts therefrom, is classified according to its own content and not according to its relationship to other classified matter.

GRADES OF CLASSIFICATION

Official information which requires protection in the interest of national defense is limited to one of three categories: Top Secret, Secret, or Confidential (including Confidential—Modified Handling Authorized). No information may be withheld or classified, if otherwise releasable, simply because such information might reveal an error or inefficiency, or might be embarrassing.

Top Secret

The use of the classification Top Secret is limited to defense information or material which requires the highest degree of protection. Top Secret is applied only to that information or material, the unauthorized disclosure of which could result in exceptionally grave damage to the Nation, such as:

1. Leading to a break in diplomatic relations, an armed attack on the United States or its Allies, or a war.
2. The compromise of military plans or scientific or technological developments vital to the national defense.

Secret

The use of the classification Secret is limited to defense information or material the unauthorized disclosure of which could result in serious damage to the Nation, such as:

1. Jeopardizing the international relations of the United States.
2. Endangering the effectiveness of a program or policy vital to the national defense.
3. Compromising important military or defense plans, scientific or technological developments important to national defense.
4. Revealing important intelligence operations.

Confidential (Confidential—Modified Handling Authorized)

Information or material classified Confidential is placed in the category in which unauthorized disclosure could be prejudicial to the defense interest of the nation.

Certain types of Confidential information may be identified by the term "Confidential—Modified Handling Authorized." This is material which, although falling into the group described by Confidential, has been designated by the originator for slightly lesser safeguards of stowage and transmission. This is done only after careful consideration of its content and only for the purpose of making it more easily available to those who need to use it. Examples are textbooks, manuals, maps, and photographs the contents of which make it permissible and desirable for them to be used for training purposes.

Restricted Data

The term "Restricted Data" is not a category of classification, but is assigned because of the general subject of the documents. It applies to all data concerning the design, manufacture, or utilization of nuclear weapons; the production of special nuclear material; or the use of special nuclear material in the production of energy—unless such data or materials have been declassified or removed from the category by the Atomic Energy Commission.

Information is marked Restricted Data (Top Secret), (Secret), or (Confidential) according to the protection it should receive. It is declassified when the Atomic Energy Commission decides it may be published without undue risk to the defense and security of the Nation.

RESPONSIBILITY

The Chief of Naval Operations is responsible to the Secretary of the Navy for all policies relating to the security of all classified information within the Naval Establishment. Under the Chief of Naval Operations, the Director of Naval Intelligence has been designated as the officer primarily responsible for the protection of classified information. Therefore, the Office of Naval Intelligence formulates and promulgates naval policies which relate to the security of classified information.

Loss or Compromise

Any person having knowledge of the loss or possible compromise of classified matter must report the fact immediately to his commanding officer. The commanding officer then takes the proper action as outlined in detail in the Security Manual.

Violations of regulations pertaining to the safeguarding of classified information, but not resulting in its loss, compromise, or disclosure, are acted upon by the commanding officer.

It is vital that every Aviation Weapons Officer who handles classified material be completely familiar with paragraph 0805 of the Security Manual. This paragraph sets forth the policy for disciplinary action in the case of violations of security.

It must always be remembered that the Aviation Weapons Officer is responsible for the classified material in his care. Anyone who willfully or negligently mishandles classified material is disciplined by his commanding officer or by a court-martial, depending on the circumstances. If mishandling results in loss or compromise, disciplinary action is almost certain to be severe.

Personal Censorship

There is no way of estimating how many battles have been lost, how many ships were sunk, or how many lives were sacrificed because someone casually, or in a moment of boasting, unintentionally betrayed a vital military secret.

It is quite natural for a man to be proud of the work he is doing. He wants to share this pride with his friends and family. This would be fine with most jobs in the Navy. However, for the Aviation Weapons Officer, this very definitely may not be done. Enthusiasm towards one's work is clearly a desirable trait, but not when it results in discussing classified information. There is only one safe conversational policy to follow and that is to say nothing about the work one does to anyone.

To keep the silence, one should decline to discuss official matters by skillful maneuvering of the conversation or by outright refusal to talk shop.

Security

Security is a means—not an end. Rules which govern security of classified matter are much the same as gunnery safety rules. They do not guarantee protection, and they do not attempt to meet every situation.

Security regulations are not intended to restrict the initiative of mature individuals. With commonsense and mature thinking, it is possible to obtain a satisfactory degree of security with a minimum of sacrifice in operating efficiency

The Department of Defense employs a security formula which is simple in principle. It is based on the theory of circulation control—the control of the dissemination of classified information. Therefore, knowledge or possession of classified information is permitted only to those who actually require it in the performance of their duties, and then only if they have been determined to be trustworthy. This is sometimes called the principle of the "need to know."

Control

Each individual in the Naval Establishment should take every precaution to prevent deliberate or casual access to classified information by unauthorized persons. Some of the precautions are discussed in this section.

When classified materials are removed from stowage for working purposes, they should be kept face down or covered when not in use.

Visitors not authorized access to the particular classified information within a working space should be received in a specially designated visiting space.

Classified information should never be discussed over a telephone. Remember also that a telephone scrambler device does not insure security.

If, for any reason, a room must be vacated during working hours, all classified material in the room should be stowed in its proper containers.

At the close of the working day a system of security checks should be performed to insure that the classified material is properly protected. All classified material must be properly stowed.

In the event of a fire alarm or other emergency, classified material is stowed in the same manner as at the end of a working day. Each person who has classified material in his possession at the time of a fire alarm or other emergency assures that the material is properly safeguarded.

An accurate record of destruction of classified material is as important as its destruction. A certificate of destruction of nonregistered Top Secret and Secret documents is always prepared. The certificate is retained for a period of 2 years by the command destroying the material. The certificate provides complete identification of the material destroyed, the date of destruction, and it is signed by the officer authorizing destruction.

AUTOMATIC DECLASSIFICATION

Documents require certain additional markings in accordance with the Automatic, Time-Phased, Downgrading and Declassification System. This system divides documents into four groups according to the type of information contained, and provides for standard downgrading or declassification for certain documents, based on elapsed time since origination and the type of information included. The complete details of the system may be found in OpNav Instruction 5500.40A or subsequent issue.

ADMINISTRATION

The various directives, reports, records, and memorandums are the necessary communications whereby all concerned activities are informed of the latest available information regarding fleet aviation. The administrative responsibilities associated with these directives, reports, etc. are of the utmost importance to the Aviation Weapons Officer. The efficiency of any squadron, department, division, or branch is reflected in the manner in which these administrative details are handled.

AVIATION WEAPONS OFFICER'S DUTIES AND RESPONSIBILITIES

The Aviation Weapons Officer, afloat or ashore, is normally assigned the following general duties and responsibilities:

1. Supervision of maintenance and repair of aviation ordnance equipment.
2 Implementation of maintenance directives and instructions.
3. Formulation of local directive and aviation weapons division/branch maintenance policies.
4. Promotion and enforcement of high standards of workmanship and shop practices.

In addition, the Aviation Weapons Officer is responsible for having available an adequate allowance for providing training of personnel in the maintenance, operation, and use of aviation ordnance equipment. He is also responsible for insuring that all safety precautions, methods, and regulations are complied with. He must advise tactical personnel regarding the operational capabilities and limitations of aircraft ammunition and ordnance equipment as installed or carried aboard aircraft. He must also be thoroughly familiar with the duties of the division/branch officer.

BRANCH MANAGEMENT

The more responsible the Aviation Weapons Officer's position, the more important it is that he direct and supervise the work of his subordinates, and seemingly the less time he has available to accomplish this priority task. One solution to this problem is the proper delegation of authority to subordinates. The Navy's lineal system, popularly known as the "chain of command," encourages delegation of authority and thereby makes it possible for one person to control the activities of many others. When a subordinate is told to perform a job, he is responsible for its accomplishment. This does not relieve the officer of the final responsibility to his seniors for completion of the job, nor does it eliminate the need for supervisory control on his part. It does, however, free him from the countless details involved in direct supervision of a group of individuals.

Proper delegation of authority is one of the most difficult tasks that an inexperienced supervisor faces. He may realize that it is physically impossible for him to supervise the activities of an entire division or branch, but be reluctant to rely upon the judgment and ability of a subordinate.

To properly manage an ordnance division or branch, the Aviation Weapons Officer should be thoroughly familiar with the tools or media that are combined to operate a shop effectively. The tools or media used are basically as follows:

1. The various directives, records, reports, and memorandums received or promulgated.
2. The locally drafted letters or other correspondence sent out.
3. Highly trained personnel.

Each of these items are discussed in this chapter.

INSTRUCTIONS AND NOTICES

Instructions and notices (as discussed earlier in this chapter) are the two main types of directives provided for in the Navy Directives System. They are the basic tools of military management which provide means of transmitting the plans and policies of executive personnel to all levels of the organization. They also serve as the guidelines that control the decisions and actions of subordinates in the organization. The directives system must provide for the wide dissemination of the policies of the commanding officer and others in command and responsible for the operation of the ship, squadron, or unit. The directives system must also provide a medium for subordinate officers to issue amplifying and supplementary instructions for placing these policies into effect.

Local ordnance division/branch directives establish policies, procedures, and programs; transmit orders and instructions; allocate duties and responsibilities; and, in general, govern the activities of the division/branch. To insure that the crew receives the proper direction, instruction, and information, the directives, which must be channeled to the attention of the shops, discuss the following subjects:

1. Proper operation of aircraft power units.
2. Ordnance safety precautions.
3. Ordnance preflight procedures.
4. Ordnance maintenance checks.
5. Specific electrical safety precautions to be observed.
6. Night crew instructions.
7. Line maintenance procedures.
8. Shop maintenance procedures.
9. Flight crew instructions and procedures.

Additional instructions should be promulgated concerning the following type items in order to provide the division/branch with information of which they should be cognizant:

1. Storm, fire, and battle stations.
2. Equipment custody.
3. Security information.
4. FUR form preparation.
5. Ordnance storeroom organization.
6. Report and record requirements.

These lists are by no means all inclusive, but are a few of the topics to be covered at the division/branch level.

Reports are required from various departments and command levels to compile statistical and other data regarding implementation of various directives. Reports are also prepared for evaluating the effectiveness of various activities, facilities, groups, etc., and to determine the effectiveness of these policies, procedures, and activities in order to improve and keep current the operational capabilities of the naval aviation force. Records are those documents formulated to keep a current status of various operations, training, facilities, inventories, etc., necessary for maintaining Navy efficiency.

CORRESPONDENCE

A great asset to the Aviation Weapons Officer is the ability to properly draft or supervise preparation of official correspondence.

Official correspondence in the Navy includes all recorded communications sent or received by a person in the Navy in the execution of the duties of his office. Aviation Ordnance activities, both ashore and afloat, originate and receive various amounts of correspondence. Some of the more common types are directives outlining basic policies and procedures, naval letters requesting and furnishing procedural information and authority, and letters and memorandums assigning duties and individual responsibilities.

Outgoing correspondence is normally drafted by senior petty officers or officers of the ordnance division/branch. Some correspondence originated by ordnance divisions/branches, however, is of a recurring nature and is relatively standard in content. This may include such correspondence as recommended changes to allowance lists, requests for special material, or periodic reports to higher authority.

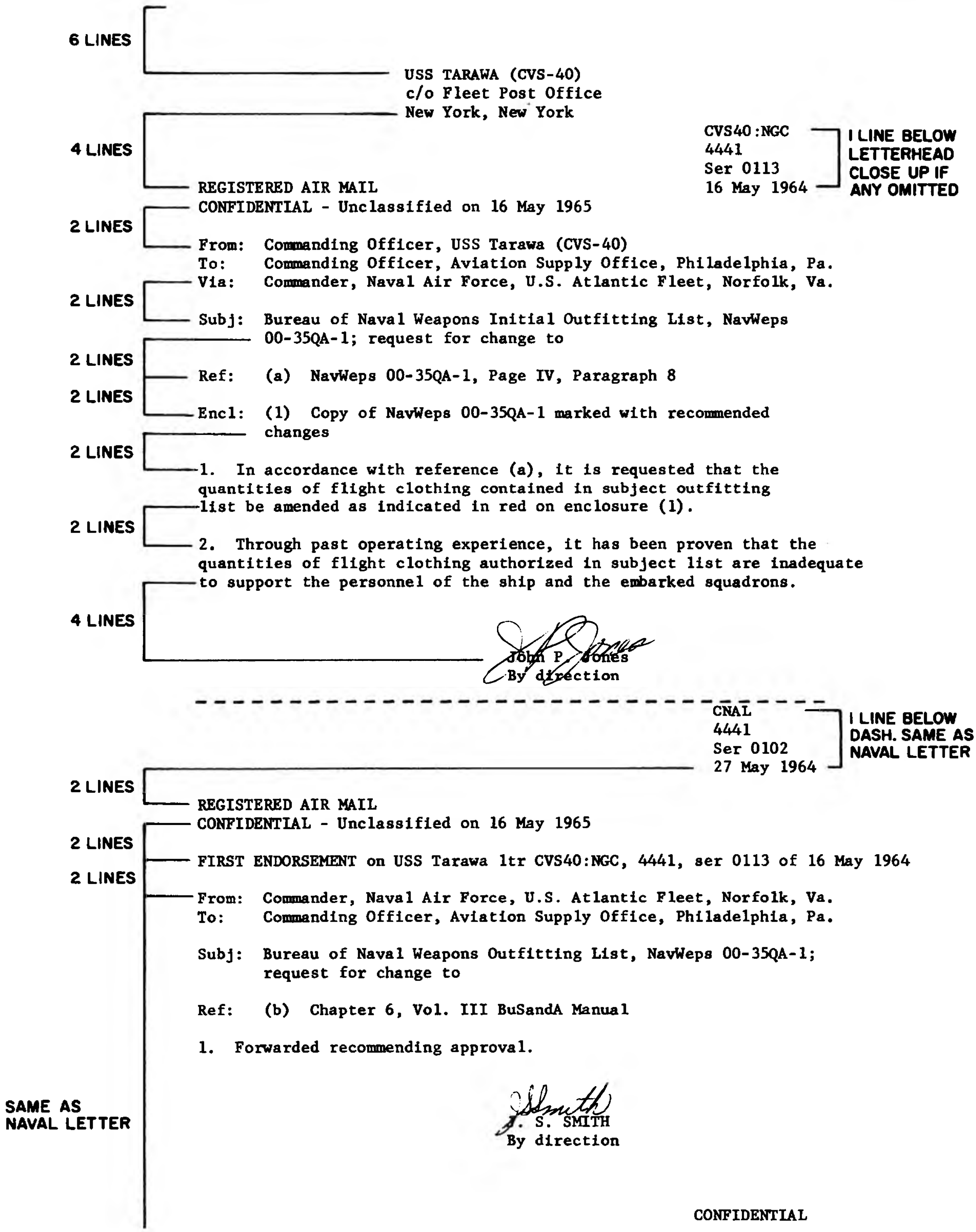
The samples shown in this chapter are based on the instructions contained in the Navy Correspondence Manual, SecNav Instruction 5216.5. Slight variations from these formats may be practiced at different commands. When assigned to a billet requiring the preparation of correspondence, it is necessary to consult local command instructions outlining the details pertaining to the preparation of official correspondence in that command.

Naval Letters

Within the Navy, official letters are usually prepared in naval format. This format also is used when writing to certain other agencies of the U.S. Government, especially those within the Department of Defense or the Coast Guard. Some civilian firms that deal extensively with the Navy have also adopted the naval format. The various components of a naval letter are discussed in the following paragraphs and are illustrated by figure 3-1.

STATIONERY.—Letterhead stationery of the activity responsible for signing the correspondence is used for the first page of a naval letter. If printed letterhead is not available, the letterhead is typed or stamped in the center of the page 6 lines or 1 inch from the top of the page.

Second and subsequent pages are typed on plain bond paper similar to the letterhead in size, color, and quality. For carbon copies, white and colored tissues are used. The official file copy is prepared on green tissue.



USS TARAWA (CVS-40)
c/o Fleet Post Office
New York, New York

CVS40:NGC
4441
Ser 0113
16 May 1964

REGISTERED AIR MAIL
CONFIDENTIAL - Unclassified on 16 May 1965

From: Commanding Officer, USS Tarawa (CVS-40)
To: Commanding Officer, Aviation Supply Office, Philadelphia, Pa.
Via: Commander, Naval Air Force, U.S. Atlantic Fleet, Norfolk, Va.

Subj: Bureau of Naval Weapons Initial Outfitting List, NavWeps 00-35QA-1; request for change to

Ref: (a) NavWeps 00-35QA-1, Page IV, Paragraph 8

Encl: (1) Copy of NavWeps 00-35QA-1 marked with recommended changes

1. In accordance with reference (a), it is requested that the quantities of flight clothing contained in subject outfitting list be amended as indicated in red on enclosure (1).

2. Through past operating experience, it has been proven that the quantities of flight clothing authorized in subject list are inadequate to support the personnel of the ship and the embarked squadrons.

John P. Jones
By direction

CNAL
4441
Ser 0102
27 May 1964

REGISTERED AIR MAIL
CONFIDENTIAL - Unclassified on 16 May 1965

FIRST ENDORSEMENT on USS Tarawa ltr CVS40:NGC, 4441, ser 0113 of 16 May 1964

From: Commander, Naval Air Force, U.S. Atlantic Fleet, Norfolk, Va.
To: Commanding Officer, Aviation Supply Office, Philadelphia, Pa.

Subj: Bureau of Naval Weapons Outfitting List, NavWeps 00-35QA-1; request for change to

Ref: (b) Chapter 6, Vol. III BuSandA Manual

1. Forwarded recommending approval.

J. S. SMITH
By direction

CONFIDENTIAL

Figure 3-1. —Format of naval letter and endorsement.

COPIES.—Before a letter is typed, determine the number of copies needed. Requirements for copies of naval letters are determined by such factors as subject of the letter, type and number of addresses, and local filing practices. Although the necessary number of copies must be determined separately for each letter, the following copies are generally standard:

1. One green copy for originator's official files.
2. One white copy for each "Via" addressee.
3. One white copy for each "Copy to" addressee.

MARGINS.—On the first page of all naval letters, the left margin and the right margin are 1 inch, and the bottom margin at least 1 inch. On the second and succeeding pages, the margin at the top is 1 inch. The other margins are the same as on the first page.

GENERAL STYLE.—No salutation or complimentary close appears on a naval letter. Major paragraphs are typed in block style; that is, without indenting. Periods do not follow the parts of the heading or the closing. Abbreviations are used in the following items of the heading: Subiect (Subj), Reference (Ref), and Enclosure (Encl). When referred to in the text of the letter, these are spelled out. A heading entry that is too long to be completed on one line is carried over to the next line, flush with the first word following the colon.

IDENTIFICATION SYMBOLS.—Three types of identification symbols may be used on correspondence for reference and record purposes. They are the originator's code, the file number, and the serial number. One or more may appear on a letter, depending on local practice.

An ORIGINATOR'S CODE is a system of letters, numbers, or a combination of both, used for the sake of brevity to indicate the organizational unit within the activity preparing the correspondence. An originator's code is formed according to local instructions and must appear on all outgoing correspondence. Since the "From" line appears on all naval letters, the originator's code should not contain the activity code. It should, except in the case of ships, identify the department or organizational unit within the activity preparing the letter. The hull number of a ship may be used instead of an originator's code. The originator's code should appear 1 line below the last line of the letterhead and commence 2 inches from the right of the page.

A FILE NUMBER is used to indicate the subject under which the letter is to be filed. A file number is not mandatory, but when it consists of a 4- or 5-digit numeric code selected from the list of standard subject classification numbers, which is contained in Navy-Marine Corps Standard Subject Classification System Manual, SecNav Instruction P5210.11. The file number, when used, should appear 1 line below and blocked with the originator's code.

A SERIAL NUMBER is one of a consecutive group of Arabic numerals assigned to a specific piece of correspondence for identification purposes. Classified correspondence must be serially numbered in each calendar year by the originator. Unclassified mail may be serially numbered if desired. The serial number, when used, should appear 1 line below the preceding line of type and blocked with the originator's code.

On continuation pages the originator's code begins 2 inches from the right margin and 6 lines from the top of the page. The other identification symbols are blocked as they are on the first page.

DATE.—The date is always placed on the right side of the page, blocked 1 line below the last line of the identification symbols and is arranged as follows:

1. The day, month, and year (1 July 1965) are expressed in the order named.
2. The day is always expressed by numerals.
3. The month is either spelled out or abbreviated by using the first 3 letters of the word. If abbreviated, it is not followed by a period.
4. The year is expressed in 4 digits.
5. No punctuation is used between the month and the year.

Correspondence is dated with the date on which it is signed. The date may be typed or stamped according to local practices.

SPECIAL POSTAL SERVICE.—If special postal service is to be used, the appropriate designation (airmail, special delivery, or registered mail) is typed in capital letters or stamped on the letter. The designation is positioned at the left margin 4 lines below the last line of the address in the letterhead.

CLASSIFICATION.—If a letter is classified, the appropriate designation (Top Secret, Secret, or Confidential) is typed in capital letters or stamped on the letter. The appropriate designation is positioned at the left margin 5 lines below the last line of the address in the letterhead. When practicable, the stamped lettering should be in red.

On succeeding pages, the classification is typed in capitals or stamped at the left margin, 1 inch, or 6 lines, from the top of the page. The classification is repeated at the bottom of all pages, one-half inch from the lower edge and ends flush with the right margin. In addition, the serial number on a classified letter is preceded by one or more 0's to indicate the degree of classification. One 0 indicates Confidential, two 0's Secret, and three 0's Top Secret

"FROM" LINE.—The "From" line is typed 7 lines below the last line of the letterhead address and begins at the left margin. Two spaces are allowed between the colon after "From" and the beginning of the addressor's title. The "From" line identifies by title the official in authority (commanding officer, officer in charge, etc.) over the activity or other organizational unit having cognizance of the subject covered by the letter. As the addressor of the letter, he is the official to whom reply, if necessary, is directed. Sufficient information is given in the title to enable the recipient of a copy not on a letterhead to identify the letter as to its origin.

If a window envelope is to be used for transmitting a letter, the position of heading entries on the letter must be adjusted to meet the spacing requirements of the envelope. The "From" line is 4 lines below the last line of the address in the letterhead. Figure 3-2 illustrates a letter to be transmitted in a window envelope.

"TO" LINE.—The "To" line is placed on the line below the "From" line. There are 4 spaces between the colon after "To" and the beginning of the title of the addressee. An official letter intended for a command or activity is normally addressed to the commanding officer or officer in charge, as opposed to an organizational component of the command or activity. Except in the case of correspondence intended for a ship, the title of the addressee may be followed by the title or the code designation (in parentheses) of the organizational component having immediate responsibility for the subject matter.

If the letter is to be transmitted in a window envelope, special care in placing the address is necessary. The "To" line on letters for window envelopes is 3 lines below the "From" line (fig. 3-2). No line of the address may extend more than 5 inches from the left side of the

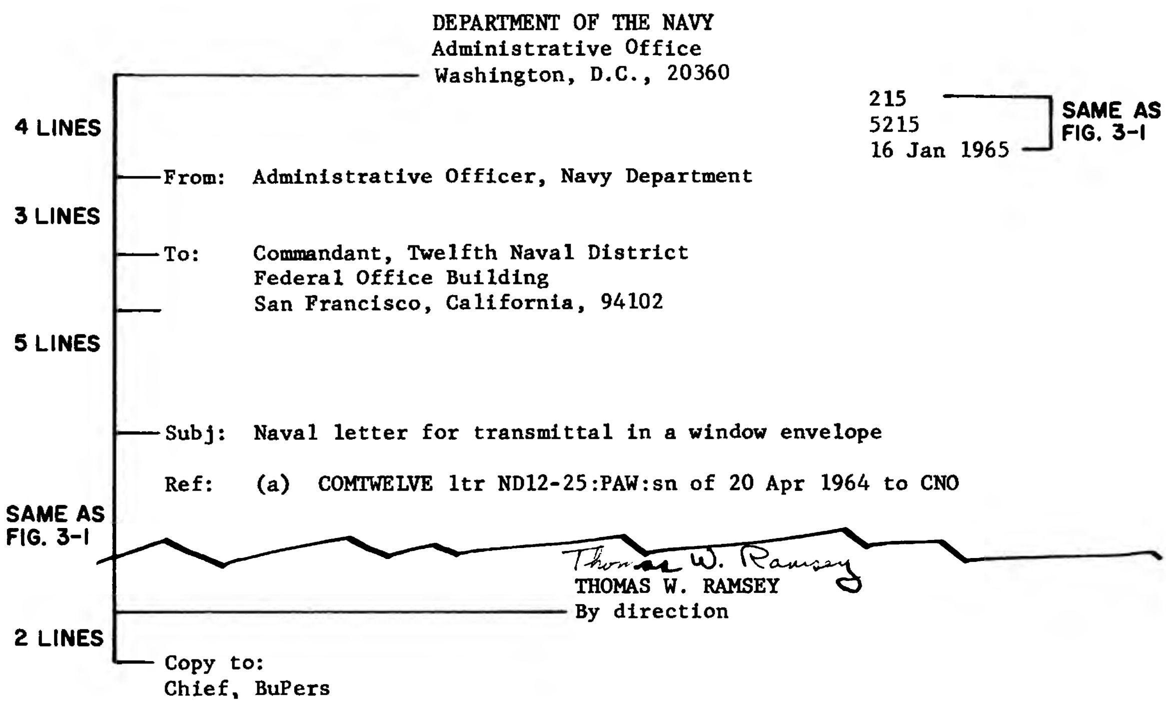


Figure 3-2.—Letter prepared for transmission by window envelope.

page. Only the title and the address should appear in the window.

"VIA" LINE.—The "Via" line is placed on the line below the "To" line. If there is more than one "Via" addressee, each is numbered with an Arabic numeral enclosed in parentheses The numerals indicate the sequence through which the correspondence is to be sent, the official numbered (1), being the first "Via" addressee to receive the letter, and so on. When there is only one "Via" addressee, 3 spaces are left between the colon after "Via" and the beginning of the title of the addressee. If more than one "Via" addressees are to be included, 3 spaces are left between the colon and the beginning of the numbering of the first addressee.

A letter containing two or more "Via" addressees is not suited for transmission in a window envelope. If there is only one "Via" addressee, such transmission is possible by raising the "From" line 1 space and placing the "To" line (from which the address is omitted) on the line below. The "Via" line is then placed, with the full address, in the position usually occupied by the "To" line.

SUBJECT LINE.—The abbreviation "Subj" is used to introduce a topical statement of the subject of the correspondence. The "Subj" line is 2 lines below the preceding line of type (5 lines for window envelope). There are 2 spaces from the colon after "Subj" to the beginning of the subject.

The subject is stated briefly and specifically, with key words first, and followed by necessary explanatory words. Only the first word and proper nouns are capitalized. If the explanatory words break the normal sequence of words in the subject, they are separated from the key phrases by a semicolon; for example, Naval letters; instructions for preparation and use of. A letter of reply usually repeats the subject of the incoming letter.

On continuation pages, if a file number is not used, the subject (with the caption, "Subj") should be placed at the left margin 2 lines below the originator's code. If a file number is used, the subject is not repeated on continuation pages.

REFERENCE LINE.—The abbreviation "Ref" (without "s" even though there is more than one reference) is used as the caption when previously prepared material is cited. The "Ref" line is 2 lines below the last line of the subject; each reference citation begins on a new line. Three spaces intervene between the colon after "Ref" and the beginning of the first reference.

References are listed in the order in which they are discussed in the text of the letter. They are designated by small letters enclosed in parentheses ((a), (b), (c), etc.) An enclosure is never listed as a reference.

When a letter is cited as a reference, the reference line should include the following identifying information:

1. The abbreviated title of the originator of the referenced letter.
2. The location of the activity.
3. The abbreviation "ltr."
4. All identification symbols assigned to the referenced letter.
5. The date of the referenced letter preceded by the preposition "of."
6. The functional title of the addressee of the referenced letter if the letter was not addressed to the originator of the letter being prepared. The functional title is preceded by the preposition "to."
7. If no identification symbols appear on the letter, the subject is given instead. The subject is introduced by the abbreviation "Subj" followed by a colon and is added at the end of the reference.

When documents other than letters are listed as references, they are fully identified as to origin, type, title, and date.

ENCLOSURE LINE. — The abbreviation "Encl" (without "s" even though there is more than one enclosure) is used to introduce a listing of materials forwarded with the letter. The "Encl" line is 2 lines below the preceding line of typing, with each enclosure notation beginning on a new line. Two spaces follow the colon after "Encl."

Enclosures are numbered with Arabic numerals in parentheses. They are identified in the same manner as references are in the "Ref" line. When material must go under separate cover, the designation "(SC)" is placed between the number and the description of the enclosure.

Each enclosure that accompanies the letter is identified by typing, stamping, or writing in the lower margin the word "Enclosure" and the number assigned to it in the heading of the letter. An enclosure to be sent under separate cover is identified by placing in the lower margin the word "Enclosure" and the number assigned to it in the heading of the letter, the abbreviated functional title of the addressor, the abbreviated word "ltr," and the date of the letter. If a carbon copy of the orginial letter is attached to an enclosure that goes under separate cover, only the word "Enclosure" and the assigned number need be indicated on the transmittal.

Ordinarily a transmittal of multiple copies of the same material is considered a single enclosure, and only one copy is labeled. The number of copies should be indicated on the "Encl" line.

TEXT.—The text (or body) of the letter begins 2 lines below the preceding line of typing.

Major paragraphs are numbered at the left margin with Arabic numerals followed by a period. Two spaces are allowed between the period and the beginning of the first word. The test of the letter is single spaced, with double spacing between paragraphs and subparagraphs.

Subparagraphs are indented 4 spaces from the left margin and are lettered with small letters, followed by a period. The second and succeeding lines extend from left to right margins.

Each further degree of subdivision is indented correspondingly. Sub-paragraphs are marked by numerals in parentheses, the next degree by small letters in parentheses, after which come numerals underscored, and then letters underscored.

SIGNATURE.—The typed or stamped signature, in block style, begins at the center of the page. It is placed 4 lines below the last line of the text, with one exception. When the official whose title follows "From" is not signing the letter but his name is to be shown in the closing, it is placed only 2 lines below the text, and the name of the person signing the letter, usually "By direction," is placed 4 lines below the first name. All names are typed in capitals in the close of a letter. Neither the rank nor, as a rule, the functional title of the signing official is shown in the signature.

"COPY TO" LINE.—The "Copy to" line is placed at the left margin, 2 lines below the last line of the signature information. "Copy to" is not abbreviated. Officials receiving copies are listed, with titles abbreviated, below the words "Copy to," even with the left margin. If copies of any of the enclosures listed in the heading are sent to "Copy to" addressees, the words "with encl" and the enclosure numbers assigned in the heading are added in parentheses after the title of each recipient. Figure 3-2 shows placing of the "Copy to" line.

PAGING.—The first page of a letter is not numbered. Second and succeeding pages are numbered consecutively with Arabic numerals, beginning with "2," centered one-half inch from the bottom of the page. The numerals are typed without parentheses or dashes.

The signature page of a letter exceeding 1 page in length should contain a minimum of 2 lines of the test.

A paragraph is not begun near the end of a page unless there is space for at least 2 lines of text on the initial page and unless at least 2 lines are carried over to the next page.

IDENTIFYING PAGES.—For identification of second and succeeding pages, the originator's code and the file number, if any, are repeated at the top of each page. They are typed, block style if both are used, on the same side that they occupy on the first page, beginning usually 1 inch from the top. When a file number is not used, the subject (introduced by the abbreviation "Subj") is repeated, beginning at the left margin, 2 lines below the last preceding line of typing. The text is continued 2 lines below the subject, or the symbols, as the case may be.

Endorsements

The endorsement is used to approve, disapprove, or comment on the content of a letter which is forwarded through one or more addressees before reaching its final destination. When there is adequate space remaining on the page, the first and subsequent endorsements may be placed on the same page containing the basic letter or prior endorsement. Plain bond paper is used for the original of an endorsement and manifold (tissue) paper is used for carbon copies.

When an endorsement is typed below the preceding basic letter or endorsement a dash line is placed 1 line below the last line in the preceding communication. The originator's code is placed 1 line below the dash line. If endorsements are started on a new page where no dash line is required, the originator's code is typed 6 lines from the top of the paper.

Endorsements may be typewritten, stamped, or handwritten. Stamped or handwritten endorsements may be used when comment is brief and no record copies are needed.

The format of an endorsement (fig. 3-1) is much the same as that of an official letter except for the heading.

Multiple Address Letters

A multiple address letter is a naval letter addressed to two or more activities individually identified in the address or addressed as a group. A multiple address letter may be typed if the number of addresses is small enough that one or two typings provide sufficient copies. Otherwise, another type of duplicating process is used.

When a multiple address letter is typed, letterhead tissues are used for all mail copies. If letterhead tissues are not available, a letterhead is typed or stamped on the tissues. The format of the multiple address letter (fig. 3-3) is basically the same as the naval letter except for the following:

1. The title of the first addressee begins on the same line as "To." Titles of other addressees are listed on succeeding lines, each title flush with the first.

2. Instead of this list of titles, the words "Distribution List" may be used after the word "To" and the addressees listed separately at the end of the letter. If an established distribution list is cited, the entry after "To" may be "Distribution List No.__________." without further identification of addressees.

Navy Directives

The purpose and the numbering system for Navy directives were discussed earlier in this chapter. The discussion here is primarily limited to the proper format. A directive is designated either as an instruction or as a notice. The two are equally authoritative. The determination as to whether it should be an instruction or a notice is based entirely on the duration of the directive. If it is of a continuing nature and if it should be retained by the recipient for reference in day-to-day work, then it should be an instruction. If it requires action which can be completed at once or if it is applicable for only a brief period of time, it should be a notice. Regardless of its designation the format of Navy directives is nearly the same. Paragraphs are a notable exception.

The sequence of paragraphs in directives is at the discretion of the originating office except as follows:

1. The purpose of each directive is stated in the first paragraph.

2. The second paragraph of a directive which cancels another directive contains the statement of cancellation. In a notice whose sole purpose is to cancel another directive, the statement of such cancellation may be made in the purpose paragraph.

DEPARTMENT OF THE NAVY
Administrative Office
Washington, D.C., 20360

OMD
15 June 1965

SAME AS FIG. 3-1

From: Administrative Officer, Navy Department
To: Distribution List

Subj: Multiple address letters; general instructions and procedures for the preparation of

Ref: (a) SECNAVINST 5216.5

Jasper J. Johnson
JASPER J. JOHNSON

2 LINES

Distribution:
Navy Comptroller
Chief, Bureau of Naval Weapons
Chief, Bureau of Naval Personnel (2 copies)

Figure 3-3.—Format of multiple address letter.

SAME AS NAVAL LETTER

6 LINES

DEPARTMENT OF THE NAVY
Office of the Secretary
Washington

SECNAV 0000.0
AO:OMD
23 June 1965

5 LINES

SECNAV INSTRUCTION 0000.0

2 LINES

From: Administrative Assistant to the Secretary of the Navy
To: Distribution List

Subj: General instructions for the preparation of Navy directives

Ref: (a) SECNAVINST 5216.5, Subj: Navy Correspondence Manual

1. Purpose. This Instruction illustrates for the typist the format for Instructions and Notices issued in the Navy Directives System.

2. Typing the Directive. Since a directive is distributed to a number of addressees, it is usually reproduced by a mechanical process. The duplicating process used to produce the required copies will determine how the original is prepared by the typist.

a. If the directive is to be multilithed or if an original is required for signature before a reproducible master is prepared, printed letterhead stationery, or plain bond paper on which the letterhead is typed, is used for the first page. Continuation pages are typed on plain bond paper. With the approval of the originator, a directive may be typed on a reproducible master directly from a rough draft, thus eliminating the intermediate step of preparing a finished original on bond paper.

SAME AS NAVAL LETTER

b. Each activity will determine whether record copies will be prepared on manifold (tissue) sheets or whether processed copies, appropriately marked, may be used for official file copies.

3. Margins. On the first page of a directive the left and right margins are one and one-fourth inches and the bottom margin at least one inch. On second and succeeding pages, the margin at the top is one inch, and other margins are the same as on the first page.

4. Paragraph Titles. Paragraph titles are used for all major paragraphs and may be used for subparagraphs. The paragraph titles are written as follows:

a. The first and main words in the title are capitalized. Articles, conjunctions, and two- and three-letter prepositions are not capitalized.

b. A period is placed after a title followed on the same line by the text material. No period is used after a title which stands alone.

Figure 3-4 (A).—Format of Navy directive, first page.

3. If the applicable, the last paragraph of each instruction and the next to last paragraph of each notice indicates any reports required. This paragraph also lists forms prescribed for use and states where the required forms may be obtained.

4. The last paragraph of each notice states when or under what conditions the notice is to be canceled. In all cases, a specific cancellation date is provided for record purposes.

Figure 3-4 illustrates and furnishes additional information on the proper format and preparation of Navy directives.

Joint Letter

A joint letter is a naval letter signed by officials of two or more activities. It deals with a subject or administrative problem common to those activities. For a sample of a joint letter and directions for preparing one, read and study figure 3-5.

6 LINES (REF. PAR. 5A)

6 LINES (REF. PAR. 5A)

SECNAVINST 0000.0 OFFICE OF THE SECRETARY
23 June 1965

c. Each title is underscored throughout.

5. Continuation Pages. In the typed directive, the position of the identifying data (consisting of the directive symbol and the date) is alternated from left to right at the top of each new page. This is done so that the directive symbol and the date will appear in the upper outside corner of each page when the directive is reproduced on both sides of the sheet. The name of the originating activity, if used, will appear in the upper inside corner of the printed page. These identification data are typed on continuation pages as follows:

a. On the even-numbered pages (2, 4, 6, etc.) the directive symbol (consisting of the abbreviated short title of the originating office; the abbreviation "INST" or "NOTE"; and the subject number, with prefix-suffix elements, if any) is placed at the left margin, one inch from the top of the page. The date is blocked with the directive symbol. As the date is added to the directive when it is signed, sufficient space is allowed between the directive symbol and the first line of the text so that the date may be inserted. The name of the originating office, if used, is placed on the line with the directive symbol, ending flush with the right margin.

SAME AS NAVAL LETTER

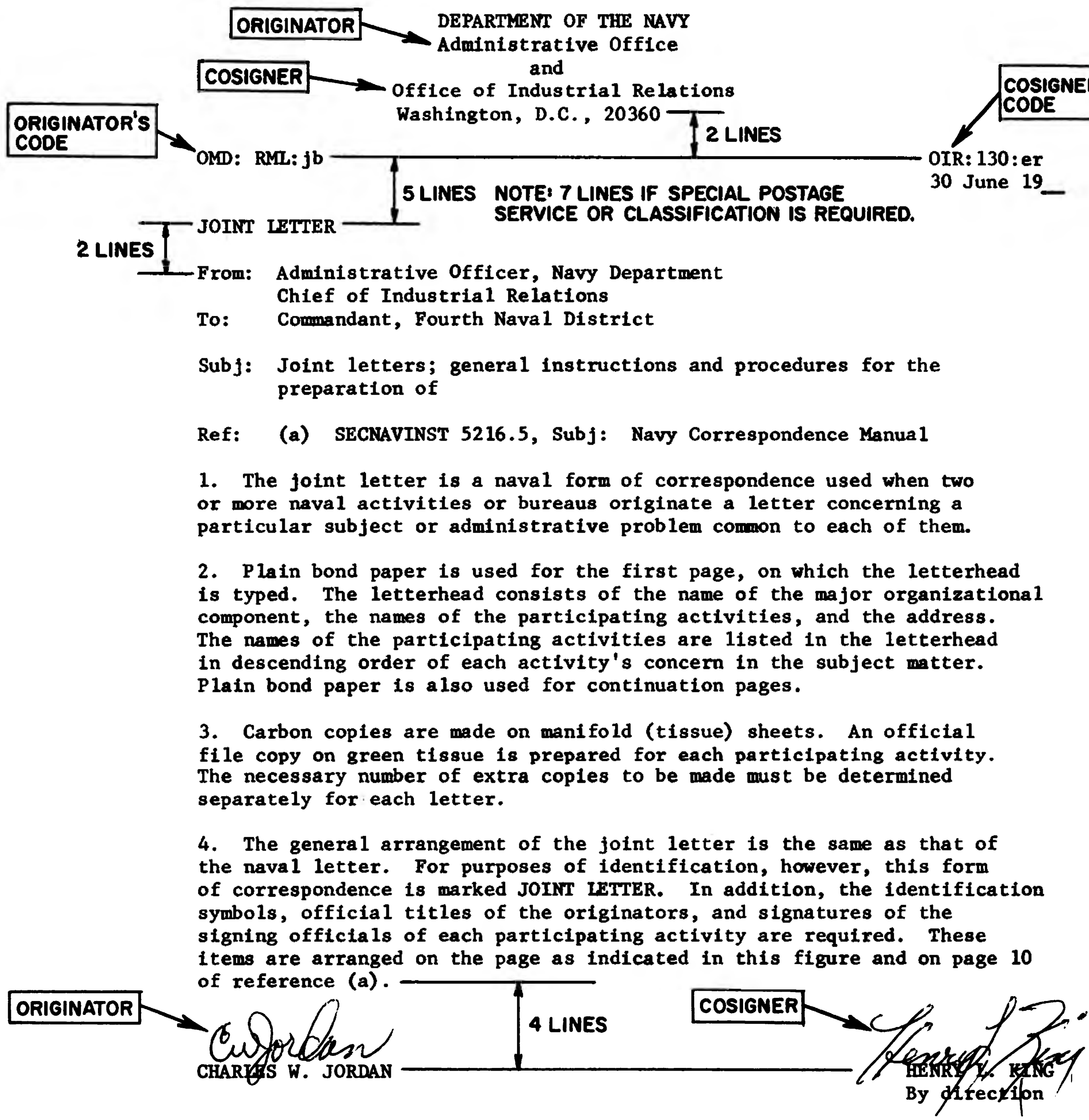
b. On the odd-numbered pages (3, 5, 7, etc.) the name of the originating office, if used, is placed at the left margin, one inch from the top of the page. The directive symbol is typed on the same line, ending flush with the right margin. The date is blocked with the directive symbol.

6. Labeling Enclosures. Ordinarily, each enclosure is labeled to associate it with the directive of which it is a part. The labeling of enclosures is explained and illustrated on page 27 of reference (a).

R. R. Kittrell
R. R. KITTRELL

Distribution: (2 copies each)
SNDL E6

Figure 3-4.(B).–Format of Navy directive, second page.



DEPARTMENT OF THE NAVY
Administrative Office
and
Office of Industrial Relations
Washington, D.C., 20360

OMD: RML:jb

OIR:130:er
30 June 19__

JOINT LETTER

From: Administrative Officer, Navy Department
Chief of Industrial Relations
To: Commandant, Fourth Naval District

Subj: Joint letters; general instructions and procedures for the preparation of

Ref: (a) SECNAVINST 5216.5, Subj: Navy Correspondence Manual

1. The joint letter is a naval form of correspondence used when two or more naval activities or bureaus originate a letter concerning a particular subject or administrative problem common to each of them.

2. Plain bond paper is used for the first page, on which the letterhead is typed. The letterhead consists of the name of the major organizational component, the names of the participating activities, and the address. The names of the participating activities are listed in the letterhead in descending order of each activity's concern in the subject matter. Plain bond paper is also used for continuation pages.

3. Carbon copies are made on manifold (tissue) sheets. An official file copy on green tissue is prepared for each participating activity. The necessary number of extra copies to be made must be determined separately for each letter.

4. The general arrangement of the joint letter is the same as that of the naval letter. For purposes of identification, however, this form of correspondence is marked JOINT LETTER. In addition, the identification symbols, official titles of the originators, and signatures of the signing officials of each participating activity are required. These items are arranged on the page as indicated in this figure and on page 10 of reference (a).

CHARLES W. JORDAN

HENRY [illegible]. KING
By direction

Figure 3-5.—Joint letter.

Speedletter

The naval speedletter is a quick, informal means of communication combining the brevity of messages with the economy of transmission by mail. It can be prepared and released more quickly than the naval letter. Another important purpose of the speedletter form is to call attention to the communication so that the recipient handles it as promptly as possible. Speedletters may be used for both urgent and routine correspondence. Urgent speedletters concern emergencies that are not so critical as to require a message. Use of the speedletter for routine purposes is permitted so as to provide a more economical form of correspondence.

A speedletter is prepared on Form Nav Exos-4181. The first page is typed on a white copy of the form, and the second and succeeding pages, if required, are typed on plain white paper. For official files, a carbon copy is prepared on a green form or plain tissue. Information copies are prepared on white blanks. Blanks of other colors are obtainable, and may be used as determined locally.

Boxes labeled to indicate their use are provided on the form for indicating special mail service, classification, identification symbols, date, address, copy to, and sender's address.

The "Subj" line is not necessary. If one is desired, it may be typed in the naval letter style immediately below the first fold line. If the letter is long, a subject is an aid in filing. Reference to material relating to the subject is made in the text of a speedletter in lieu of a "Ref" line. Both the "To" box and the sender's address box are arranged so that they can be used with window envelopes.

So that priority may be given to urgent matters, speedletters requiring rapid handling should be conspicuously labeled urgent by means of a stamp or tag. If a stamp is used, the place for it is the upper right corner. Speedletters marked urgent by the originator are given priority in handling and in reply, usually second to that given messages. Routine speedletters receive the same handling as nonurgent naval letters.

Usually, a reply to a speedletter, especially one marked urgent, is made by speedletter. The reply may be placed on the original speedletter when space permits. If it is expected that a reply will be made on the same speedletter, an extra white copy should accompany the original.

Figure 3-6 illustrates and furnishes additional information concerning the naval speedletter.

Naval Message

For the purpose of this text, a naval message is defined as a brief form of communication transmitted by rapid means such as radio or telegraph. A naval message is used for urgent communication where speed is of primary importance. It should not be used when the necessary information can reach its destination in time for proper action by speedletter or letter, utilizing airmail as appropriate.

The naval message is prepared on OpNav Form 2110.28. The number of copies of unclassified messages required is dependent on the needs of the originating office, and the needs of the communications office handling the message. Only one copy of a classified message should be prepared.

The text should be typewritten in capital letters. Punctuation should be used when essential for clarity. Abbreviations should not be used unless the addressor is reasonaly certain that their meaning will be immediately clear to addressee.

A DATE TIME GROUP (DTG) NUMBER is assigned by the communications office at the time of release of the message. This number consists of 6 digits; e.g., 162121Z. The first 2 digits represents the day of the month, and the last 4 digits represent the time of the day.

So that a standard time may be kept throughout the service, Greenwich mean time is used to indicate the time of origin of most naval messages. This eliminates any doubt as to which time the originator is using. Greenwich mean time is designated by the letter "Z." Figure 3-7 is a sample of a naval message and furnishes further information on the format and preparation.

Memorandum

The memorandum is used for informal correspondence between offices, divisions, branches, sections, or individuals within the same naval activity.

Since the use of a memorandum is restricted to within activities, the format and preparation are determined by the respective activities. Standard From 64, Office Memorandum - United States Government, is often used by naval activities as an interoffice or intraoffice memorandum form.

Business Form Letter

Under some conditions the Aviation Weapons Officer may be required to draft a letter to a commercial concern. In this case the business form letter should be utilized unless it has been ascertained that the recipient is familiar with the naval letter.

The letterhead, identification symbols (originator's code, file and serial number when used), NAVEXOS-4181

USE FOR URGENT LETTERS ONLY

NAVAL SPEEDLETTER

DO NOT CLEAR THROUGH COMMUNICATION OFFICE

(One box must be checked)

[X] REGULAR MAIL [ ] SPECIAL DELIVERY

[ ] AIR MAIL [ ] REGISTERED MAIL

CLASSIFICATION

IN REPLY REFER TO

OMD-12

DATE 24 June 1964

NAVAL SPEEDLETTER—

Permits dispatch or informal language.

May be sent (1) with enclosures, (2) in a window envelope (size 8⅞" x 3⅞"), if contents are not classified as confidential or higher, (3) to both naval and nonnaval activities.

Is packaged 500 sheets of white or of one color: yellow, pink, or green.

TO: Commandant, Fifth Naval District
(Code 25)
Norfolk, Virginia, 23511

(Fold)

When originated, speedletters were intended only for urgent routine naval communications. Their use has since been increased to include routine communications that are not urgent. To assure appropriate priority, speedletters dealing with urgent matters should be stamped or tagged URGENT in the upper right corner. Speedletters so marked by the originator are given priority, usually second to that given messages. Routine speedletters receive the same handling as nonurgent naval letters.

John Spencer
JOHN SPENCER
By direction

Code 25
28 June 1964

The speedletter blank is so designed that, if space permits, a reply may be made on the same blank if the originator has supplied an extra copy of the letter. When an extra copy has not been received, the reply may be made on the same form if an official record copy is not required.

Charles H. Brown
CHARLES H. BROWN
By direction

COPY TO

ADDRESS: Administrative Officer,
Navy Department
Washington, D.C., 20360

← SENDER'S MAILING ADDRESS

Address reply as shown at left; or reply hereon and return in window envelope (size 8⅞" x 3⅞"), if not classified as confidential or higher.

CLASSIFICATION

U. S. GOVERNMENT PRINTING OFFICE 16—64002-8

Figure 3-6.—Format of naval speedletter.

NAVAL MESSAGE
OPNAV FORM 2110-26 (REV. 3-61)

RELEASED BY	DRAFTED BY	PHONE EXT. NR.	PAGE	PAGES
I. M. SMITH, CDR USN	R. J. IVERS	2122	1 OF	1

DATE	TOR/TOD	ROUTED BY	CHECKED BY
12/16/64			

MESSAGE NR.	DATE/TIME GROUP (GCT)	PRECE-DENCE	FLASH	EMERGENCY	OPERATIONAL IMMEDIATE	PRIORITY	ROUTINE	DEFERRED
		ACTION						
		INFO						

FM: CNO
TO: COMNAVAIRPAC

UNCLAS

PREPARATION OF A NAVAL MESSAGE

A. REFERENCES ARE IDENTIFIED BY LETTERS

1. PARAGRAPHS ARE NUMBERED

   A. SUB-PARAGRAPHS ARE INDENTED AND LETTERED

   B. IF A MESSAGE IS CLASSIFIED, INCLUDE PROPER DOWNGRADING/ DECLASSIFICATION MARKINGS IMMEDIATELY FOLLOWING THE CLASSIFICATION

   C. THE SUBJECT IS NOT IDENTIFIED BY LETTERS OR NUMBERS

DISTRIBUTION:
(PAGE ONE ONLY)

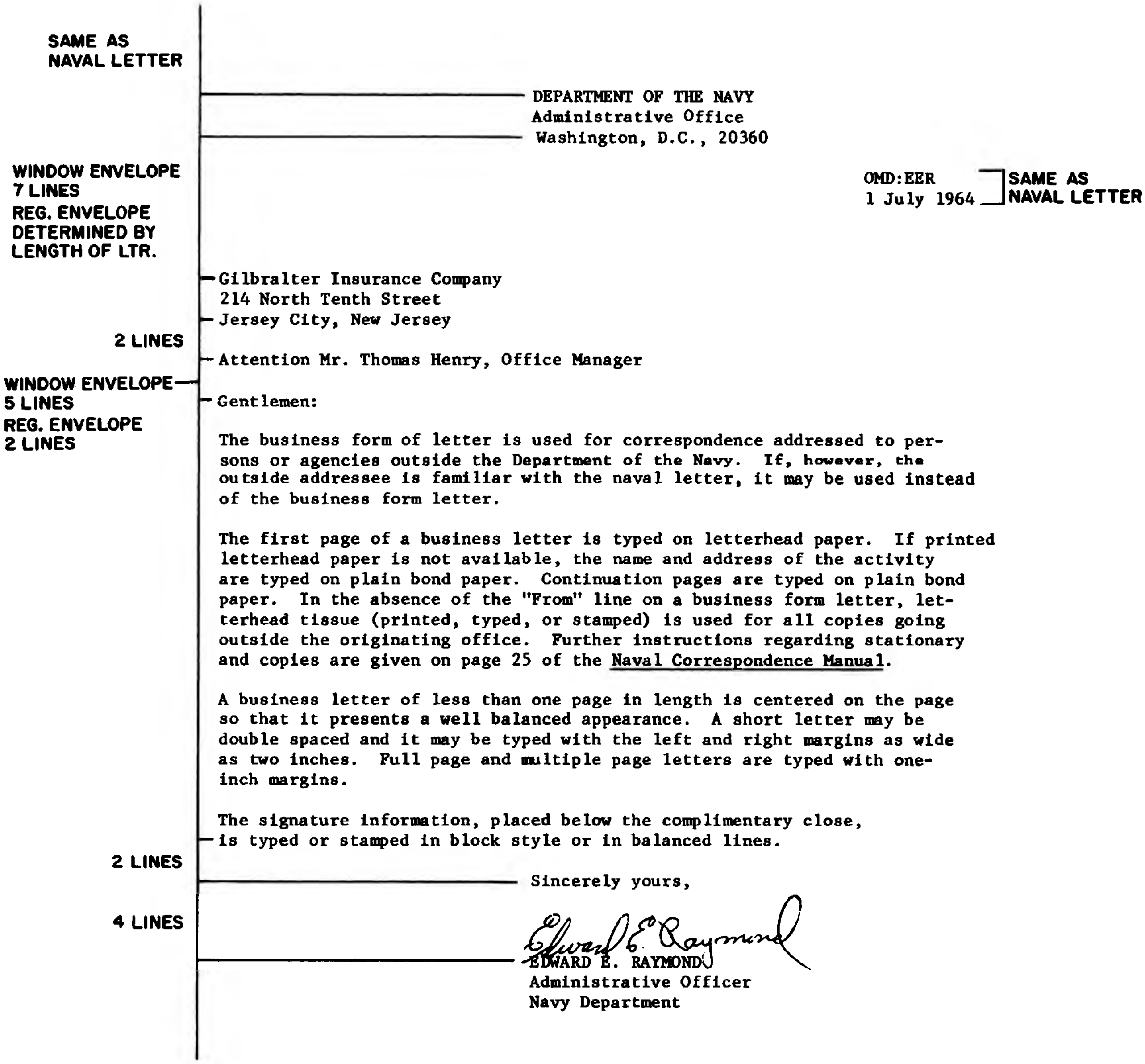
UNCLASSIFIED DATE/TIME GROUP (GCT)

Figure 3-7.—Naval message.

and date are located on the page in the same manner and position as in a naval letter. The address is typed 7 lines below the last line in the letterhead when the letter is to be mailed in a window type envelope. For use in regular envelopes, the length of the letter determines the correct location of the address. Further information on the use of and the format of the business form letter is presented by figure 3-8.

ROUTING AND HANDLING OFFICIAL CORRESPONDENCE

The fact that official correspondence is originated implies that information is being requested or furnished. It follows that unless this information is properly disseminated, the mere originating has accomplished very little. Correspondence requesting a report does not



DEPARTMENT OF THE NAVY
Administrative Office
Washington, D.C., 20360

OMD:EER
1 July 1964

Gilbralter Insurance Company
214 North Tenth Street
Jersey City, New Jersey

Attention Mr. Thomas Henry, Office Manager

Gentlemen:

The business form of letter is used for correspondence addressed to persons or agencies outside the Department of the Navy. If, however, the outside addressee is familiar with the naval letter, it may be used instead of the business form letter.

The first page of a business letter is typed on letterhead paper. If printed letterhead paper is not available, the name and address of the activity are typed on plain bond paper. Continuation pages are typed on plain bond paper. In the absence of the "From" line on a business form letter, letterhead tissue (printed, typed, or stamped) is used for all copies going outside the originating office. Further instructions regarding stationary and copies are given on page 25 of the Naval Correspondence Manual.

A business letter of less than one page in length is centered on the page so that it presents a well balanced appearance. A short letter may be double spaced and it may be typed with the left and right margins as wide as two inches. Full page and multiple page letters are typed with one-inch margins.

The signature information, placed below the complimentary close, is typed or stamped in block style or in balanced lines.

Sincerely yours,

Edward E. Raymond
EDWARD E. RAYMOND
Administrative Officer
Navy Department

Figure 3-8.—Format of business form letter.

UNCLASSIFIED MAIL CONTROL RECORD

FROM COMNAVAIRLANT	DATE OF CORRESPONDENCE 6/1/64
ORIGINATOR'S IDENTIFICATION DATA	DATE RECEIVED 6/8/64
SUBJECT MULTIPLE BOMB RACK A/A37B-1, SPECIAL REPORT OF.	COPIES RECEIVED 1 / ENCL.
	REG. NO./FILE NO. 4441
	ACTION DUE DATE 6/12/64

INTER-DEPARTMENTAL				INTRA-DEPARTMENTAL			
ACTION	INFO	INITIALS	DATE OUT	ACTION	INFO	INITIALS	DATE OUT
					06		
					61		
				62			
					63		
					67		

REMARKS *(ACTION OFFICE indicate action taken) (Use reverse, if needed)*

INSTRUCTIONS

Figure 3-9.—Route sheet.

produce the report unless the person responsible for its preparation receives the request.

The responsibility for the dissemination and proper handling of official correspondence is assigned to a specific organizational component of each respective department.

Incoming Correspondence

Official correspondence received by the ordnance branch should ultimately become a part of the permanent records of that branch. The routing required between the receipt of and the filing of the correspondence depends upon the type of information furnished and/or the action required. Local procedures usually prescribe a standard routing for all incoming correspondence in addition to the routing to those individuals or organizational components primarily concerned with the individual communication.

A route sheet similar to figure 3-9 is usually employed to insure the proper routing of correspondence requiring action. This should be prepared in duplicate with the original attached to the correspondence being routed and the copy being retained by the correspondence head. As the correspondence progresses through the routing indicated, appropriate action is taken and the routing sheet is initialed by the responsible individuals. When the routing is complete, the correspondence with the original route sheet is returned to the correspondence head for filing.

The routing may be placed on the correspondence itself if the correspondence is in the nature of information. This may be accomplished by the use of a rubber stamp. (See fig. 3-10.)

ACTION	INFO	INITIAL	DATE
	06		
	61		
62			
	64		
	66		

Figure 3-10. –Routing stamp.

Outgoing Correspondence

Outgoing correspondence is prepared by the correspondence organizational component, utilizing a rough draft prepared by the originator. The letter is then presented to the appropriate official for signature.

The correspondence file which accompanies the letter to be signed is arranged according to the instructions of the signing official. The arrangement outlined below is merely a guide which may be varied to conform to local practices:

1. Outgoing letter, arranged in reverse order if two or more pages long.
2. Courtesy copy if required.
3. Enclosures, if any, arranged as far as possible in the order listed in the letter.
4. Copies for "Via" addressees, properly checked or arrowed.
5. Envelopes, if required, face up.
6. Copies, and envelopes as appropriate, for "Copy to" addressees, checked for arrowed.
7. File copies, with green tissue on top, protruding three-fourths of an inch to one side for initialing or other indication of approval.
8. Incoming letter and previous correspondence, if any.

After the signature is obtained, the correspondence is dated with the date on which it is signed, the file copies removed for filing, and the correspondence forwarded to the appropriate addressees. The preparation of letters for window type envelopes is recommended for the transmittal of all unclassified letters of a routine nature which cannot be mailed in bulk. The chief advantages in using window envelopes are as follows:

1. Time is saved in that the name and address of the recipient are typed only once.
2. Errors in mailing are reduced in that a letter cannot be sent out in a wrong envelope.

Prior to preparing classified matter for mailing, the provisions of the Department of the Navy Security Manual for Classified Information should be clearly understood and followed. Top Secret may not be sent through any postal system, United States or foreign. Secret may be sent by United States registered mail. Confidential may be sent by United States registered or certified mail. Classified matter may not be sent through foreign mails. When classified material is transmitted through the U.S. mails, it must be enclosed in two sealed envelopes. The inner envelope shows the address, classification, and any other special instructions. The outer envelope is fully addressed but is not marked with the security classification or any other unusual data or marks which might invite special attention.

Outgoing messages are normally hand carried to the communications center for transmitting. A copy of each outgoing message should be extracted and held in a suspense file, pending receipt of the return copy from the communications center containing the date time group number.

PERSONNEL

The Aviation Weapons Officer must observe the chain of command in dealing with personnel. Nothing destroys a subordinate's confidence faster than to find that he has been bypassed by a senior in a routine matter. Loyalty extends in two directions, up and down. Subordinates must try to solve matters with their immediate supervisors before being allowed to bring them to higher authority. Practice the procedure of always discussing plans and policies with leading petty officers so that they have a clear perspective of what is happening. Allow them to disseminate this information to their men.

One way to instill pride in an organization is to allow an individual's immediate supervisor the privilege of making the first public announcement of that individual's selection for advancement. Too often this is a matter for routine announcement in an impersonal manner, such as a notice in the Plan of the Day. This is only one situation which can be an occasion for mutual pride in the accomplishment of an individual. Many other methods of developing the stature of subordinates as leaders will occur. Make use of them.

Maintaining personnel performance at a high level of proficiency is one of the primary functions of management. This requires providing the incentives and recognition that will retain personnel in the organization and motivate them to greater effort. It also requires the evaluation of the performance of the individuals to assist in the following:

1. Assignments to duty.
2. Selections for promotion of those best fitted for assuming additional responsibility.
3. Determining the need for correction of individual deficiencies.
4. Eliminating unfit personnel.

The Navy enlisted and officer structure may be thought of as forming a pyramid, with many personnel at the base and successively fewer at each higher level. All cannot reach the top. It behooves the Aviation Weapons Officer to weigh personal characteristics and performance factors closely in determining those personnel to be selected for promotion or to assume duties of increasing responsibility.

SAFETY AND SECURITY

The Secretary of the Navy vests in the Chief of Naval Operations the authority and responsibility for carrying out safety and security programs at the various naval activities. Commanding officers are delegated the authority by CNO with responsibility for control and enforcement of safety and security aboard their respective commands. Commanding officers are directly responsible for instructing and training personnel in regards to safety and security within their activity.

In some cases safety precautions and security measures disseminated by higher authority may not cover all local situations. In this case commanding officers may delegate responsible officers to prepare and disseminate (with his approval) safety precautions and security measures.

The Aviation Weapons Officer should review the compiled safety precautions and security measures of his unit to ascertain that they are current, complete, and correct.

A list of the basic publications which involve safety and security is contained in table 3-3. It should aid the Aviation Weapons Officer in compiling or reviewing the safety precautions and security measures of his activity. The list is divided into four parts as follows:

1. Explosive.
2. Vehicle.
3. Industrial.
4. Flight line.

With the issuance of SecNav Notice 5100 of April 15, 1964, the manual United States Navy Safety Precautions, OpNav 34P1, is no longer applicable to fleet activities. Cognizance of the subject manual has been transferred from the Chief of Naval Operations to the Chief of Industrial Relations and the revised manual has been renamed "Department of the Navy Industrial Safety Precautions." The Chief of Naval Operations is currently developing and issuing a separate publication to the Operating

Table 3-3.—Safety and security publications.

Type	Title
Explosive	OP 4 Ammunition Afloat. OP 5 Ammunition Ashore, Handling, Stowing, and Shipping. Op 1014 Ordnance Safety Precautions, Their Origin and Necessity.
Vehicle.	NavWeps OP 2173 Handling Equipment for Ammunition and Explosives (Appendix A). OP 2239 Explosive Drivers Handbook. OP 2165 Navy Ordnance Shipping Handbook. OP 5 Ammunition Ashore, Handling, Stowing, and Shipping.
Industrial	NavWeps OP 2173 Handling Equipment for Ammunition and Explosives (Appendix A). NavAer 00-80T-64 Aviation Electronics Officer's Guide (chapter 2). NavDocks TP-Tr-1, 2, and 3 Administration and Operation of Transportation Equipment.
Flight line	OpNav Instruction 5510. 1B Security Manual for Classified Information. OpNav Instruction P5510. 45A U.S. Navy Physical Security Manual. NavAer 00-80T-64 Aviation Electronics Officer's Guide (chapter 2).

NOTE: Current applicable BuWeps safety instructions pertaining to explosive, vehicle, industrial, and the flight line should be consulted.

Forces which, as an index only, lists by subject matter and identifying designation specific safety precautions issued by the Navy Department. For example, BuWeps 00-80T-96, "Aviation Support Equipment and Safety Manual."

It behooves the Aviation Weapons Officer to obtain a current copy of the above mentioned BuWeps Index. This index should be reviewed thoroughly and the applicable safety precautions should be obtained or ordered.

CHAPTER 4

SUPPLY

To have an effective aircraft maintenance program, the availability of spare parts and equipment is of prime importance. Without material, the maintenance of armament or weapons systems cannot be sustained. The roles of supply and maintenance and the responsibilities of each must be clearly understood by personnel at all levels.

In general, maintenance personnel have the responsibility to make known their requirements to supply. Supply personnel convert this demand to the proper format and obtain the required item. No attempt is made here to present a comprehensive study of the supply system. This chapter is to acquaint the Aviation Weapons Officer with the aviation supply system to the extent that he should be able to understand what is required of the ordnance branch and the effects his actions have upon supply support.

SUPPLY SYSTEM ORGANIZATION

The supply system consists of several levels of logistic responsibility leading from the civilian management at the top to the smallest field supply activity. Each level is concerned with the performance of specific duties.

AVIATION SUPPLY OFFICE

The Aviation Supply Office (ASO) is the central nerve center of the aviation supply system. ASO is an agency under the joint control of the Bureau of Supplies and Accounts and the Bureau of Naval Weapons. This agency is assigned the responsibility for supply support of technical aeronautical material. As a Navy inventory manager, the primary job of the ASO is to determine which items to buy, how much of each item to buy, when to buy, and the distribution required to meet system demands.

Information flows to the ASO from several sources. The Bureau of Naval Weapons relays information received from higher authority, shore activities, and fleet commands relative to the composition and deployment of the Operating Forces. In addition, BuWeps provides engineering and technical information. The Bureau of Supplies and Accounts (BuSandA) furnishes guidance and policy relative to business management practices. Field supply points report at regular intervals such information as quantity of material on hand, quantity on order, demands, obligations, and planned requirements. ASO also receives maintenance usage data reports from designated maintenance activities. The evaluation of this data forms the basis for the decisions of the Navy inventory manager.

All materials required by aviation maintenance personnel are not managed by ASO. There are several other Navy inventory managers responsible for a designated commodity segment of material. Each is jointly controlled by a technical bureau and the Bureau of Supplies and Accounts. In general, they operate under the same principles as ASO. A relatively recent innovation is the single manager concept of inventory management. Under this concept a single manager operating agency performs inventory management functions of common type materials for all the military services. In addition the technical bureaus themselves manage certain categories of materials such as major equipments, material under development, and certain specialized materials.

The applicable managing agency for individual items may be determined by the cognizance symbol prefixing the federal stock number. Table 4-1 lists several cognizance symbols which are of interest to aviation maintenance

Table 4-1.–Material cognizance.

Cognizance symbol	Controlling agency	Material commodity
1E	Aviation Supply Office	Photographic material.
1I	Forms and Publications Supply Office	Forms and publications.
1W	Fuels Supply Office	Fuels, lubricants, and gases.
2O	Navy Training Device Center	Training devices.
2R	Aviation Supply Office	Technical aeronautical material.
2V	Bureau of Naval Weapons	Aeronautical equipment (major equipment).
4N	Electronics Supply Office	Electronic repair parts to support Bureau of Naval Weapons systems, equipments, and components.

personnel, together with the commodity segment of material controlled and the name of the controlling agency.

DISTRIBUTION SYSTEM

The aviation supply distribution system consists of reserve stock points, primary stock points, secondary stock points, and consumer activities. These are discussed briefly in the following paragraphs.

1. Reserve stock points carry reserve and backup stock for the aviation supply system. The range and quantity of stock are determined by the Aviation Supply Office. Reserve stock points provide storage facilities for bulk material.
2. Primary stock points carry stock for their own consumption. They may be designated as support activities for secondary stock points, for fleet units, and/or yard and district craft in the area.
3. Secondary stock points carry stock for their own consumption as well as stock for aircraft and assigned yard and district craft.
4. Consumer activities are aviation activities which are dependent for support on a primary or secondary stock point. Consumer activities are usually minor activities and normally receive their supply support on a shop store basis.

As far as the consumers are concerned, they may be assigned to any of the primary, secondary, or satellite stock points for supply support. The same basic principles affect any supply support. (Hereafter in this chapter, they are referred to as field supply points.)

SYSTEM REPLENISHMENT AND DISTRIBUTION

The preponderance of aeronautical material is procured and distributed throughout the distribution system by ASO. Numerous factors contribute to the attainment of an acceptable balance between the supply of and the demand for the multitude of materials required by the Navy aeronautical program. Some categories of materials require special management techniques; a prime example is the High Value Asset Control (HIVAC) System material which is discussed briefly later in this section. Stock status reporting by field supply points provides a prime factor in the computation of both procurement and distribution requirements. Stock status reporting in terms of significance to aviation maintenance management personnel is discussed in the following paragraphs.

STOCK STATUS REPORTING

Stock status reporting simply means that periodically, on a scheduled basis, reporting field supply points report to ASO status of material carried at that activity. This report includes five factors: demand, obligations, planned requirements, quantity on hand, and quantity due in for each individual item reported. These reporting factors are defined as follows.

1. Demand falls into two categories, recurring demand and nonrecurring demand.

Recurring demands (RD) are those demands presented to the supply department to fill material requirements expected to recur periodically for an indefinite period. Material requirements to support day-to-day maintenance fall in this category.

Nonrecurring demands (NON-RD) are those demands presented to the supply department to fill material requirements of a one-time nature or are not expected to recur within a 9-month period. Material required for initial outfitting of allowance list material and material required for maintenance of a transient aircraft are two examples of a nonrecurring demand.

2. Obligations are those material requests placed upon the supply department for which insufficient material is on hand to make the issue and are held by the supply department pending receipt of sufficient material.

3. Planned requirements (PR) are future estimated material requirements that are in excess of those expressed by past demand.

4. Onhand (OH) quantities are those quantities of material stocked in the supply department as recorded on the stock records.

5. Due-in (DI) quantities are those quantities expected to be received by the supply department as a result of local procurement action or inventory manager distribution action.

Stock status reports furnish information from which ASO may determine system demand rates for procurement purposes. In addition they furnish ASO with information on which to base redistribution actions by indicating where excesses and deficiencies exist. This is illustrated as follows:

2RF1560-123-4567ABCD Fitting assembly

NAS QUONSET POINT

RD	OBL		PR		OH		DI	
12+	3	+	35	-	(2	+	0)	=48 Net requirement for similar period.

NAS JACKSONVILLE

RD	OBL		PR		OH		DI	
12+	0	+	0	-	(75	+	0)	=63 Net excess for similar period.

In the hypothetical stock status report covering the fitting assembly, NAS Quonset Point shows a net requirement of 48 fittings while NAS Jacksonville indicates an excess of 63 of the same fittings. In this case ASO may redistribute 48 fittings from Jacksonville to Quonset Point to satisfy this requirement. However, the stock status reports from all the field activities, when consolidated, might show that requirements exceed excesses; therefore, procurement action would be in order. Upon consolidation by the inventory manager, the stock status reports reveal not only where deficiencies exist but whether this requirement can be satisfied by redistribution or if it must be met by procurement action.

Ships and minor shore activities do not report stock status to ASO. These latter activities compute their own requirements and replenish material by requisition. The five factors of stock status, however, are the primary basis for determining material requirements.

Two of the stock status factors are a result of your actions. They are demand and, in many instances, planned requirements.

Recurring demand is recorded by your supporting supply department each time that you submit a request for material in support of a continuing program. From the previous discussion in this chapter it should become obvious that total recurring demands are compared periodically with the other factors of stock status to provide for future support. Back door methods of obtaining material, such as obtaining from visiting aircraft crews, picking up on cross-country flights, obtaining from salvage, etc. are not recorded and obviously have an adverse effect on planning future support. Certainly, a more expeditious or effective source of obtaining required material, if discovered, should not be ignored. However, such sources should be brought to the attention of the supply department for appropriate action.

Supply departments automatically select additional items to stock according to the number of recurring demands generated over a specific period. In this respect you might have a continuous demand for an item while the supply departments records indicate an insufficient number of demands to justify stocking. It is well to keep in mind that the management and stocking of spare parts are supply responsibilities.

Conversely, an unacceptable condition may result by the recording of excess demand. Requesting material in quantities in excess of your shop requirements may not only result in the overage or deterioration, but may result in the same for the material in supply stocks replenished as a result of your demand.

Planned requirements are established and reported by supply when information is obtained that material in excess of past demands is required for future programs. Many times this information is available to you and not to the local supply personnel, or is not deemed significant by them. Changes in major equipments, increased operations, material changes due to incorporation of service changes are but a few instances where a planned requirement might be in order. Your local supply department is sometimes initially outfitted to support a significant change in the quantity or type of aircraft or major systems. However, your practical experience of material requirements of similar aircraft or systems could greatly enhance your support until sufficient demand history is accumulated.

Squadrons anticipating deployment are required to furnish their future support activity with usage data on high usage items. Special attention should be given to this usage data report, paying particular attention to items that have proven to be trouble items in the recent past.

Local instructions normally outline the methods by which this information is brought to the attention of the supply department. Usually a simple memorandum or telephone call will commence appropriate action. Many activities hold supply/maintenance meetings periodically to solve mutual problems. Many supply departments have senior supply personnel assigned as liaison and welcome your assistance.

MAINTENANCE USAGE DATA REPORTING

Maintenance usage data is required by ASO to determine the range and quantity of aircraft and avionics/weapons material actually used by operating activities in the performance of their mission. This data is used, as applicable, in the compilation of certain BuWeps allowance lists and in the procurement of material particularly during the period before sufficient system demand history has been generated.

Usage data is defined as being the quantity of each part, subassembly, or assembly actually removed during the reporting period and for which a replacement is required for maintenance support of the aeronautical article. When subassemblies or assemblies are repaired locally (either by the custodian of the equipment or a supporting activity), usage reported does not indicate usage of the subassembly or assembly as such, but indicates only the parts utilized in making the repair. Reports of assemblies or subassemblies used cover only those requiring rework beyond the scope of local maintenance capability.

The significant point in the definition of the term "usage data" is that the data sought in this program is related primarily to the "demand factor" rather than to the "supply factor." Therefore, the usage data to be reported under the reporting procedure is basically a listing each month of maintenance requirements generated during the month instead of a material delivered recapitulation.

Reporting Units

The maintenance usage data reporting system encompases primarily new aircraft models and avionic equipments. Definition of new in this program is generally applied to aeronautical articles that have been in operation in organized squadrons less than 2 years. When an adequate usage sample is obtained, the reporting of usage data on the aeronautical material is discontinued. Therefore, not every aviation activity is a reporting activity. Reporting activities are those operating units of the fleet and training commands designated by ASO to report usage data.

Responsibilities of Reporting Activities

Maintenance usage data reporting by operating squadrons and/or by supporting activities usually conforms to the following general principles.

SECTION B TYPE MATERIAL (AIRFRAMES, ELECTRICAL, ETC.)—A report of usage data and operating hours is submitted by the operating squadron (or Marine air group) concerned; in the Training Command it is submitted by the supporting naval air station. Usage data generated by supporting activities (AMD's, carriers, tenders) is turned over to the operating squadron concerned for inclusion in its usage data report to ASO. Detachments of designated reporting squadrons also submit usage data; but in this case, it is submitted direct to ASO on a separate reporting form.

SECTION R TYPE MATERIAL.—Report of usage data is normally completed by the supporting activity (AMD's, carriers, tenders) or by the squadron concerned. In general, the usage data reporting activity for any particular reporting period is the activity rendering maintenance support at the close of the reporting period. Therefore, when a supported squadron in the reporting program embarks or debarks during the reporting period, the usage data accumulated during the expired portion of the reporting period should be carried by the squadron in order that the reporting activity may include all usage accumulated during that period. Supporting activities are allowed under existing directives to consolidate the usage of supported squadrons and submit one report for each equipment without associating the usage with individual supported squadrons.

Effect of Usage Data on Allowance Lists

When usage data received by ASO indicates usage of a part that is not stocked, a usage record is prepared to record the demand for that item, and is filed in the maintenance usage file. The usage data reports should include all items needed during the reporting period whether or not they are stock items. The reporting of the use of M items can lead to a change in source code to P in the event the need is indicated by operating activities. When the demand warrants a change, allowance lists may be revised to reflect an increase or the addition of an item to the appropriate list.

Forms

Usage data is submitted directly to ASO on the revised Maintenance Usage Data Report Form, ASO Report Symbol 4700-4, or its revision. ASO supplies three blank copies of the report form for each month to the reporting activities. One copy only is required by ASO.

The report form is a two-part form. Part I is the Operation Data Section and is usually prepared by the maintenance office. Part II is the Usage Section, and the Aviation Weapons Officer may be required to assist in its preparation. The usage section is a preprinted, columnar list of all items in Sections B and R for which usage has been developed. The preprinted forms have one column each for stock number (FSN), nomenclature, unit of issue, and whether or not the report item is an allowance list item. The fifth column is blank and is to be filled in with the number of times items of a particular FSN and nomenclature were required the previous month. The number of times that the demand for an item created an AOCP is listed in the same "quantity" column, in parenthesis.

Example: 1 (1) or 3 (2)

A blank page is provided in the report form for "write-ins." These are items for which a demand was generated and was satisfied from some other source such as cannibalization, from contractor representatives, other squadrons, or manufactured because of source code M. Each "write-in" should be fully identified. Report everything that was actually removed for which a replacement was required during the reporting period.

Change material and material under the cognizance of ESO are not reported as usage on this reporting form.

HIGH VALUE ASSET CONTROL (HIVAC) SYSTEM

A major program which caused some changes in supply procedures for stock points and end users is the Navy-wide High Value Asset Control (HIVAC) System. The system provides for worldwide asset control of high unit cost/high annual demand ($1,000.00/and $40,000.00 plus) consumables and repairables, and requires some participation from all ships and shore activities. Standard Navy-wide procedures for identification, requisitioning, and turn-in of HIVAC items are contained in BuSandA Instruction 4440.105 of April 1964.

The ever-increasing costs of weapon systems and the increase in the costs of the major supporting spares and components for these systems have created an impact on the national economy which is approaching that of the military expenditures of World War II. In order to maintain an acceptable level of readiness, it is necessary that Navy and Marine Corps inventory managers explore and implement all possible means of reducing inventory and total procurement dollar investment. In the past, the military services have been criticized for inventory management deficiencies which have led to the accumulation of costly excess stocks.

High Value Item Management is designed to achieve inventory and procurement reductions through assignment of the best talent and by the use of the best techniques in the management of High Value Items. The total number of High Value Items should be determined by the criteria prescribed in the High Value Item Management Policy Manual, SecNav Instruction P4440.29 dated 18 June 1963 (or latest revision). It is estimated the High Value program initially will encompass less than 1 percent of the items in Department of the Navy inventories and more than 40 percent of the annual dollar investment.

MATERIAL IDENTIFICATION

The cataloging system developed by the Department of Defense is such that it identifies with one name and stock number any item of supply that is carried in any or all governmental agencies. In the procurement of material it is normally necessary to identify a material requirement in the medium understandable to the supply system, the federal stock number.

FEDERAL STOCK NUMBER

The federal stock number consists of an 11-digit number. The Aviation Supply Office uses federal stock numbers with prefixes composed of one, two, or three symbols, and suffixes composed of four characters which may be all letters or a combination of letters and numbers. When the prefixes and suffixes are used, the federal stock number becomes a coded federal stock number. A coded federal stock number and its breakdown is as follows:

2R H B 1560 - 123 - 4567 - ABEL

- 2R — Cognizance Symbol
- H — Fraction Code
- B — Material Condition Code
- 15 (first two digits of 1560) — Federal Group Code
- 1560 — Federal Supply Classification Code (FSC)
- 123 - 4567 — Federal Item Identification Number (FI IN)
- ABEL — Technical Supply Management Code (TSMC)

Many variations of coded stock numbers are encountered in field maintenance work. These variations indicate material management responsibilities for the item; flag certain items as recoverable, consumable, high value, and so forth; and identify the condition of the material if it is not ready for issue. Some of the more common codes that maintenance management are likely to encounter are:

2RH—a recoverable aeronautical component of high value.

2RHB—a recoverable aeronautical component of high value that is not ready for issue.

Because the variety of codes is so extensive and the trend to the single management concept which caused so many changes in recent years, a list of codes that might be prefixed or suffixed to a stock number would not be appropriate for this text. The primary things to keep in mind are that the basic stock number, consisting of three groups of numerals, identifies the item from a technical point of view and that the other codes identify material management characteristics.

MATERIAL IDENTIFICATION AIDS

There may be times when a part or some technical material is needed and the stock number is unknown. At other times some material may be on hand and its identity is not positively known. A knowledge of the several methods by which material may be identified is very helpful in speeding the completion of a maintenance task. There are many ways in which material may be identified. Certain data may be available which does not identify an item but may lead to positive identification. An aircraft part has a part number. The part number may be looked up in the IPB and identified by nomenclature and often by the stock number. If the stock number is not furnished in the IPB, it may be found by referring to the Cross-Reference Section C0006 of the Navy Stock List of ASO.

Some equipments have attached nameplates which provide such information as the manufacturer's name, make or model number, serial number, size, voltage, phase, etc. Identification data taken from the nameplate of the old part can be very helpful in procuring a replacement.

When only the description of the item is known, the best source for identification is the descriptive sections of the various Navy Stock Lists.

Various publications used in identifying material are described in the following paragraphs.

NAVSANDA PUBLICATION 2002, SECTION VIII, PARTS C and D contain a complete numerical listing of all available naval aeronautic publications distributed by BuWeps. This stock list is supplemented by and should be used in conjunction with NavWeps 00-500A, Equipment Applicability List, and NavWeps 00-500B, Aircraft Application List. These lists are handy references to publications that should assist in the identification of material.

ILLUSTRATED PARTS BREAKDOWN (IPB) lists are probably the most important tool for the identification of aeronautical material. As an Aviation Weapons Officer, you are undoubtedly familiar with them. However, due to the importance attached to them as a material identification source, they are discussed briefly in the following paragraphs.

IPB's are compiled by the manufacturer for each aircraft model in naval use. In this text IPB's encompass IPB's for aircraft, IPB's for aircraft engines, and IPB's for individual accessories and equipments.

Although slight variations in format exist among the various IPB's each normally includes the following major sections.

I. Table of Contents—This section shows the breakdown of the catalog into sections and furnishes a cross-reference between the various assemblies and figures where they are illustrated. The section also cross-references assemblies and pages where they are broken down into subassemblies and parts.

II. Introduction—This section includes general information and instructions for using the publication. Because variations between IPB's do exist, this section should be referred to prior to using an IPB with which the user is not thoroughly familiar.

III. Group Assembly Parts List—This section is the main text of the publication. It consists of a series of illustrations and parts lists in which all parts of the aircraft/engine/equipment are shown in assembly breakdown order. The illustrations and parts lists are keyed to each other by means of figure and index numbers. Each assembly included in the parts lists is followed immediately by its component parts properly indented to show their relationship to the assembly. The group assembly parts list is subdivided into groups such as wing group, tail group, and fuselage.

IV. Numerical Index–This section lists all parts in alpha-numerical order, and each part is cross-referenced to the figure and index number where it is illustrated. This list also shows the official source code of each part listed in the applicable IPB.

Source codes are codes which indicate to a consumer a source for a part required in the maintenance or repair of an aeronautical article.

Source codes are provided in six series–P, M, A, N, X, and U.

Source code P series parts are parts of supply system stock which are purchased.

Source code M series applies to parts which are not purchased but are capable of being manufactured at Navy fleet or overhaul activities (MF, MO, or MOA).

Source code A series applies to assemblies which are not purchased.

Source code N applies to nonstock items which are purchased on demand.

Source code X applies to main structural members or similar parts which, if required, would suggest extensive repair. The need for a part or parts coded X normally results in a recommendation for complete overhaul or retirement of the equipment from service.

Source code U applies to parts which are not of supply or maintenance significance, such as installation drawings, diagrams, instruction sheets, etc.

Within each of the source code series listed above there are one or more subcodes identified by a letter or number appended to the basic code letter. These subcodes provide detailed information concerning the procurement or manufacture of various parts within the scope of the particular code series. The introduction section of the applicable IPB provides a ready reference for each of the codes and subcodes as required.

AERONAUTICAL ALLOWANCE LISTS as used in this text include BuWeps Allowance Lists, BuWeps Initial Outfitting Lists, and BuWeps Tables of Basic Allowance.

Aeronautical allowance lists are lists of equipment and material, known or estimated to be required, to place and maintain aeronautical activities in a material readiness condition. These lists contain substantially all items used with sufficient frequency to justify their issuance to all activities maintaining aircraft or equipment for which the lists are designed. They also contain information concerning stock number, nomenclature, interchangeability, and supersedures. These publications are further defined in subsequent paragraphs. Keep in mind that allowance lists normally contain support equipment allowed to maintenance personnel consistent with their assigned level of maintenance. Initial outfitting lists contain material of a spare parts nature required for maintenance of aircraft/equipments. Materials listed in the initial outfitting lists normally are held in supply stocks and under most conditions are not authorized shop spares.

Allowance lists indicate the range and quantities of support equipment considered necessary for maintenance support of assigned and/or supported aircraft. Generally, these items are in-use items required for daily or continual use, such as handtools and avionics test equipment.

Initial Outfitting Lists (IOL's) are publications which indicate the range and quantities of maintenance spare parts considered necessary to support various aeronautical articles. This material is provided to vessels or activities and is firm only at the time of initial outfitting. Increases and decreases in both range and/or quantities of material are based upon the experience (demand history) of each activity concerned. Each series list is designed to support an aircraft, electronic equipment, or some other aeronautical article. The allowances of material are established for various articles for a 90-day period. All items capable of replacement by a maintenance activity are not listed, but rather, only those that are expected to be used at least once in 9 months.

Publications listing equipment and material required for performance of specific functions are known as Tables of Basic Allowance. They contain both shop equipment and common supporting spare parts. They cover allowances of tools and equipment required for use by such activities as Fleet Marine Force squadrons and guided missile activities.

Initial Outfitting Lists and Allowance Lists are identified by the publication number NavWeps 00-35Q series, while Tables of Basic Allowance are identified by the publication number NavWeps 00-35T series. Those allowance lists of primary interest to the Aviation Weapons Officer are contained in the following paragraphs.

Section A (IOL), Standard Aeronautical Material and Naval Stock Material—Section A covers general material such as nuts, bolts, tubing, hose, paint, and other items common to the operation of all aircraft models. Both equipage and consumable supplies are listed. Quantities of consumable supplies appearing in Section A are firm for initial outfitting and may be used as a guide for replenishment until sufficient usage data are available for determining requirements.

Section B (IOL), Aircraft Maintenance Parts—Section B contains airframe, engine, and accessory maintenance parts peculiar to each type aircraft. A separate Section B is issued for each model of aircraft. Quantities of items included in this section are the amounts estimated to be required for a given period of time (normally 90 days). Quantities of items appearing in the Section B are firm allowances for outfitting only, and are used as a guide for replenishment until such time that sufficient usage data are available for determining requirements. (Includes lists for certain target aircraft and guided missiles.)

Section BR (IOL), Initial Outfitting Lists—Section BR series lists peculiar maintenance parts (airframe, engine, accessories, electronics) required for support of concerned target aircraft model, drone helicopter, or guided missile. (It is prepared in lieu of a separate Section B for airframe, engine, accessories, and Section R lists for electronic parts due to limited installation of electronic equipment.)

Section C (Allowance List), Office Furniture and Laborsaving Devices—Section C lists the items and quantities of office furniture and laborsaving devices for the administrative support of deployable fleet air activities only.

Section G (Allowance List), Shop Handling and Servicing Equipment—Section G lists the quantities of shop handling and servicing equipment including handtools which are made available for maintenance support of aircraft as may be assigned or supported.

Section H (Allowance List), Flight Operational Material—Section H is applicable to air task group commanders and all Navy and Marine squadrons operating aircraft or having aircraft assigned. It contains items and quantities of flight operational material considered necessary to maintain the concerned activities in a continual condition of operational readiness.

Section K (Allowance List), Naval Aeronautic Publications and Forms—Section K outlines the general types and classes of aeronautical technical and training publications and forms which are provided as a commissioning allowance for various Navy and Marine Corps aviation activities. It lists those publications and forms which are issued by the Deputy Chief of Naval Operations (Air) and by the Chief, Bureau of Naval Weapons, but does not include publications provided to aviation activities by other Navy Department bureaus, fleet commands, or non-Navy offices.

Section M (Allowance List), Motor Vehicles, Equipment, and Spare Parts—Section M indicates motor vehicles and equipment and related spare parts authorized for naval vessels and aeronautical maintenance and tactical activities, but does not include items for activities of the shore establishment.

Section O (Allowance List), Aviation Armament Material (Arming and Gunnery Training)—Section O lists allowances of aviation armament materials (arming and gunnery training) which are made available to activities of the aeronautical organization for the support of assigned aircraft.

Section P (Allowance List), Photographic Equipment and Materials-Section P lists allowances of photographic equipment and material for the support of aeronautical activities.

Section QT (Allowance List), Special Maintenance Support Equipment—Section QT is applicable to Navy and Marine aeronautical maintenance activities and lists the allowances of special support equipment required for maintenance support of assigned aircraft. A separate Section QT allowance is published for each manufacturer.

Section R (IOL), Aeronautical Electronics Material—Section R comprises allowance lists of electronic equipment and material required for the test and maintenance of aeronautical electronic equipments within the Naval Establishment.

Section X (IOL), Maintenance Parts, Accessories, and Test Equipment for Instrument and Armament Control Systems—Section X outfitting lists indicate the quantities of major components and detail parts estimated to be required at the time of initial outfitting for maintenance support of aircraft instrument and armament control systems for a period of 90 days.

Section Z (IOL), Mobile Electric Powerplant Spare Parts and Equipment, and Spare Parts Support for Aircraft Support Equipment—Section Z indicates the quantities of maintenance spare parts estimated at the time of initial outfitting to be required for aircraft support equipment for a period of 90 days.

Tables of Basic Allowances (NavWeps 00-35T)—Series lists equipment and material required by activities to which the list applies for performance of assigned mission. An example is NW 00-35T-40, BuWeps Allowance List, Air Launched Guided Missile Activities.

For a complete listing of all aeronautic allowance lists, initial outfitting lists, and table of basic allowances refer to the Navy Stock List of Forms and Publications, NavSandA Publication 2002, Section VIII, Part C (latest revision).

STOCK CATALOGS provide information necessary to procure items for operation and maintenance of activities afloat and ashore. The stock catalogs commonly used by aviation maintenance personnel are the Federal Supply Catalog for General Supplies and the Navy Stock List of ASO for aeronautical material.

The Navy Stock List of ASO is divided into four parts, each consisting of several volumes Many of these stock list sections are designed for supply management purposes and are not discussed in this text. The sections normally utilized by maintenance personnel include the following:

1. Sections C0006 and C0009—cross-reference sections Section C0006 is used to cross-reference a manufacturer's part number to a federal stock number. Section C0009 is used to cross-reference a federal stock number to a manufacturer's part number. These are multiple volume sections and are not normally available in individual shops, but may be available in a centralized area for use by several shops.

2. Parts list sections provide supply data to supplement information contained in the Illustrated Parts Breakdown. These sections contain valuable information relative to application and interchangeability. Parts list sections are set up by TSMC. Each section contains an application checkoff list, a listing of repairable assemblies, and a listing of supporting spare parts.

3. Descriptive sections are used when only the item nomenclature and physical characteristics are known. Illustrations are provided to aid in the identification of items that cannot be defined by words. The descriptive sections are established by federal supply classification class.

With the advent of the single manager concept many items formally carried in the individual Navy Stock Lists are cataloged in the Federal Supply Catalog For General Supplies. The complete catalog consists of many sections and is arranged by federal supply classification class.

MATERIAL REQUISITIONING

Maintenance personnel are apt to encounter a variety of local requisitioning channels; all designed to present a demand for an item to the supporting supply department. Assigned levels of maintenance, geographical location of shops relative to supply facilities, and mission of activities requiring support all influence the local requisitioning channels. Local instructions normally promulgate detailed procedures for submitting demands to the appropriate supply point.

RETAIL ISSUE OUTLETS

Retail issue outlets are inclusive of auxiliary stores, ready supply stores, and shop stores. The basic difference is in the internal supply recording procedures.

Ready issue outlets are established in the maintenance working area ashore to provide a ready supply of spare parts to maintenance personnel. The retail issue outlet location is a matter of joint maintenance and supply department determination. The storeroom normally is located as near as possible to the center of material consumption. If several well defined consumption areas are evidenced, there may be several ready issue outlets. The ready issue outlet is, in most cases, the first echelon of supply. Close liaison with this level, and the establishment of a close working relationship should greatly enhance supply support.

Initial stocking of ready issue outlets normally is based on the applicable initial outfitting lists and the recommendations of the supported maintenance activities. Subsequent to initial stocking, replenishment is based on stock status factors. Recommendations relative to range or quantity of material carried should be submitted to the ready issue outlet whenever justified.

The ready issue outlet organization normally provides for ready access to the store by material consumers with a minimum of intermediate channels. Procedures may feature systems that employ credit card type operations to minimize processing individual request documents and permit periodic summary of issues. Further, local procedures may provide for the submission of demands with a minimum amount of data to identify the requirement. The C0006 previously discussed in this chapter and several other material identification publications are normally available at the ready issue outlet.

Aboard ship, maintenance personnel normally submit request documents to the aviation ready issue room. The aviation ready issue room is generally stocked with a wide range of frequently used items. It is normally located above the hangar deck, thus facilitating issues during battle conditions.

Documentation for the expenditure of material from supply stocks must be accomplished. This not only provides for accountability which is a prime consideration for anyone concerned with the handling of public funds and materials, but more important from the standpoint of the Aviation Weapons Officers is that it provides analytical information essential for effective future support. The DOD has developed a standard requisitioning and issue procedure common to the entire military establishment.

The Military Standard Requisitioning and Issue Procedure (MILSTRIP) and Uniform Material Issue Priority System were developed by the DOD to provide a common supply language and more effective supply system operations within the military establishment. This system, known as NAVSTRIP in the Navy, standardizes forms, formats, codes, procedures, and priority systems. It became effective on 1 July 1962

NAVSTRIP employs two forms for the requisitioning and issuing of material. The single line item requisition DD Form 1348 is the basic request document which is submitted to the applicable supply echelon for material requirements Single line item release/receipt document DD Form 1348-1 is the issue document. The DD Form 1348-1 is also used by maintenance personnel to return RFI material to the supply system. The information required on the form depends upon local requirements. These local requirements normally are promulgated by local instructions with which the Aviation Weapons Officer should become thoroughly familiar. Normally the ordnance branch is not required to prepare the final requisition, but submit a rough copy to the supply echelon. Figure 4-1 is an example of the DD Form 1348 showing the blocks that are normally completed by maintenance personnel. A brief explanation of the entries is as follows:

Block A—Supporting supply department.
Block B—The shop or department.
Blocks 4, 5, and 6—Stock number (material control code should be inserted directly above FSC in block B). (EXAMPLE: H, Q, G, etc.)
Block 7—Unit of issue.
Block 8—Quantity.
Blocks 9-12—Document number (commonly referred to as stub number).
- Block 9—Department code as assigned locally.
- Block 10—Accounting number, shop number, work center, etc.
- Block 11—Calendar year and Julian date. (EXAMPLE: 2 185) Calendar year—185 days expired since 1 January.
- Block 12—Serial number as determined locally.

Block 13—Demand code (R—recurring demand, N—nonrecurring demand).
Blocks 14, 15, and 16—Job orders as assigned locally.
Block 17—Fund code as assigned locally.
Block 18—Material cognizance code.
Block 19—Whenever applicable, the specific project codes listed in appendix 8 of NavSandA Publication 408 should be inserted in this block. (EXAMPLE: 700—ANFE, 777—AOCP, etc.)
Block 20—Priority as determined by force activity number and urgency of need definition.
Block 21—Can be used to specify date material is required to maintain schedule.
Blocks L and M—Part number when FSN is not known or available.
Blocks N and O—Source reference of part number indicated in blocks L and M.

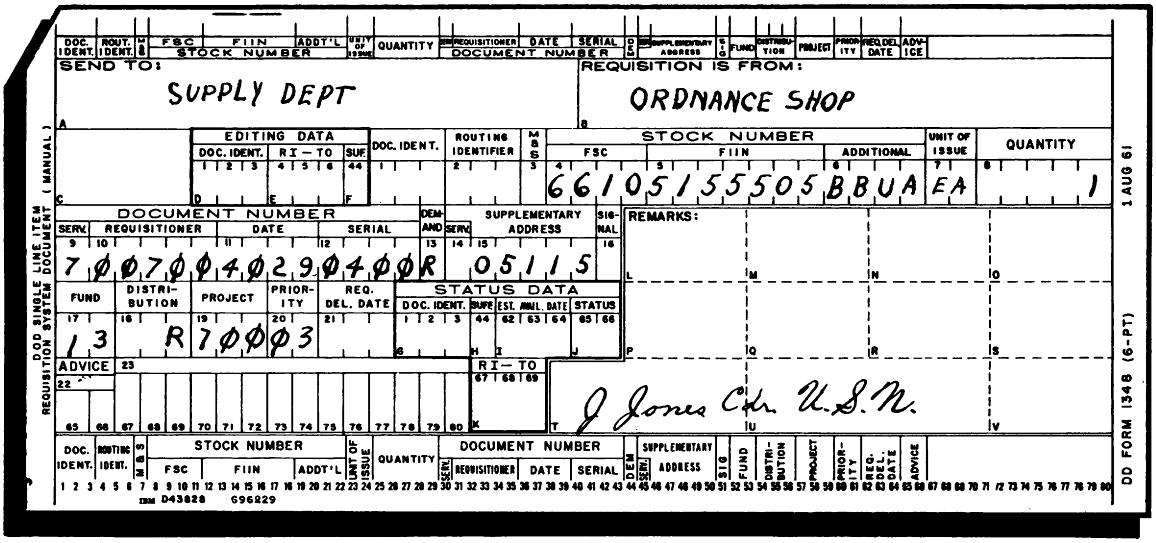


Figure 4-1.—DD Form 1348.

Blocks T and U—Authorized signature.
Block V—Estimated cost of requested material.

The uniform material issue priority system is covered by OpNav Instruction 4614.1A. Its provisions are discussed briefly in the following paragraphs. Under the present priority system there is no decision to be made in assigning priorities. The urgency of need combined with the activity's military importance when applied to the priority number chart (table 4-2) indicates the proper priority number and no deviation is allowed.

Table 4-2.—Priority number chart.

Force/Activity Designator	Urgency-of-need categories			
	A	B	C	D
I	1	4	11	16
II	2	5	12	17
III	3	6	13	18
IV	7	9	14	19
V	8	10	15	20

Every activity is assigned one of five force/activity designations according to their military importance. These designators are:

I—Combat—The highest order of military importance. This designator is not used in peacetime unless approved by the President or the Joint Chiefs of Staff.

II—Positioned—U.S. Forces positioned and maintained in a state of readiness for immediate combat or direct combat support.

III—Ready—U.S. Forces maintained in a state of readiness to deploy for combat.

IV—Reserve and Support—U.S. active and selected reserve forces planned for employment in support of approved joint war plans. This category includes training units and units in training for scheduled deployment.

V—Others—All units not otherwise assigned.

Force/activity designators are assigned by the Secretary of the Navy, the Chief of Naval Operations, and Commanders in Chief of Fleets. Authority to make assignments may be delegated to Fleet Commanders with the exception of I—COMBAT.

The urgency of need for an aircraft spare part or aeronautical material may be determined in accordance with the following designators:

A—Emergency repairs or replacement for aircraft or missiles. (Includes material without which the activity is unable to perform its assigned mission.)

B—Emergency replacement or repairs which impair the operational capability of the activity.

C—Material required for weapons systems or support equipment to avoid disruption of operations. This category also includes material for scheduled deployments.

D—Material required for scheduled maintenance, filling allowance lists, and all other routine stock replenishments.

If a squadron or unit has been assigned force/activity designator III and it is determined that a part or some material is needed which if not received will impair the capability of the aircraft to perform its assigned mission, then the priority assigned must be number 6. The only other priorities available to force/activity designated III units or squadrons are 3, 13, and 18.

There are two allowable exceptions to the force/activity designator governed priority number system. Medical or disaster supplies and essential clothing may be requisitioned under priorities 3 and 6 respectively by any activity regardless of the force/activity designator.

PARTS KIT

Parts kits contain supporting items and material for the maintenance, repair, and rework of selected aeronautical repairable type items and are procured, stocked, requisitioned, accounted for, and used on a kit basis as one line item.

A parts kit consists of a group of maintenance or overhaul parts that are bought, packaged, and stock-listed as a single item regardless of classification that may be included therein. Normally, these parts have either a very low unit cost or have a high replacement rate in overhaul or repair of the next higher assembly. Depending on the complexity of the end item, there can be one or more kits needed for its repair. Parts kits are designed to serve three separate requirements as described in the following paragraphs.

C KIT (CURE-DATED OR SOFT GOODS). This kit provides cure-dated items such as diaphragms, packings, and O-rings. The C kit may also contain soft goods not subjected to age control such as gaskets and seals, plus metallic items such as screws, nuts, and washers required to be removed when cure-dated or soft goods type materials are replaced. Any metallic item placed in the C kit is not duplicated in the D kit. When mixed categories or cure-dated parts are packaged in a single container, the control or cure-date of the package must be that of the oldest cure-dated part contained therein. If cure-dated kits become overaged due to the expiration of the storage limitations, the kit must be administratively disposed of as excess material.

D KIT (OVERHAUL). This kit provides hard good spare parts required while performing the depot level of maintenance. This kit does not contain cure-dated parts.

F KIT (FIELD). This kit provides those items that are required to be replaced at intermediate and organizational maintenance levels. These parts are normally items not requiring special tools or equipment. This kit does not contain cure-dated parts.

Part numbers for applicable parts kits for intermediate and organizational levels of maintenance are listed in the Illustrated Parts Breakdown and the Maintenance Instructions Manual. Components of kits are additionally identified in the Illustrated Parts Breakdown by a footnote and a symbol appearing to the right in the part number column and indicating which items are furnished in the kit. The Maintenance Instructions Manual utilizes a symbol keyed to the illustration to indicate parts furnished in the kit.

Presence of a new part in an applicable parts kit eliminates the necessity of cleaning, inspection, or rework of the equivalent part removed from the assembly being repaired. Removed parts in this category must be administratively condemned. Removed parts not supplied in applicable kits must be handled in accordance with instructions contained in the Maintenance Instructions Manual.

Detailed instructions on parts kits are contained in BuWeps Instruction 4423.2.

PREEXPENDED BINS

A preexpended bin is one which contains low cost, high usage items which have already been charged to final expenditure. Many items of small dollar value are used repetitively in the aircraft maintenance program. The accepted practice is to stock these repetitively used items in the immediate maintenance area in a semicontrolled preexpended bin. Preexpended bins are normally established by the supply department in consort with the maintenance activity and are labeled, stocked, and replenished by the supply department. The normal responsibilities of maintenance personnel in this are:

1. Recommending items to be stocked.

2. Supervising the use of the bins to prevent waste, pilferage, and deterioration of the contents to a scrap heap.

3. Insuring that preexpended bins are separate and distinct from the normal "salvage" boxes located in most shops.

Preexpended bins provide repetitively used items to the user with the minimum of effort. The material is immediately available to all shop personnel. The bins also provide the supply department with a constant and realistic demand history.

Nonstandard and/or Navy manufactured items may at times be required. These are normally obtained through the normal supply channels as outlined in local directives.

Manufactured items are those items which are source coded in the M series in applicable illustrated parts breakdown lists. Request documents submitted for manufactured items should contain additional reference data such as, part number, drawing number, and publication reference, or any other information which would be advantageous in the acquisition of the material.

Nonstandard material (material requiring open purchase) may not be procured when standard stock items are available except when the nonstandard material is considered to be indispensable. When the procurement of nonstandard material is considered essential, the originating request document must contain the following information:

1. A certification that no standard stock material is suitable.

2. A justification for the procurement of the nonstandard material.

ROTABLE POOLS

Rotable pools consist of a range of selected components maintained by a specific maintenance activity, on custody from the supporting supply department. The items generally carried in the pool are those required to sustain operations where immediate availability is essential. Aircraft wheels, tires, avionics assemblies, propellers, and carburetors are examples of items that might be included in the pools. The range and quantity of items to be carried in the pool are subject to the recommendations of the maintenance activities. The supply department establishes the rotable pool stock and prescribes detailed procedures for operation and control of the pool.

RECORD OF MATERIAL ON ORDER

A record of the material that is on order serves many functions. There are many instances when there is confusion, loss of time, and misunderstanding in relation to whether or not a certain item has been ordered. Unless a record is kept there may be uncertainty until the item is received or correspondence regarding the order presents some evidence. Records of material ordered will not only establish if it were ordered, but also the priority, date, by whom ordered, and for what unit of equipment. Also, this information aids in the installation or use of the material, for in many cases the time elapsed may be great and the man ordering the material may not be present. The record that has been kept may be used as a reference. A suggested means of keeping such a record is to enter pertinent information on the back of the sub requisition that is retained in the ordnance shop.

FUNDING

At one time or another, almost everyone has had the frustrating experience of not being able to draw from supply an item that he thought necessary to have immediately; the usual reason given being, "We don't have any money left." It takes only a short time to realize that the Navy does not operate with unlimited funds. This section is presented to further an understanding of the system whereby funds are made available at the user activity level for operating expenses.

The main money pool of the government is the General Fund of the Treasury. Funds can come into the General Fund from sources such as income taxes, excise taxes, import-export taxes, etc. The only way for money to be expended from the General Fund is by congressional action, which has to be approved by the President. A bill passed by Congress which authorizes the expenditure of funds from the General Fund is called an appropriation.

An estimate of the amount of money required for the operation of the Defense Department during a given fiscal year is prepared by Department of Defense fiscal experts well in advance of the beginning of the fiscal year. The Congress studies the proposed budget in the light of world affairs, the current domestic economy, and such other considerations as they see fit—then acts upon it. They may increase the amount requested, decrease it, or pass it as is. After presidential action is completed, the money is made available to the Department of Defense to be spent during a specified year. This is known as an "annual" or "1-year" appropriation.

Congress and the President may also approve "no-year" appropriations for special projects such as large construction over an unspecified length of time. Another form of appropriation is the "multiple-year" appropriation for projects which will be completed in a predictable length of time. An example of this type of appropriation might be the money appropriated to cover the expenses of the NROTC college programs for the next 4 years.

The appropriation by which maintenance management is most affected is the current year appropriation. After the appropriation or expenditure authorization is received in the Department of Defense, it is prorated among the services based on their previously submitted budget estimates. The Navy's share is prorated among the various bureaus in essentially the same manner; that is, as a percentage of their estimated requirements for the coming fiscal year. The money to be spent for naval aviation is made available to BuWeps. Here, part of the money is allocated to ASO to pay for the purchase of aircraft spare parts in quantities which past demand has indicated will be sufficient for the coming year.

The material is held in stock ashore in an account known as the appropriation purchase account (APA). When APA material is drawn by the consumer, it is not charged to the local allotment as its usage has been anticipated and has already been purchased with BuWeps funds.

Another part of BuWeps funds is made available to the operating activities in the form of allotments.

ALLOTMENTS

Allotments concerning naval aviation are authorizations by BuWeps to the user activities to spend a certain amount of money during a given length of time for specified purposes. User activities are shore commands which operate aircraft, and the major air type commanders. Major air type commanders are Commander, Naval Air Force, Atlantic (CNAL); Commander, Naval Air Force, Pacific (CNAP); Chief of Naval Air Training (CNATra); and Chief of Naval Air Reserve Training (CNAResTra). Operating funds for squadrons and units are apportioned to them by their type commander as an Operating Target (OPTAR). Routine nonaviation expenses for operating squadrons and units are absorbed by the ship or station to which assigned.

There are five types of allotments:

1. Station operation and maintenance allotment.
2. The operation and line maintenance of aircraft allotment.
3. The aircraft rework allotment.
4. The research allotment.
5. The special purpose series allotment.

The first three allotments are of particular concern and are discussed further. The latter two have special application, and are not covered in this text.

Station Operation and Maintenance Allotment

Funds in this allotment are made available to commanders of the shore establishment to pay their operating expenses, exclusive of aircraft operating expenses. This money is used to pay civilian labor, buy office supplies, and to pay for all other upkeep and housekeeping supplies. Squadrons aboard the station have no allotment of this type and are dependent on the station for their support. A segment of the station's allotment is allocated to the squadrons for their nonaviation routine expenses. Funds from this source are generally scarce, but it is possible by careful management to make them last through the specified spending period. Shore commanders, in some cases, may elect to provide basic supplies in limited amounts to the tenant activities without providing any funds which the squadron or unit can spend as needed.

Operation and Line Maintenance of Aircraft Allotment

Major air type commanders and shore commands which operate aircraft are furnished this allotment by BuWeps. The OPTAR provided to fleet squadrons and units by their type commanders is usually a monthly segment of these funds. Unused funds revert to the control of the type commander when a new OPTAR is authorized. Type commanders provide OPTAR's to all squadrons and units under their operational control, whether or not the user activity is based ashore. Shore station commanders have no responsibility for providing money for the operation and line maintenance of aircraft of tenant fleet activities.

Funds allotted for the operation and line maintenance of aircraft may be used to buy any type material as long as the material is used for the purpose of the allotment. By far the greatest expenditures against this account are for fuel and oil. Other materials that may be purchased against this allotment include rags, N cognizance electronics material, preservatives, crewmen's flight clothing, or anything else that is consumable due to its use on or about the aircraft.

Aircraft Rework Allotment

This allotment is provided to the commanding officers of overhaul and repair activities by BuWeps. Its purpose is self-explanatory.

ACCOUNTING FOR MATERIAL IN USE

Accounting for material does not cease when it is withdrawn from the supply department. It is at this point that the accounting responsibility passes to the applicable maintenance personnel.

AIRCRAFT PARTS

Normally, the accounting for aircraft parts drawn to replace similar defective parts is satisfied when the part is installed on the aircraft. No further custodial records are required. Likewise, the accounting for materials drawn for general maintenance is satisfied when the material is consumed in the authorized maintenance work. In these cases it is actually the removed defective material that requires additional action to insure its accountability from the time it is removed until it is returned to the supply department.

The degree of accountability required for aeronautical material may be ascertained by the material accountability recoverability codes (MARC). Material accountability recoverability codes are a part of the source, maintenance and recoverability codes which are assigned provisioned items as required by current ASO and BuWeps directives. The MARC's appear in the descriptive sections and parts lists sections of the ASO Navy Stock List, BuWeps Allowance Lists, and may appear in such other publications as directed by BuWeps. These codes aid personnel to determine the proper method of:

1. Requisitioning material.
2. Accounting for material while in use.
3. Turn-in or disposition of material.
4. Repair or overhaul of material,

The following list defines the various material accountability codes:

B—Exchange Consumables. Code B is applied to items which are consumable or expendable but normally require item-for-item exchange for replacement. Such items may contain precious metals, may be highly pilferable, or may be high cost items.

C—Consumables. Code C is applied to all other consumable or expendable items which do not require item-for-item exchange for replacement.

D—Equipage, Support Type. Code D is applied to end items of support equipment which are economical and practical to repair on a scheduled basis through a major rework activity. Code D items are maintained on a custodial basis and normally require item-for-item exchange for replacement.

E—Equipage, Locally Repairable, Support Type. Code E is applied to end items of support equipment which are to be repaired locally by the using or fleet support activity within their assigned maintenance responsibility. Code E items are maintained on a custody basis and normally require item-for-item exchange for replacement.

R—Equipage. Code R is applied to repairable (except end items of support equipment) items which are economical and practical to repair on a programed basis through a major rework activity. Code R items are maintained on a custody basis in some cases, depending upon the use of the item. These items normally require item-for-item exchange for replacement.

L—Equipage, Locally Repairable. Code L is applied to repairable (except end items of support equipment) items which are to be repaired locally by the using or fleet support activity within their assigned maintenance responsibility. Code L items are maintained on a custody basis in some cases, depending on the use of the item. They will normally require item-for-item exchange for replacement.

Some allowance lists may still be in use which utilize a different accountability code system than MARC. The following equivalents may apply, pending issuance of new publications using the latest material accountability recoverability codes:

MARC	INTERIM	OLD
D	A	A
D	O	A
D	E	AX
R	R	X
B	D	NONE
C	C	C
E	NONE	NONE
L	NONE	NONE

As is apparent upon reviewing the material accountability recoverability codes, the disposition of defective material is largely dependent upon its potential repairability. Codes D, E, R, and L signify that the item is repairable and is required to be returned to the supply system even though it is not RFI. The need for the expeditious handling of prospective repairable material cannot be overemphasized. The repair program is the prime source of supply for many critical high value items. Code C items are normally consumed or are not of a repairable nature and do not require turn-in if non-RFI.

An aeronautical material screening unit is established by all activities assigned the responsibility to perform intermediate levels of maintenance. The basic responsibility of the screening unit is to screen all defective aeronautical material generated on the station by tenant squadrons and station operating units prior to further processing of the material by the supply system or higher echelons of maintenance. The screening unit determines if such material is within the repair responsibility of local intermediate level maintenance activities and, if so, initiates action to effect its local repair.

Normally, the following sequence of events should be followed in the repair of aeronautical material:

1. The using activity should repair the defective item without removal from the aircraft.
2. The using activity should remove the defective item from the aircraft, check, test, and repair it within their assigned responsibilities and replace it on the aircraft.
3. In the event the item requires repair and the time involved is excessive from the operational or readiness point of view, the using activity may draw a replacement item from supply. The defective item should subsequently be repaired by the using activity, if within their assigned repair responsibility, and forwarded to the supporting intermediate maintenance activity for check, test, and certification as ready for issue (RFI). The supporting activity then packages and preserves the items, if required, and turns it in to the local supply department as RFI material.
4. If the using activity determines that repair of the item is beyond its repair responsibility, the activity should so certify and forward the item to the screening unit of the supporting intermediate maintenance activity.
5. This screening unit determines if the item is within the repair responsibility of the intermediate maintenance activity, and, if so, the item is repaired and forwarded to supply as RFI. If not, the item is forwarded to supply as prospective repairable material.
6. If the only local capability to test or repair the item is the assigned responsibility of the using activity, certification of the using activity is accepted by the supporting activity's screening unit that the item is beyond local repair responsibility or that the item has been repaired and is RFI.

A relatively new NavWeps Form 13070/3 is presently being used in the reporting of failures, deficiencies, or malfunctions of aeronautical material. It has replaced the Failure, Unsatisfactory or Removal Report, Form NavAer 3069 and the Electronic Failure Report, DD Form 787. The Failure, Unsatisfactory or Removal Report is designed so that certain copies may also be used for custodial purposes of the defective material including its return to the supply department.

(NOTE: The FUR set is discussed in chapter 2 of this text.)

AIRCRAFT MAINTENANCE SUPPORT EQUIPMENT (AMSE)

Developing and supervising proper procedures to insure the maintenance and accountability of aircraft maintenance support equipment (AMSE) is normally a prime administrative function of any shop. Unlike most aircraft parts, AMSE requires the maintenance of custodial records and periodic physical inventories throughout its inuse life.

Aircraft maintenance support equipment as discussed in this chapter applies to all accountable type support equipment listed in BuWeps Allowance Lists, Sections G, O, R5, T, and TBA's. Accountable AMSE items are those assigned material accountability recoverability codes D and E. These items are assigned material control code X which appears as part of the federal stock number identification.

Because stocks of AMSE are so limited, issues are strictly controlled to insure proper program support. After initial outfitting, AMSE items are issued on an item-for-item exchange basis. When an AMSE item is lost, missing, or beyond economical repair, and replacement is required, approval of the replacement item is granted only when accompanied by a copy of the survey document. Aircraft maintenance support equipment is issued by the supply activity to the end user only upon the approval by the following:

1. The cognizant type commander or his designated representative for fleet and training command activities.
2. The cognizant BuWepsFleReadRep/BuWepsFleSupRepCen for overhaul and repair activities and shore activities.
3. ASO for special programs, bailment programs, military aid programs (MAP), etc.

Aircraft maintenance support equipment includes such items as test stands, wrenches, drills, and voltmeters as listed in the BuWeps Allowance Lists mentioned above. These equipments are made available as organizational property or custody/subcustody from supporting station/squadron/ship dependent upon the characteristics of the equipment and the assigned maintenance, operational, and/or logistics responsibilities. Except for ships, equipments required are authorized through the application of appropriate allowance lists as shown in enclosure (2) to BuWeps Instructions 04700.3. This enclosure consists of an allowance list applicability chart (ALAC) for each activity of the naval shore establishment indicating the equipment by allowance list category authorized to specific activities. Actual equipment authorized for naval ships may be determined from BuWeps Instruction 4423.3.

Under the aircraft maintenance material readiness list (AMMRL) program established by the Bureau of Naval Weapons, all applicable intermediate and organizational levels of maintenance support equipment listed in the various allowance lists are consolidated into one individual material readiness list (IMRL) for each aircraft maintenance activity. Each IMRL is approved by the cognizant fleet or training command and is used as the firm mandatory material readiness list of the activity to which the list applies.

All aircraft maintenance support equipment must receive continued accountability while in use. The activity having prime custody of the support equipment is considered to be the accountable activity. Equipment furnished as organizational property is accounted for by the holder of such equipment. Equipment furnished or received on subcustody is accounted for by the supporting activity.

The department head is held responsible for the maintenance support equipment in his department. The Aviation Weapons Officer or shop senior petty officers normally are required to receipt on subcustody for all the AMSE in their shops. Periodical inventories are required to ascertain if material for which you are responsible is actually on hand. Material which cannot be accounted for must be surveyed.

An annual inventory of inuse aircraft maintenance support equipment is required to provide ASO and BuWeps with an accurate assessment of the quantity and condition of this support equipment in the possession of custodians in order that sound decisions can be made concerning the procurement of new and replacement equipment. Type commanders or the BuWepsFltReadRep/SupRep forwards to all activities having reportable items of support equipment a deck of EAM cards and/or an EAM listing indicating those items of support equipment requiring inventory. Care should be taken to insure that items held or issued on a custody basis are reported only by the controlling custodian.

Transaction reporting of selected AMSE items is sometimes required. Type commanders or BuWepsFltReadRep/SupRep selects the items of AMSE desired to be reported on a transaction basis and publish appropriate instructions for reporting. Upon receipt or transfer of an item of AMSE (subject to transaction reporting) on a permanent basis, or when the condition or status of the equipment changes, activities are required to submit a transaction report.

NAVWEPS ORDNANCE ALLOWANCE LISTS

Ordnance allowance lists consist of listings of required equipment, ammunition, accessories, spare parts, special tools, consumables, and consolidated load lists. At present there are over 700 separate NavOrd allowance lists. However, many of the lists have been consolidated. Although each list retains its own numerical identity within a combined list, the number assigned to the consolidated list identifies the group of lists. For example, NavOrd List 21416 consists of approximately 15 separate lists.

Some lists are in the form of ordnance data (OD's), publication requirements, and ordnance equipment lists. Publication requirement lists are minimal only, while other lists are in the form of instructions issued under the Navy Directives System. Still others are published in looseleaf manual form.

Listings of NavOrd lists, with the exception of instructions and OD type publications, may be found in NavOrd List 0.

Some of the more pertinent ordnance allowance lists concerning the Aviation Weapons Officer are briefly discussed in the following paragraphs:

NavOrd List 20870 (latest revision). This list is a Confidential allowance of ordnance equipment for all service model aircraft. The list is divided into two parts. The first part contains instructions and general notes, while the second part is the equipment allowance section. The equipment allowance section consists of a series of tables representing each service model aircraft. Since each table lists the total installations per aircraft, these lists may be used as an inventory for each aircraft.

NavOrd List 21416 (latest revision). Line maintenance and tool sets are covered by this allowance. It also contains a listing of parts allowed in each kit, and may be used as an inventory list when checking each kit.

NavOrd List 21486 (latest revision). This list contains allowance of ordnance handling equipment for ships carrying or tending aircraft. The list has a separate column for each class of carrier or seaplane tender.

NavOrd List 21543 (latest revision). This list contains aviation ordnance equipment allowed to naval districts and some of the other major commands including the Naval Air Reserve Training Command.

Ordnance publication requirements lists for various aircraft, miscellaneous type squadrons, and air groups are to be found in the Publications Requirements List for Aircraft Activities NavOrd OD 7012 (latest revision).

Additional publications requirements lists are published for various classes and/or types of aircraft carriers and seaplane tenders. The basic requirement list of ordnance publications for aircraft activities is contained in OD 7012.

ORDNANCE SUPPLY OFFICE (OSO)

The Ordnance Supply Office is a joint agency of the Bureau of Naval Weapons and the Bureau of Supplies and Accounts (BuSandA). Its mission is to implement the Navy Supply System by the establishment and integration of inventory procedures within the ordnance supply system for materials under its cognizance.

Prior to 1961, OSO had limited functions consisting of distributing ordnance repair parts, tools, accessories, and preparing and issuing ordnance allowance lists.

With the issuance of BuWeps Instruction 5450.27, basic inventory control functions pertaining to conventional ammunition were reassigned to BuSandA and the OSO.

In the past, various functions pertaining to the inventory management of conventional ammunition have been performed by the Bureau of Naval Weapons; the Central Ammunition Supply and Control Organization (CASCO); Naval Ammunition Depot, Crane, Indiana; and the Ammunition Stock Recording Office (ASRO) at the Naval Weapons Plant. In the interest of improved responsiveness and effectiveness, the decision was made to consolidate responsibility for performance of these functions under centralized management within the Navy Supply System. The basic inventory control functions, pertaining to conventional ammunition, were reassigned to the Bureau of Supplies and Accounts and to the Ordnance Supply Office, Mechanicsburg, Pennsylvania.

The functional responsibilities reassigned to OSO apply to the following items of ammunition and related material:

1. Gun ammunition, all types.
2. Bombs (all types, except special weapons).

3. Rockets and projector charges (except guided missiles).
4. Small arms ammunition.
5. Pyrotechnics.
6. Demolition material.
7. Chemicals and chemical ammunition.
8. Cartridge-actuated devices.
9. JATO.
10. Propellants for conventional ammunition.
11. Explosives.
12. Pallets, pallet adapters, and pallet crates.

NOTE: BuWeps exercises basic inventory control responsibilities on items or principal components of guided missiles, mines, torpedoes, depth charges, and underwater sound signals (except explosives for loading as authorized by BuWeps).

OSO has been designated as the inventory control point, for conventional ammunition material, to include appropriate cataloging, reporting, procurement, inventory control, and disposal. NOTE: BuWeps exercises technical guidance and direction, including responsibility for all functions relating to safety, for the ammunition program.

For a complete breakdown of responsibility in performance of functions and tasks for each echelon pertaining to the ammunition distribution program refer to BuWeps Instruction 5450.27 (latest revision).

AMMUNITION DISTRIBUTION SYSTEM

The ammunition distribution system was established to provide a means of supervising all phases of ammunition logistics from manufacture to expenditure. The system is basically the same as other segments of the supply system. However, the problems of ammunition manufacture, handling, stowage, and transportation sometimes require that the ammunition distribution system operate independently.

The Bureau of Naval Weapons controls, guides, and directs, either directly or by delegation, all technical phases of the ammunition distribution system.

SOURCE OF SUPPLY

The source of supply of ammunition, as in the case of any material, must be reliable and economical. These factors dictate the organization principles governing the procuring, stocking, restocking, and issuing of ammunition.

The Ordnance Supply Office designates the supply points and their position within the echelon of supply, which carry ordnance material and ammunition under OSO cognizance. It should be understood that the basic mission and echelon of supply of any activity may be determined by its general location as well as other factors for purposes of distribution and issue of ammunition. An ammunition activity, as defined by BuWeps, is any naval activity the mission of which includes storage and issue of ammunition. It can easily be seen that this encompasses practically all naval activities to some degree.

In support of procurement, production, and issue, there are many ammunition activities located at strategic points wherever the Navy maintains forces.

Naval Ammunition Depot (NAD)

Naval ammunition depots (NAD's) of several categories are strategically located within the continental U.S. and overseas. Some of these depots (inland) are large activities having facilities for loading, preparing, renovating, receiving, storing, and issuing nearly all types of ammunition. Many also have manufacturing facilities for specific types of ammunition. In addition, they store, maintain, and when necessary issue war reserve stocks.

Coastal NAD's store and issue ammunition of nearly all types, but have only limited facilities for production and renovation. They serve as receipt and issue points for overseas shipment and support adjacent naval activities.

Still other depots are special-purpose types. They are required to load, overhaul, test, and store only specific types of ammunition.

Naval Magazines (NavMags)

Navy magazines serve primarily as receipt, storage, and issue activities and may have only limited renovation facilities. At present, most NavMags are located overseas and serve essentially the same purpose as continental naval ordnance facilities.

Naval Air Station Magazines (NASMags)

Naval air station ammunition activities are part of the ammunition supply echelon. They are at the level of direct support to operating forces (squadrons) assigned. Only in emergencies do NASMags make issue to ships or other ammunition activities. However, NASMags may receive and store ammunition belonging to other activities (ships, etc.). This ammunition is not considered as NAS stock and is carried as nonstock material.

NAS magazines make issues in small lots to supported activities. They provide storage in the form of ready service magazines or lockers. Ammunition drawn by the using activity and not used, may be returned to NAS magazines. However, certain conditions may be required and should be met by the using activity. Cleaning, disassembling, repacking, or unbelting should normally be accomplished by the using activity, since returned ammunition is subject to reissue.

All issues of ammunition and explosives are controlled by policies promulgated by BuWeps and BuSandA (OSO) in accordance with Navy Regulations and CNO policy. These policies are issued in NavWeps or BuSandA (OSO) instructions as the need arises. These instructions may be a part of specific basic stock letters or allowance lists, or may be general instructions covering procedures for all ammunition activities. For example, BuWeps Inst. 8015.6 (or latest revision) covers the general subject of issue and distribution of ammunition.

Upon commissioning or reactivation of each naval ammunition activity, they receive an initial outfitting of basic stock of ammunition in accordance with an established allowance list, or in some instances a basic stock letter originated by BuWeps. This document lists the types and amounts of ammunition to be maintained on hand by the activity concerned.

Basic stocks of ammunition activities are to be maintained at a level of 80 to 110 percent of the authorized allowances, as established in the allowance lists or basic stock letter.

Maintenance of the prescribed stocks is accomplished by the replenishment process. Both initial outfitting and replenishment processes vary somewhat, depending on the particular type of activity involved.

Naval Ammunition Depots and Magazines (CONUS)

Continental U.S. Naval ammunition depots and magazines are initially outfitted in accordance with a basic stock letter which sets forth a source of initial and replenishment supply. The basic stock letter also contains authorization for the source of supply to make issues to fill and maintain basic stocks within allowances. Basic stocking and replenishment is accomplished automatically through the ammunition distribution system.

Naval Air Station Magazines

Initial stocks for NASMags may be automatically supplied or ordered from the source of supply indicated in the allowance list or basic stock letter. Replenishment of other than new types or special ammunition is not automatic and must be ordered by letter or dispatch from the assigned source of supply. NAS ammunition allowances are based on type and number of aircraft supported. NAS magazines may make only emergency issues to ships or other ammunition activities.

Ships Initial Outfitting

The initial outfitting of ammunition for all ships, new construction, and reactivation is as follows:

For new construction, the prospective commanding officer must submit a letter of request via the cognizant district commandant, to the nearest ammunition activity, at least four weeks prior to the required date of delivery.

For reactivated ships, the same procedure is used, except letters of request are routed via the reserve group commander and the cognizant district commandant to the nearest ammunition activity.

Replenishment of allowances for ships is obtained by written request to the nearest ammunition activity, tender, or ammunition supply ship.

Advanced Bases

Initial outfitting allowances for advanced bases are authorized only by BuWeps. Advance Base Catalog (OpNav Inst. 04040.22) indicates that the allowances will be drawn in the operating area. Initial allowances authorized by BuWeps are supplied automatically, on a staggered schedule to facilitate handling and stowage.

Operating activities (squadrons) have no initial outfitting allowance, but receive support within established allowances from NAS magazines.

AMMUNITION ALLOWANCE LISTS

In order to economically achieve maximum readiness of the operating forces through training and maintain a constantly available stock of service ammunition, all activities must necessarily be governed by a specific allowance.

Under the joint direction of BuWeps and BuSandA, the Ordnance Supply Office, with the approval of the Chief of Naval Operations and the fleet commanders, prepares, maintains, revises, and distributes the following:

1. Ship's ammunition allowance lists.
2. Training allowances.
3. Fleet issue load lists.
4. Basic stock lists for appropriate bases and stations.

Training Allowance Lists

Some of the pertinent training ammunition allowances lists with which the Aviation Weapons Officer should be familiar and will normally use are set forth in the following instructions:

1. Fleet Training, BuWeps Instruction 08011.10C (Confidential).
2. Small Arms Training, NavOrd Instruction 8370.4.
3. Small Arms Training and Matches, BuWeps Instruction 8011.13.
4. Service and Training for East Coast Air Stations (North), BuWeps Instruction 8011.6.
5. East Coast Air Stations (South), BuWeps Instruction 8011.5.
6. Small Arms Ammunition, OpNav Instruction 8011.6.
7. Naval Air Reserve, BuWeps Instruction 8011.12.

NOTE: Insure that only the latest revision is used.

Service Ammunition Allowance Lists

Allowance lists for service ammunition are for the purpose of establishing the onboard ammunition to be used for combat purposes. These lists may be combined with training allowance lists. Lists may be for a group of activities such as the NavOrd List 23457 (latest revision) which lists aircraft service ammunition for east coast air stations. The great number of ammunition allowance lists makes a thorough discussion here impossible. Indexes to all of the ammunition allowance lists may be found in NavOrd List 0.

CONVENTIONAL AMMUNITION DISTRIBUTION SYSTEM

A revised ammunition distribution system, the Conventional Ammunition Distribution System, is currently in operation with the recent assignment of management responsibilities of conventional ammunition to the Ordnance Supply Office (OSO).

NOTE: Refer to BuWeps Instruction 5450.27 (Responsibility for conventional ammunition inventory management and related functions; reassignment of) for more complete information.

The term "Conventional Ammunition Distribution System" refers to a special system that controls the flow of conventional ammunition from the point of receipt to the point of issue and encompasses all regulating and directing actions necessary in the acquisition, distribution, and disposition of this material. Consequently, the Ammunition Stock Recording System (ASRS) has been replaced with the Conventional Ammunition Distribution System. NavOrd Instruction 8015.3 (which contained detailed information on the Ammunition Stock Recording System) has been canceled and superseded by the following instructions and publication:

1. BuWeps Instruction 8015.6.
2. BuWeps Instruction 4440.2B.
3. OSO Field Instruction 8015.4.
4. OSO Field Instruction P8010.12.
5. NavSandA Publication 408 (Chapter 11).

The scope of the above listed instructions and publication are briefly discussed in the following paragraphs.

BUWEPS INSTRUCTION 8015.6

BuWeps Instruction 8015.6 provides revised procedures for Primary Distribution Points in the receipt, storage, and issue of expendable ordnance material assigned the cognizance symbols 0T, 2T, and 4T. (NOTE: Principal cognizance symbol codes are shown in OSO Field Instruction P8012.12.) The Primary Distribution Points are guided by BuWeps Instruction 8015.6 in reporting expendable ordnance material to the Ordnance Supply Office under the Conventional Ammunition Distribution System.

BUWEPS INSTRUCTION 4440.2B

BuWeps Instruction 4440.2B promulgates revised procedures for physical inventory of stores account material at activities under the management control of BuWeps. This instruction cancels chapter 7 of NavOrd Instruction 8015.3.

OSO FIELD INSTRUCTION 8015.4

OSO Field Instruction 8015.4 was issued for the purpose of explaining some of the details that apply to the ammunition stock recording and reporting procedural changes for Distribution Points. This instruction in accordance with BuWeps Instruction 5450.27 (Responsibility for conventional ammunition inventory management and related functions; reassignment of) provides detailed implementation procedures as prescribed by the Ordnance Supply Office with the concurrence of the Bureau of Naval Weapons, the Bureau of Supplies and Accounts, and the U.S. Marine Corps Headquarters. The revised recording and reporting procedures include the use of the new National Cash Register (NCR) single program bar, a new Ammunition Stock Record (NavSandA Form 1172), a new Transaction Stock Status EAM Card (NavSandA Form 1173), and many other items that apply to the Conventional Ammunition Distribution System.

OSO FIELD INSTRUCTION P8010.12

Ordnance Supply Office (OSO) Field Instruction P8010.12 outlines OSO's policy, procedures, and responsibilities in regard to the Conventional Ammunition Distribution System. This instruction is applicable to all activities in any way involved in the procurement, production, storage, issue, consumption, or expenditure of conventional ammunition. This instruction should provide Aviation Weapons Officers with answers to such questions as: What is the Conventional Ammunition Distribution System? Under the Conventional Ammunition Distribution System, what is the relationship with BuWeps, OSO, COMSERPAC, and COMSERVLANT? What are the mechanics of requisitioning under the Conventional Ammunition Distribution System? What role does OSO play in the Conventional Ammunition Distribution System? Also included in this instruction is a bibliography of significant Conventional Ammunition Distribution System directives.

NAVSANDA PUBLICATION 408
(NAVSTRIP) (CHAPTER 11)

Chapter 11 of NavSandA Publication 408, describes the supply aspects of requisitioning and issue procedures to be used throughout the Conventional Ammunition Distribution System. Also included are completed samples of the standard forms (DD Form 1348 and DD Form 1348-1) required to be used by Inventory Control Points (ICP), Fleet Commands, and other activities when requisitioning or issuing conventional types of ammunition.

NOTE: Appendix III of this text contains a bibliography of significant Conventional Ammunition Distribution System directives.

To properly perform their duties, NAS Aviation Weapons Officers attached to Reporting Secondary Stock Points should keep informed of the latest BuWeps instructions, OSO instructions, OD 12067 series (Index to Ammunition Stock), OD 16135 (Navy Ammunition Logistics Code), and other pertinent instructions. Continually reading and evaluating these instructions will allow Aviation Weapons Officers to keep current of the rapid changes in the Conventional Ammunition Distribution System.

INDEX OF NAVY AMMUNITION STOCK

This index is used by Conventional Ammunition Distribution (Primary) Stock Points as well as Secondary Stock Points. Aviation Weapons Officers assigned to a NAS magazine complex would find the index indispensable. The index consists of 14 volumes (OD 12067A through 12067V), which carry a complete listing of ammunition carried by the Navy.

The index of ammunition stocks (OD's 12067A-V) is arranged in alphabetical order (by federal item name) and contains the unit of issue, weight, cube, and standard unit price.

NOTE: For current revisions to OD's, refer to NavWeps OP 0 Index of Ordnance Publications.

OD 16135 NAVY AMMUNITION LOGISTICS CODES (LATEST REVISION)

For practically all Aviation Weapons Officer billets, the OD 16135 (Navy Ammunitions Logistics Codes) is indispensable. With the handy index in the back of the code booklet, a DOD/ Navy Management code number (and nomenclature) can be located in moments for practically any ammunition used by aviation activities. This publication provides overseas bases, ships, aircraft squadrons, and secondary stock points, with standard ammunition logistic code numbers and descriptions for expendable ordnance items. These codes may be used for recording, reporting, and requisitioning purposes.

AMMUNITION ASSET/EXPENDITURE REPORT

The issuance of BuWeps Instruction 8015.4A (November 1961) minimized and standardized the submission of expenditure reports by fleet units thereby resulting in more accurate and timely reports to the processing center. The expenditure report is normally forwarded quarterly. However, conditions may require more frequent reports. In this case, interim reports may be directed by the Chief of Naval Operations; the Bureau of Naval Weapons; the Ordnance Supply Office; or by cognizant fleet, force, or type commanders.

In keeping with the standardization policy BuWeps Instruction 8015.5 (January 1962) sets forth policies for the Navy Shore Establishment in regard to reporting assets and expenditures of Navy-owned expendable ordnance. This information combined with information received from naval ammunition depots and forces afloat provide a world-wide position of assets and expenditures for all reporting activities. NOTE: This applies to Navy-owned ammunition only.

For complete information about proper reporting forms, reporting periods, cutoff dates, etc., refer to BuWeps Instruction 8015.4A (latest revision) for forces afloat or BuWeps Instruction 8015.5 (latest revision) for shore establishments.

CHAPTER 5

NAVAL AIRCRAFT AND THEIR ARMAMENT

NAVAL AIRCRAFT AS A WEAPON

Many naval aircraft of today are able to fly at supersonic speeds and extreme altitudes, and are capable of delivering an astounding array of weapons. These qualifications make the naval aircraft of today an extremely capable weapon for naval warfare. Each type of aircraft is now being designed for a specific tactical mission such as fighter, attack, patrol, etc. However with the advent of interchangeable racks, launchers, pylons, and other components, current aircraft types are capable of a wide variety of missions. Consequently the naval aircraft can no longer be considered as a simple airborne ordnance launching platform, but rather a highly complex and efficient instrument of naval warfare.

INTEGRATED WEAPON CONCEPT

The goal of aeronautical designers and engineers is an aircraft not only highly efficient in itself, but a completely integrated selection of aerial weapons. This concept entails thorough coordination of the special weapons system, rocket launchers, missile release systems, bomb racks, and the like into one centralized armament control system. Designers are attempting to provide the pilot and bombardier with fingertip control of armament that has the precision, speed, versatility, and vitality demanded by modern aerial warfare.

In current aircraft models, the designers and engineers have practically obtained this goal. In aircraft such as the F-4, A-5, and the P-3, the pilot has control of an unbelievable weapons system; designed for selecting, arming, and releasing almost any weapon in the aviation ordnance arsenal.

The using of current models of aircraft to the fullest extent of their ordnance design capabilities offers a challenge to Aviation Weapons Officers assigned to the various aviation billets. The problems to be solved are more difficult, technically and practically, than at any previous era of aerial warfare.

DESIGNING FOR MULTIPLE ORDNANCE CAPABILITIES

Through the years of designing naval aircraft for multiple ordnance caabilities, many major problems had to be solved. A few examples of these problems are as follows:

1. Weight factor of the ordnance load to be carried.
2. Weight of suspension, arming, and releasing gear.
3. Accessibility of ordnance and armament equipment for speedier loading, unloading, and rearming.
4. Shaping ordnance and armament equipment to fit the streamlined contour of modern high-speed jet aircraft.
5. Limited size of carrier aircraft.
6. Armament equipment capable of withstanding stresses of carrier launchings, landings, etc.

Numerous major and minor designing problems are still being worked out by aircraft designers and engineers. Some of the problems may be solved in the field while others are solved on the drawing board or anywhere in between. The Aviation Weapons Officer may well be the one who determines, locates, or solves a design deficiency in the ordnance or armament equipment of his respective activity.

TECHNICAL ADVANCES

The technical advances in the Navy have been many and varied since the days of World War II. To list them all would be a massive book in itself.

Continued progress in conquering the numerous technical and engineering problems is being made. Examples of such progress in the not too distant past are as follows:

1. An adapter assembly which permits an Aero 5A launcher to be mounted directly to conventional bomb racks, thereby saving many manhours in aircraft reconfiguration.

2. A Crusader (F-8D) took off recently carrying two 1,000-pound bombs on wing pylons. (A first for the F-8D type.)

3. A new type of rocket propulsion called "hybrid," which combines a liquid and solid propellant in a single rocket motor.

4. A Sparrow III guided missile, fired from an F-8D, scored a direct hit in a head-on attack on a Regulus II missile while both were at supersonic speed.

5. An automatic antiair warfare information system wherevy a pilot is required to fill out only one handy kneepad form on any particular missile he fires. From this one input, automatic data processing (ADP) machines print the facts needed by participating squadrons and all other organizations with a need for accuracy, comprehensive, and current information on antiair warfare system performance etc.

KEEPING INFORMED

As with all types of aircraft, armament, ammunition, handling equipment, etc., there is a constant chain from innovation to operational to obsolete. The statement that this is the last word, the final change, or the perfect system would be a statement of the present only. Another change, solution, system, later model, or replacement is usually in the planning stages or on the drawing board.

A few examples of the possible things that may soon be operational with the fleet are discussed in the following paragraphs.

A new Navy series ("eye" designation) of free-fall air-to-surface missiles are now in various stages of development or testing at the Naval Ordnance Test Station, China Lake, Calif. Most sophisticated of the series unveiled to date is the Walleye, a glide-bomb which is equipped with an advaneed homing guidance system.

The Walleye, employs a high explosive type warhead, effective against most types of hard targets. Gladeye, Rockeye, and Sadeye are dispenser type weapons also in the developmental stages at NOTS. These missiles are all capable of being released and dropped by conventional methods.

Another product that is still in the developmental stage is a pilot's helmet that employs an integrated sighting and control system. Designed primarily for helicopter pilots, the helmet allows the pilot greater freedom of movement and control of the helicopter when attacking enemy objectives.

The Aviation Weapons Officer should be conscious of the vast scope of his occupation, and should continually read the latest periodicals, books, manuals, instructions, etc. to keep abreast and informed of a constantly changing subject.

Some of the available periodicals that should be read by all Aviation Weapons Officers include the following:

1. Naval Aviation News.
2. The Naval Weapons Bulletin
3. Approach (The Naval Aviation Safety Review).
4. Digest of U. S. Naval Aviation Electronics.
5. Naval Air Technical Services Reliability Digest.

These periodicals not only discuss problems encountered on operational equipment and recent developments, but also provide valuable information on future developments.

One of the fastest changing areas in which the Aviation Weapons Officer may be concerned is the various armament systems encountered in the different types of operational aircraft. Maintenance Instructions Manuals are constantly being revised to reflect the latest Airframe Changes or Aviation Armament Changes that have been incorporated since the previous revision.

An armament system is only as good as the accuracy and validity of the Maintenance Instructions Manuals and publications being utilized. Constant revisions and changes make it imperative that the Aviation Weapons Officer ascertain that the Maintenance Instructions Manuals and other publications utilized by his personnel are the most current publications available.

Recent changes in the name designation of current aircraft have standardized the designation of operational aircraft of various services. Appendix II of this text contains a listing of most of the aircraft used by the naval service. They are listed by type, name designation, and manufacturer. (NOTE: Some aircraft have no designation assigned.) Associating the name with the current designation may assist the Aviation Weapons Officer in identification and recognition of naval aircraft. Also listed in the appendix are the new and old aircraft designations, the current basic, modified, and special mission designations, and applicable instructions to assist the reader.

AIRCRAFT MISSIONS AND ARMAMENT SYSTEMS

Drastic changes to the aircraft carrier, in the form of greater tonnage, angled decks, steam catapults, more speed, etc., have been matched by aircraft of greater speed, weight, and capabilities. Both the modern aircraft and carrier bear little resemblance to their World War II counterparts. Even their tasks, missions, and tactical employment have been subjected to sweeping changes.

Greater speeds have made guns less effective; new rockets and missiles have replaced guns in most instances, and new sighting devices have increased the number of "hits" per round carried. A look at current naval aircraft shows that new armament stores have resulted in the following:

1. New types of racks, launchers, and shackles.
2. Production of more rugged suspension devices.
3. The employment of ejector racks, launchers, and guns for satisfactory supersonic releasing of stores.
4. Provisions for suspending and delivering of nuclear weapons in smaller aircraft.
5. Reduction of multiple gun installations in aircraft.

Internal suspension of armament stores in aircraft is limited to the larger naval aircraft. There is little room in the wings or fuselage of smaller aircraft, as these spaces are devoted to components of the aircraft and fuel storage. New suspension devices have been designed and old racks and shackles have been redesigned to carry current stores and components such as, electronic navigational packs (NavPacks), spray tanks, fuel tanks, refueling stores, chaff dispensers, gun pods, etc. Consequently, stores to be carried externally at present day speeds must be streamlined to present the least resistance to airflow.

Since the modern jet fighter is more streamlined, heavier, and infinitely faster than earlier ones, many changes have become necessary in suspension, arming, and releasing devices. The attack classes of aircraft are reaching top speeds formerly attributed only to the jet fighters, and are capable of delivering armament loads many times that of a fighter.

Their suspension and releasing devices are similar and in many cases identical to those of the fighter. Heavy attack and patrol classes, however, incorporate diversified internal configurations include suspension of bombs, torpedoes, aerial mines, special weapons, or combinations thereof. Special adapters will allow the suspension of training equipment such as practice bomb containes; scar rails, etc., and with minor adaptations, the aircraft can be converted to special missions such as fuel tankers, photo reconnaissance, air-sea rescue, towing, etc.

The armament circuits, which supply power to the new and redesigned racks, shackles, and other devices, have been modified—as required by the new features of these devices. They are normally actuated both manually and electrically as before. The manual releases are relatively simple in design, but the electrical releasing circuits have been complicated to a great extent by the addition of new circuits to operate the stores ejectors, monitoring systems for special weapons, new rack and shackle operating circuits, electrical fuzing circuits, and other presently incorporated features.

Present inservice aircraft armament systems, aircraft configurations, and types of missions may vary considerably in such things as components, capability, physical construction, and complexity.

The block diagram presented in this chapter does not depict any one particular installation of suspension, arming, and releasing system. It shows composite arrangements of circuits and devices likely to be found in any one aircraft type classification. It is essential to remember this point while studying the various systems.

ATTACK AIRCRAFT

The primary service mission of attack aircraft is the destruction of surface targets on land or water.

A look at the modern attack aircraft of today will reveal many changes and improvements of the attack systems of a few years ago. Improvements of armament and armament control equipment, development of multiple suspension gear, changes in sources of power, and the concept of linear bomb bays are presently being employed in operational aircraft.

At present no one attack system may be termed as typical. This is due to the variations in the systems' operating capabilities and control equipment.

Attack aircraft are classed as "heavy attack" and "light attack." All presently operational heavy attack aircraft are equipped with bomb bays and some supplement this with the use of wing stations. A current example of a heavy attack aircraft is the A-3B.

Due to their small size, light attack aircraft carry all stores externally on wing and fuselage stations. The A-4E is an example of a current light attack aircraft.

All attack aircraft in present use have the common capability of suspending and delivering special weapons. When operating from aircraft carriers, they are capable of delivering weapons to targets almost without regard to location. This special weapons capability is in addition to the almost endless variety of conventional stores that may be carried. It may be noted however, that most present heavy attack aircraft are not equipped to carry rockets or guided missiles, since heavy attack aircraft are not designed or intended for use as interceptors or for close air support.

However, the A-6A aircraft has completely integrated radar, navigation, and bombing systems that permit all-weather operation under varying tactical requirements. The integration of these systems results in an aircraft with the versatility to perform not only as an attack bomber but also in close support of ground personnel. Depending upon individual mission requirements, the aircraft can carry and accurately deliver, over all terrains, a large variety of special weapons, bombs, rockets, and missiles without having visual contact with the ground.

The basic aircraft armament—carrying configuration consists of four wing pylons and a centerline station for a total of five store stations. The wing pylons and centerline station house Aero 7A-1 ejector racks, fuel lines, and valves for adapting drop tanks. The wing pylons also have mounting provisions for the Aero 5A guided-missile launcher and the LAU-7/A guided-missile launcher. The Aero 7A-1 ejector racks are capable of carrying conventional or special weapons, or Aero 7D, Aero 6A-1, LAU-32A, or LAU-10A rocket launcher packages. A 300-gallon external fuel tank may be carried at each wing station and at the centerline station. A buddy pack refueling store may be carried at the centerline station.

As previously mentioned there is no attack system that can readily be termed as typical. Figure 5-1 shows a composite of components from several different systems. It must be understood that no one system contains all of the components shown. A brief discussion of the components shown in figure 5-1 follows.

Since most of the later model aircraft contain no battery or d-c generator, the primary source of power is derived from an a-c generator. Power supplied to the armament section normally consists of 115 v a.c. 400 cycles, and 28 v d.c. The value of the a-c and d-c power may vary in each system, but it is normally obtained from this primary supply and changed through the use of transformer-rectifiers and/or converters. The system discussed in this section consists of a 115 v a-c primary source and a 28 v d-c source.

The power to the armament system is controlled by a master armament switch. As a safety factor, the power is disrupted between the master armament switch and the system by the landing gear relay. When the landing gear handle is in the wheels DOWN position, no power is applied to the master arm switch.

To facilitate ground maintenance and testing, an armament disabling circuit is provided. When the circuit is energized and the master armament switch is in the ON position, power is supplied to close the master armament relay which in turn supplies power to the armament bus and consequently to the armament system.

Once the necessary buses and relays are energized, the power is routed to the release mode selector switches. These switches determine the mode of release for the stores selected. Mode selection may be limited to manual or low altitude bombing system (LABS) (on most light attack aircraft) or extended to manual, LABS, and bomb director on other types of aircraft. From the mode selector switch the circuit is routed to the control stick switch, and to the LABS or bomb director system whichever is selected.

If the LABS mode of release is selected, the LABS indicator lights inform the pilot that the system is functioning and advise him when to start his pullup. (Some LABS systems utilize

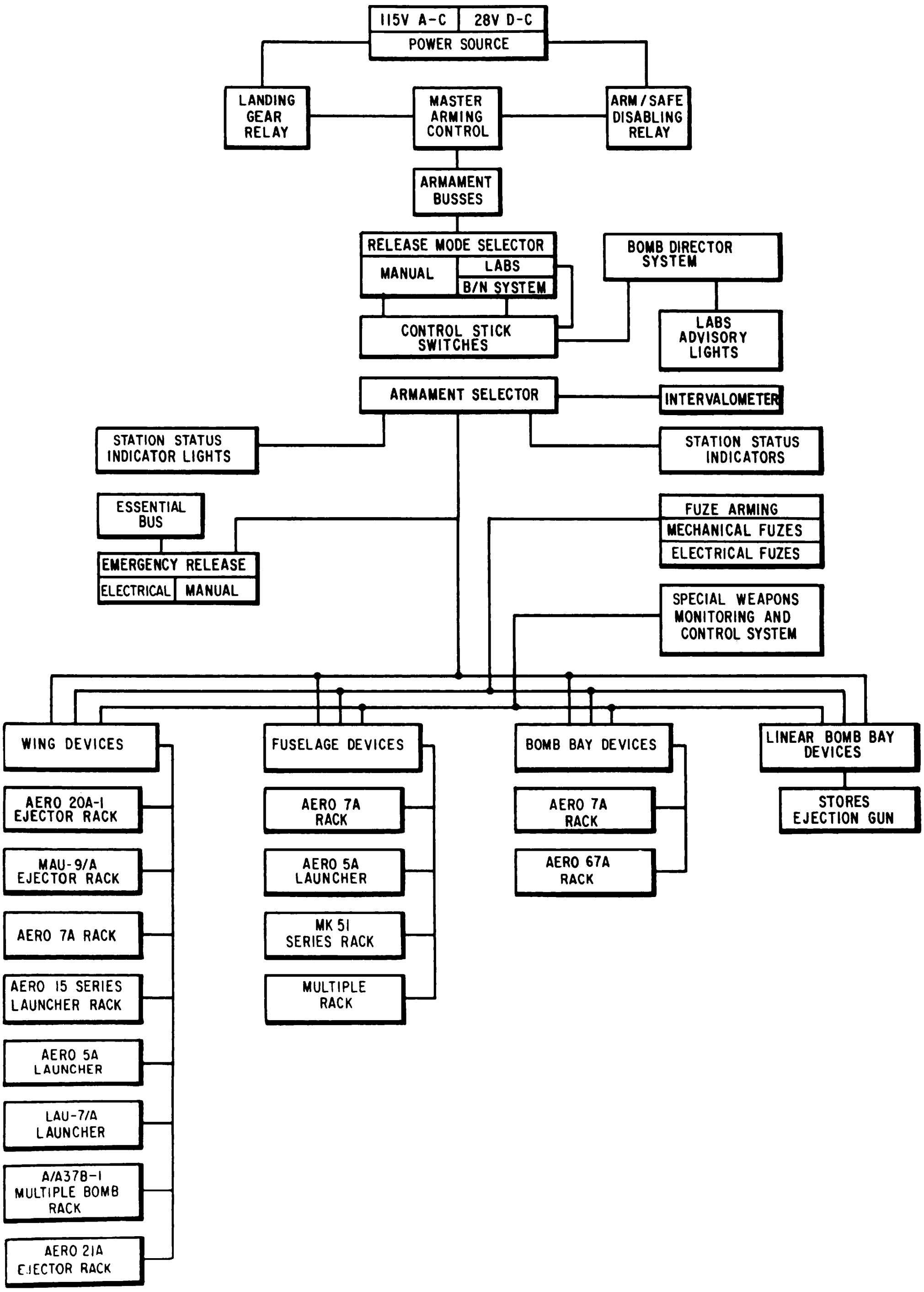


Figure 5-1.—A composite block diagram of attack system components.

an audio signal in conjunction with the lights.)

Should the manual mode be selected, the circuit is completed directly to the control stick switch. Upon closing the switch, the current is routed through the arm selector to the suspension station for release of the previously selected stores.

Should the bomb director mode be selected, the bomb director system with its incorporated radar, when in use, sends its impulses to the intervalometer. As the bomb directing problem is solved by the bomb director system, the stores are released at the exact instant for maximum effectiveness. The intervalometer may be set to either train or selective; this allows the stores to be dropped in time sequence or selectively at the desire of the operator.

The station status indicators consist of switches located in the stores stations and are used to control the station status lights. The indicator system is designed to inform the operator of the loaded or unloaded status of the stations as selected on the armament selector. In most systems when the indicator light is ON it indicates a store aboard for the selected station. Some systems utilize separate lights to indicate both stores aboard and stores away. Both types of systems are connected through and operate in conjunction with the armament selector switch.

The emergency release is designed to jettison stores in cases where an emergency exists or there is a failure in the normal release system. The emergency release system may be electrical, manual, or a combination of the two.

Electrical emergency release systems normally derive their power from an essential bus since failure of the normal release system may be caused by power failure in the armament system.

Combination electrical-manual emergency release systems usually contain a "T" handle located within easy reach of the pilot. When this handle is pulled (first movement) it closes switches to electrically release wing stores, to open bomb bays, and in some installations it disables the fuze arming circuit, so that stores are jettisoned in a safe condition. Further movement of the "T" handle manually jettisons the bomb bay stores. (NOTE: To prevent bomb bay stores from being jettisoned before the doors are fully opened, mechanical interlocks are employed allowing release cables to be actuated only when the doors are fully opened.)

Arming controls for mechanical fuzes normally consist of solenoid units mounted on some part of the aircraft structure or as an integral part of the rack. These solenoid units are mounted two units per station to provide semiselective arming. The three selections are nose and tail, tail only, and safe. More than one circuit may be used in larger aircraft having both external and internal stores.

Arming systems for electrical fuzes are considerably more complex than for mechanical fuzes. Essentially they provide for selective charging of all types of electrical fuzes.

Special weapons control and monitoring systems consist of controls for monitoring the operation of circuits within a weapon and preparing it for delivery. Since the operation of these systems is classified, the reader is referred to the supplement of the armament section of the pertinent Maintenance Instructions Manual.

The A-5A Stores System

The A-5A stores system cannot be termed a typical attack system, especially the internal part of the system which is quite unconventional. However, it is deemed important to cover this new concept of stores delivery. It is assumed that the current A-5A linear bomb bay design, or a modified version, will possibly be used in future aircraft.

STORES SYSTEM.—The armament installations (fig. 5-2) consist of a linear bomb bay and two wing mounted pylons, along with all the necessary controls and circuits for the proper operation of arming, ejection, indicating, and jettisoning of stores and pylons. The system may be used in conjunction with the bomb directing set or with the low altitude bombing system (LABS).

Normal loading of the bomb bay includes a store and two 275-gallon fuel tanks. Provisions are also made for a buddy tanker package or an additional ferry tank in place of the store. An expendable tail cone encloses the aft end of the bomb bay and falls away when released

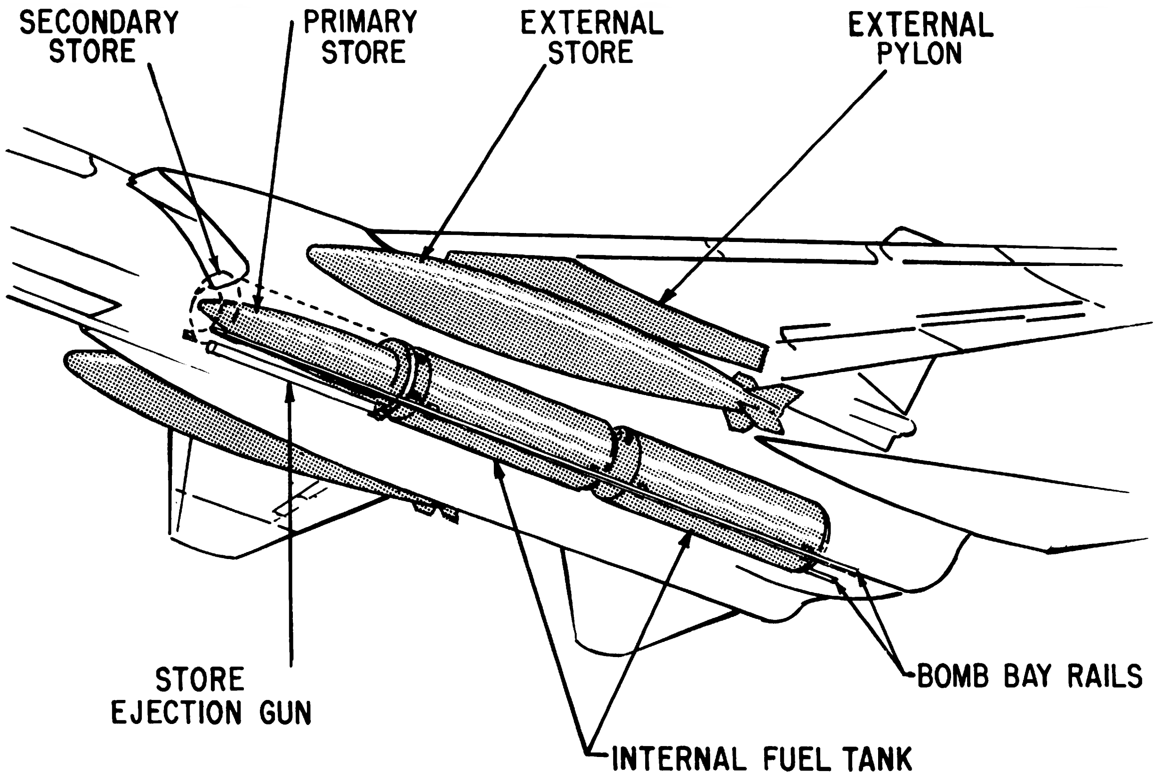


Figure 5-2.—A-5A armament installation.

by an ejected store. Loading of the wing pylons may consist of fuel tanks or stores up to 3,000 pounds. Circuits and controls are also incorporated for practice bombing system utilizing two Aero 8A practice bomb containers mounted on the pylons.

BOMB BAY.—The bomb bay (fig 5-3) is the linear type with two rails running its length. These rails guide the store during loading and ejection. Other small sections of rails located in the bottom of the bomb bay are used to guide pullout assemblies for pulling the electrical connections from stores and tanks.

An ejection gun (fig. 5-4) is mounted in the forward lower section of the bomb bay. The gun is a piston type and is operated by gas pressure developed by the burning of a solid propellant charge. A store locking and release mechanism mounted on the aft end of the ejection gun provides a means of locking the store in place in the bomb bay. In the locked position, the hooks extend into recesses in the store adapter ring retaining the store in position. Upon ejection the initial motion of the ejection gun piston compresses the spring-loaded piston head assembly and releases the hooks from the adapter ring. The store is then ejected rearward.

Upon completion of the ejection stroke, the internal gases are vented overboard through an exhaust port in the bottom of the aircraft. A pressure regulating valve is provided on the gun to maintain certain internal pressures in the gun during the ejection stroke. It is adjusted to the weight of the store by preloading the valve spring. As a safety feature, a rupture fitting located on the gun will blow out if the gun pressure exceeds 5,800 (plus or minus 300) psi.

The rupture fitting is also vented overboard to prevent gases from entering the bomb bay. As the ejection gun reaches its fully extended position a guide on the piston head assembly slides into a piston retainer which secures the piston to the bottom of the bomb bay for the remainder of the flight.

Upon ejection, the store and tanks release the expendable tail cone, and actuate the

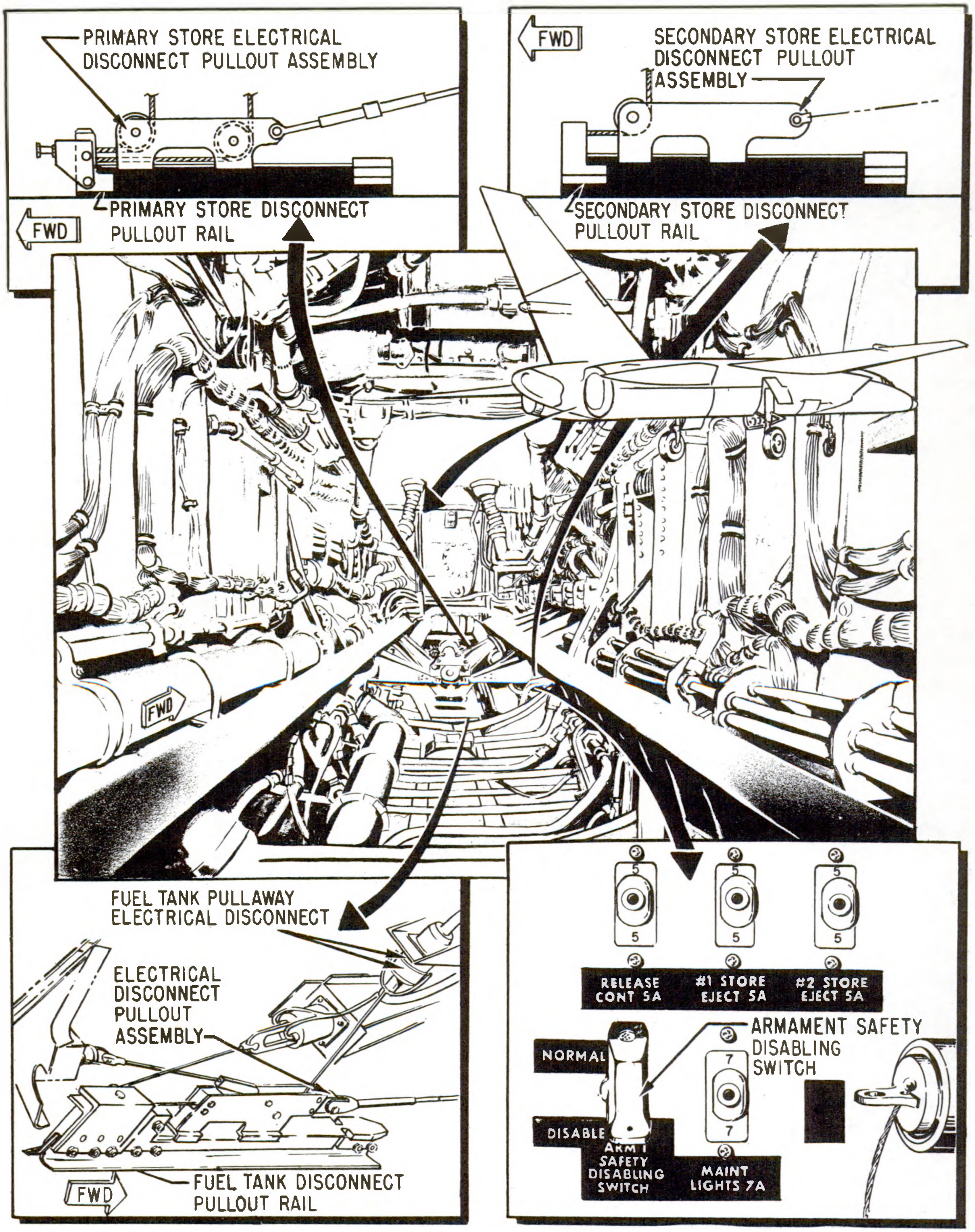


Figure 5-3. —Linear bomb bay.

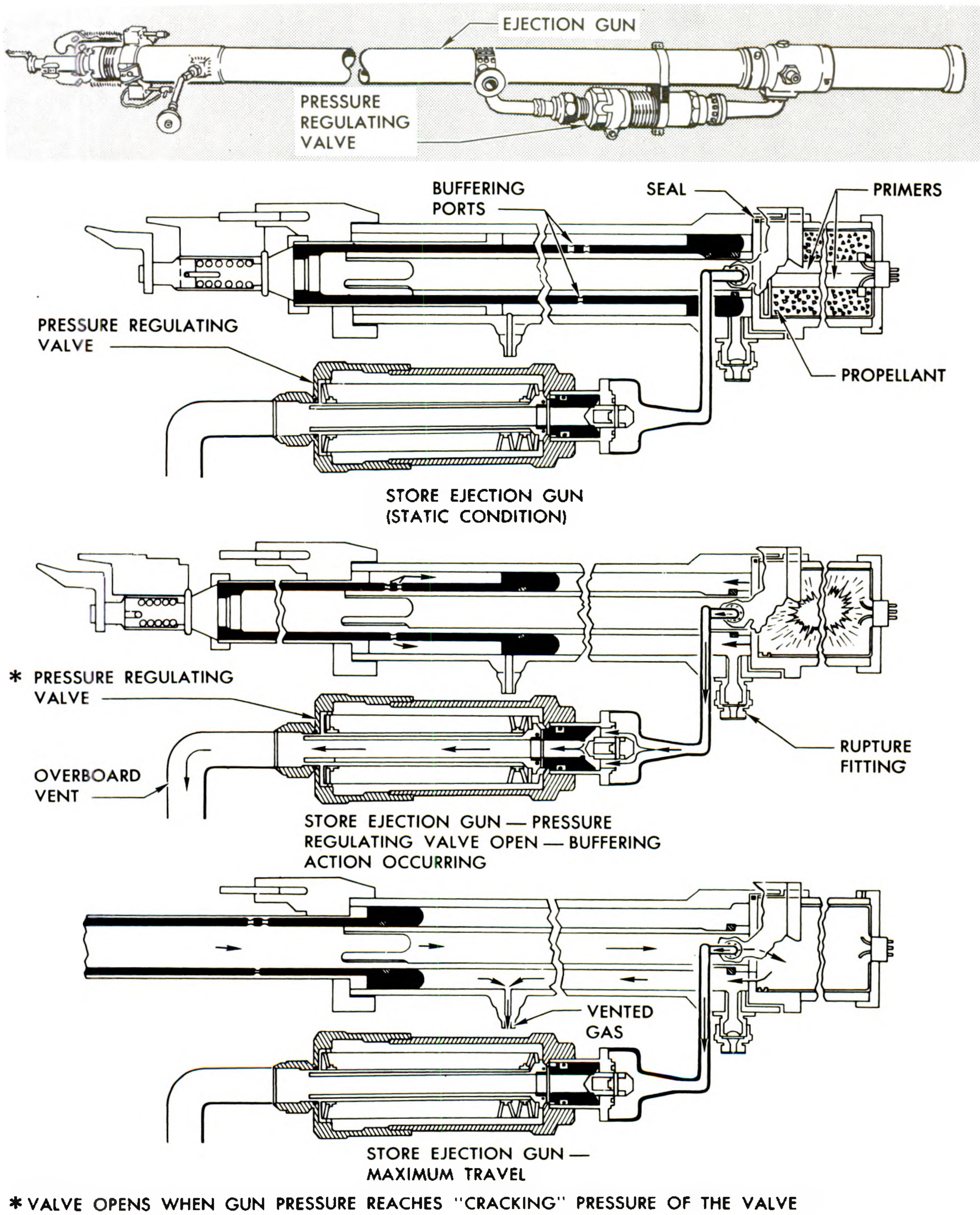


Figure 5-4. —Store ejector gun schematic.

electrical plug pullouts, the arming lever, and the stores sensing switch which gives an indication that the store has been ejected. Other components found in the bomb bay are the armament system relay panel, the armament safety disabling switch, and various circuit breakers.

Loading instructions for the linear bomb bay may be found in the A-5A Maintenance Instructions Manual, NavWeps 01-60 ABB-2-6 (latest revision), and its special stores supplement.

FIGHTER AIRCRAFT

The mission of fighter aircraft is to attack enemy aircraft and ground installations, defend surface units, escort attack aircraft, and render close support to landing forces. To accomplish this mission, the fighter aircraft is designed for maximum firepower and speed, and for a combination of these features in tactical operations. Fighters must have both the performance and the armament to stop enemy attacks, to escort strike groups, and to make effective fighter sweeps by day or night.

Advanced designs in aircraft and accessories have introduced new flexibility into fighters, giving them increased firepower and diversified multiple missions.

As each new model of fighter aircraft is placed in service with the fleet, increased speed, altitude, and performance capabilities are realized. The speed, altitude, and performance attained by present day aircraft make aircraft gun systems almost completely ineffective. Consequently most of our later model aircraft have no gun system. This places more and more emphasis on rockets, rocket pods, and guided missile launching systems.

The systems on some of the latest models of fighter aircraft are similar in operation to late model attack aircraft. The primary difference between the two systems is in the components of the suspension and releasing gear.

Since the primary mission of the fighter aircraft is to intercept and destroy enemy aircraft, it is primarily equipped with air-to-air missile launchers of various types.

As in the case of the attack aircraft, no one fighter aircraft model may be termed as typical. For instance, the F-8 series aircraft has a variety of models each having different armament capabilities. (See fig. 5-5.) Some models are equipped with bomb ejectors giving them capabilities of suspending and releasing conventional stores, while other models are equipped with missile launchers, rocket packs, and gun systems. Another model has single pylon launchers on each side of the fuselage and wing suspension capabilities. A second configuration of the pylon launchers consists of two launchers horizontally mounted on each pylon, allowing twice as many missiles to be carried.

At present there are a variety of types of missiles, launchers, and aircraft each demanding certain specifications. For instance, the F-4 aircraft utilizes missile ejector launchers mounted in missile cavities in the fuselage (it also utilizes pylon launchers mounted under the wings).

The missile fits into a recess cavity under the fuselage allowing a cleaner aircraft configuration. Operation of the ejector launcher is somewhat similar to an ejector bomb rack with the additional provisions for unplugging the umbilical from the missile, and firing the missile motor a short time after ejection.

The power supply, armament control circuits, fire control equipment, and emergency releases in fighter aircraft are generally similar in components and operation to those of attack aircraft. These were discussed earlier in this chapter. The reader is referred to figure 5-1 and accompanying text for a basic description and operation of these systems.

ASW AND PATROL AIRCRAFT

The fundamental concept of antisubmarine warfare (ASW) aircraft is to detect, locate, and destroy enemy submarines. To properly accomplish this assigned mission requires a variety of aircraft types and an even greater variety of search and detection equipment. The ASW aircraft vary in size and capabilities, and in type from the ASW helicopter to the long-range multiple engine bomber.

Two of the most current operational ASW aircraft in service with the fleet are the S-2A and the P-3A. Therefore, a breif description of their armament and armament systems is covered in this text.

P-3A Aircraft

The P-3A armament system consists of kill and search stores. Kill stores include special weapons, bombs, mines, torpedoes, and rockets.

Figure 5-5. —F-8 multiple stores capabilities.

Bombs and/or torpedoes can be carried at 8 bomb bay stations and mines can be carried at 6 bomb bay stations. Torpedoes and mines can be carried on the 10 external wing stations. However, torpedoes are carried on the wing stations for transportation purposes only. Additionally, 4 rockets can be carried singularly or 16 rockets in pods from the 4 outboard wing stations.

The search stores include retro marine markers, sonobuoys, parachute flares, smoke markers, bathythermograph buoys, and underwater sound signals. Four launchers are used for ejecting search stores. They are sonobuoy launcher, pressurized sonobuoy launcher, retro launcher, and underwater sound signal launcher. Air pressure from the pneumatic system is used to eject all search stores. Provisions for carrying a searchlight are provided on the outboard right wing station. When the searchlight is carried, nine wing station racks are available for carrying kill stores.

The armament control system is comprised of the units, panels, switches, and controls necessary for carrying, selecting, releasing, and arming (if required) of stores. Included in the system are lights for indicating the status of the aircraft armament. All armament carried aboard the aircraft is electrically controlled for selection and release by the positioning of switches and controls on the armament system control panels. An intervalometer provides a drop interval for all stores as selected and will control the release of certain combinations of search stores. In the event of an electrical failure, a manual release mechanism allows for the release of all bomb bay stores. An electrical jettison release system is provided for an emergency release of armament stores that are hazardous. The engine starter (if carried in place of a store) will also be released. All jettison operations are electrically programed so that regardless of armament store rack release malfunction, the maximum number of stores will be jettisoned and all doors returned to a closed position. The searchlight cannot be electrically or manually jettisoned.

The kill stores control system (bomb bay and wing stores) is comprised of the following six console mounted panels:

1. Pilots armament control panel.
2. Tactical coordinators armament control panel (common to both kill and search stores).
3. Mk 43 torpedo control panel.
4. Mk 44 torpedo preset panel.
5. Aircraft monitor and control panel.
6. Tactical coordinators bomb bay racks lock control panel.

In addition to the console mounted control panels, there are two interconnection boxes: A bomb bay armament station loading panel and an armament circuit breaker panel. The operational control of the kill store system is provided by the master arm switch on the pilots armament control panel.

The search stores operational control and release system is comprised of the following control panels: Pilots armament search stores control panel and the radar-MAD operators retro marine marker release panel. In addition to the separate control panels, functional search stores controls and indicators are located on the following control panels:

1. Tactical coordinator sonobuoy chute select and receiver channel panel.
2. Tactical coordinators armament control panel.
3. Julie-ECM operators ASW sonobuoy channel panel.
4. Pilots armament control panel.

The operational control of the search store system is provided by the search power switch on the pilots arm search stores control panel. Selection and functional control is provided by the tactical coordinator search store select switches and air compressor switch.

For a detailed description of the P-3A armament and armament system, the reader should consult the armament and photographic section of the current Maintenance Instructions Manual, NavWeps 01-75PAA-2-5.

S-2A Aircraft

At the present time the fleet has several carriers whose primary duty is antisubmarine warfare. These carriers are equipped with helicopters and twin-engine patrol aircraft. Currently, versions of the S-2A are utilized by the Navy as carrier-launched antisubmarine patrol aircraft. As previously mentioned, a variety of search and detection equipment is presently in use; it ranges from radar and visual contacts to MAD, sonobuoy systems, and the hydrophone systems used by helicopters.

The armament system of the S-2A consists of external and internal stores stations. Provisions for carrying and releasing sonobuoys, practice depth charges, and marine markers are also provided. The aircraft is also equipped with a searchlight for night identification of targets.

The controls for the armament system are, in some respects, quite similar to those of the larger land-based patrol aircraft. The primary difference is in the release controls for sonobuoys, marine markers, and practice depth charges. The system is equipped with safety circuits and interconnected mechanical linkage to prevent the inadvertent release of stores and also provide for the emergency release (jettison) of stores.

Power for the armament systems operation is taken from the armament bus. The armament bus is energized with current from a transformer-rectifier which in turn is supplied by the aircraft's a-c generators.

NOTE: Deck operation of the armament system requires only a-c power and hydraulic power from external sources. The hydraulic pressure is required for the operation of the bomb bay doors, practice depth charge dispensers, and marine marker dispensers.

The internal stores system consists of two stations located in the bomb bay. The bomb bay is equipped with electrically controlled hydraulically operated doors. A switch, located in the release circuit and operated by the bomb bay doors, prevents electrical release of the stores before the bomb bay doors are fully open. An alternate method of door operation is provided by the use of a hydraulic selector valve and a hand pump.

The bomb bay can be rigged for either single or double stores suspension. When single store suspension is used, an Aero 65A rack and an Aero 7B-1 release mechanism are employed. The rack is mounted in the bomb bay center position.

For double stores configuration, the Aero 65A-1 rack is mounted in the outboard (upper) position; a Mk 8 shackle utilizing an Aero 7A-1 release mechanism is mounted on the inboard (lower) station. The Mk 8 shackle is not mounted as a shackle but is first rigidly mounted on a special adapter which is mounted to the aircraft structure. Both the Aero 65A-1 and the Mk 8 shackle are equipped with nose and tail arming solenoids, and arming is semi-selective. The stores may be released electrically or manually.

The lower store is controlled electrically by the Aero 7A-1 release mechanism. The Aero 7A-1 also functions as part of the control mechanism for the upper store. Only when the lower store has been released will the Aero 7A-1 allow the Aero 7B-1 to release the upper store. This is accomplished by utilizing a transfer switch in the Aero 7A-1. When the transfer switch is in the cocked position, no power is available for the release circuit of the Aero 65A-1 rack. However, when the lower store has been dropped and the Aero 7A-1 release mechanism is uncocked, current flows through the transfer switch to the Aero 65A-1 rack.

The armament system is equipped with a manual release system for use in the event of an electrical failure. Essentially, it consists of a "T" handle located in the cockpit, a series of flexible cables, bellcranks, a mechanical sequencing system to insure that the lower store is released first, and an interlock mechanism to prevent internal stores from being jettisoned before the bomb bay doors are fully opened. External stores are jettisoned electrically when the manual release handle is pulled. As the handle is pulled, the fuze arming circuits are disabled; thus, wing stores are always jettisoned unarmed. However, before the internal stores can be jettisoned safe, the arming switch must be in the SAFE position.

To prevent accidental jettison of wing stores while the aircraft is on the ground, an air ground safety switch is used. This switch, actuated by the weight of the aircraft on the landing gear, disconnects the jettison circuit. For ground test of the jettison circuit, a spring-loaded jettison override switch will bypass the air ground safety switch when held in the ON position.

The external stores system consists of six Aero 15C combination bomb rack rocket launchers mounted three on each wing. Each station is capable of suspending and releasing stores up to 500 pounds, and suspending and launching both single or launcher packaged rockets. Stores are electrically released both in normal operation and emergency jettison of both bomb and rocket type stores. Although electrical in operation, the jettison circuit is energized by pulling the manual release handle. Stores are released by button switches located on the control yokes, one switch for bombs and one switch for rockets. Rockets may be released singly or in pairs depending on the position of the rocket selector switch.

Two stations on each wing may be used with the intervalometer. These stations and the bomb bay station are used to carry depth bombs. The intervalometer is used to properly space the drop interval. The external stores system is similar in design and operation to the systems on multiengine land-based patrol aircraft.

COMPOSITE SQUADRON AIRCRAFT

Composite squadrons (VC) are composed of both fighter and attack aircraft and may include any of the following teams:

1. All-weather attack and defense teams.
2. All-weather warning teams.
3. All-weather hunter-killer teams.
4. Photo-reconnaissance teams.

Due to the various aircraft models used in this type of squadron, many different armament systems will be encountered. For this reason no representative system is discussed here. However, these aircraft, although modified for special missions, should retain their basic armament systems. Consequently a practical knowledge of standard systems should aid the Aviation Weapons Officer assigned to a composite squadron.

UTILITY AIRCRAFT

Utility aircraft can conceivably be any type or model of Navy aircraft. The main requirement for being a utility aircraft is that they be specifically rigged for utility missions. When so rigged these aircraft perform such duties as plane guard, mail delivery, personnel transfer, air-sea rescue, radar calibration, and target towing. Of the above listed duties performed by utility aircraft, the Aviation Weapons Officer would normally be concerned only with target towing operations. Towing devices are not the same from one type of aircraft or squadron to another, nor are towing procedures standardized. Therefore, only a representative sample of a tow target system is covered in this text.

One system currently in use is the Del Mar RADOP (Radar/Optical) Weapons Training System. It consists of a tow reel-launcher combination which permits air launching, towing, and recovery of a RADOP target. The pilot's control panels contain all the necessary controls for extending and retracting the launcher and target, the reeling operation, and cutting the tow line if necessary to jettison the target. Through the use of the Radar-Optical Scorer, mounted on the weapon firing aircraft, measurements of miss-distance, direction, and magnitude between the towed target and weapons fired can be determined. Most present day aircraft with 14-inch external suspension racks are capable of utilizing this system. The RADOP Weapons Training System is covered further in chapter 18 of this text.

Towing operations are dangerous, therefore, it behooves the Aviation Weapons Officer to have a knowledge of the aircraft's capabilities and the complete tow target system in use. This information may normally be obtained by reading the applicable Maintenance Instructions Manual or the towing system technical manual.

HELICOPTERS

Helicopters have been employed in ASW work for a number of years and under certain tactical situations are more efficient for this work than fixed wing aircraft. Many models of helicopters are equipped to locate, pinpoint, and destroy enemy submarines. To accomplish this requires considerable detection equipment and an armament system capable of suspending and releasing a variety of ordnance stores including nuclear weapons. As in the case of fixed wing aircraft, new and better models of helicopters are continually being developed and placed in service with the fleet. One current model of helicopter, the SH-3A, is discussed here.

The armament system (fig. 5-6) consists of four external stores suspension stations, an armament control panel, two release switches, and a control and monitoring system. The control and monitoring system is for special stores which the helicopter is capable of suspending and launching. (NOTE: Since the operation of special stores control and monitoring systems is classified, the reader is referred to the armament section special stores supplement for further information.)

The helicopter suspension, arming, and releasing system is considerably less complex than most fixed wing aircraft systems. Due to the low speeds attained by the helicopter, streamlining of the suspension gear by fairings is not necessary, and lighter equipment may be used.

The source of power for the operation of the armament system is furnished by the 28-volt d-c generator/battery system inflight, and from a 28-volt d-c external source when ground testing. Power for normal operation is supplied from the primary 28-volt d-c bus through a circuit breaker, while power for emergency jettison is supplied through a circuit breaker directly from the 28-volt d-c essential bus. A salvo circuit incorporated in the system provides for dropping all stores simultaneously through the normal release system. This circuit is controlled by the release mode selector swtich, which provides for salvo or single release modes.

The armament safety circuit prevents normal release of stores in an unarmed condition. This is accomplished by placing a safety relay in the release circuits. The relay is controlled by the fuze arming circuit, and when this circuit is deenergized (safe), the release circuits are open. The armament control panel (fig. 5-6) contains all the controls and indicator lights, with the exception of the various armament circuit breakers and the pilot's and copilot's release buttons, for operation of the system with conventional stores.

Each of the four suspension stations essentially consist of a Mk 8 shackle, two arming solenoids, an Aero 7A release unit, and a

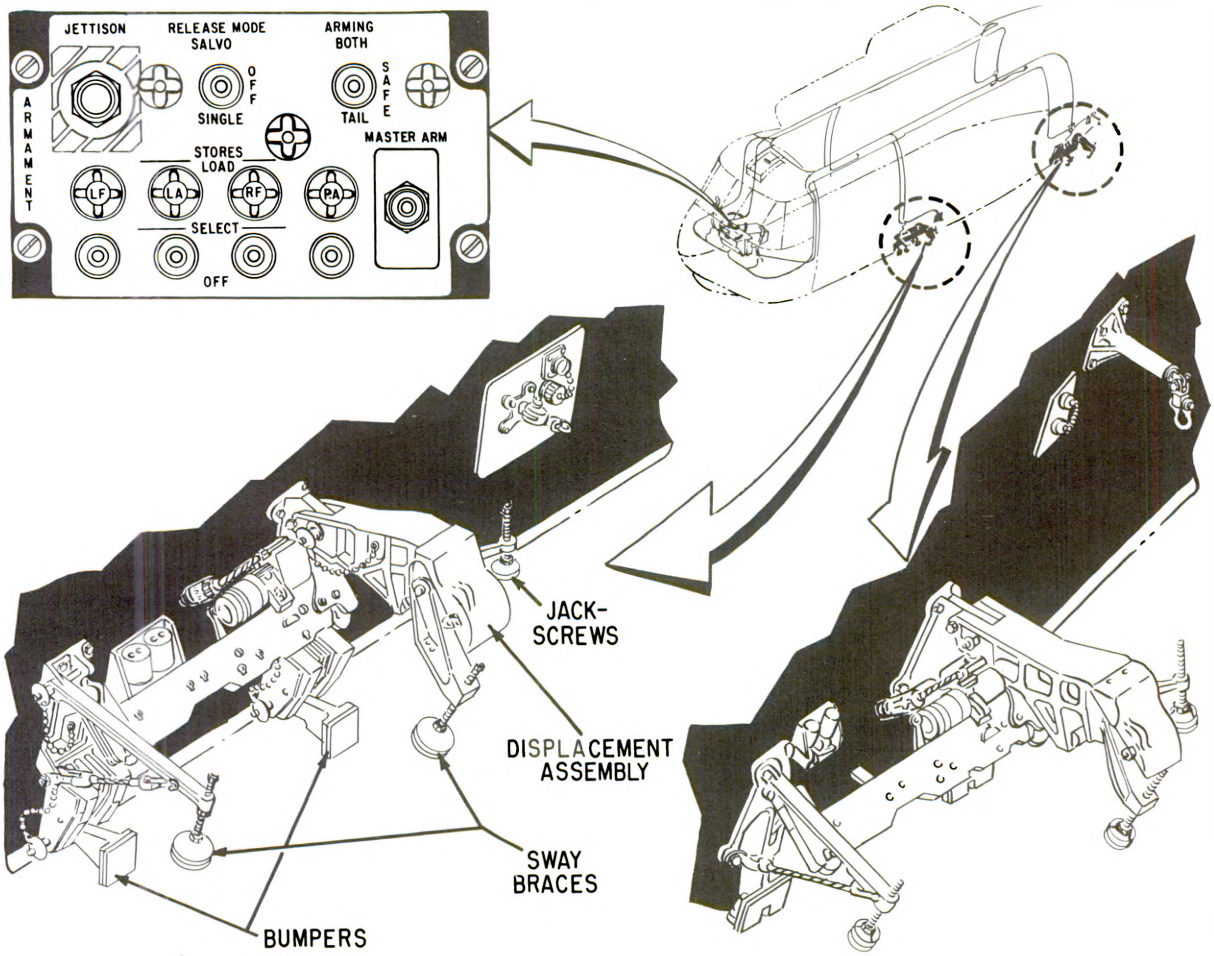


Figure 5-6. —Helicopter armament system components.

forward and aft support. The shackle is attached by hooks to the support assemblies which are in turn fastened to support members of the fuselage. Both support assemblies are equipped with sway braces and bumpers (fig. 5-6) which prevent lateral movement of the loaded store. In addition, the aft support is equipped with a displacement assembly consisting of a cable and reel and a jackscrew assembly. The purpose of the displacement assembly is to insure that stores are launched with a correct nosedown attitude. The displacement assembly functions briefly as follows.

When the store is loaded, the cable is passed under the aft end of the store and attached to the displacement mechanism lever. When the store is dropped, its aft end is held by the cable causing it to swing up and strike the jackscrew, which in turn swings up releasing the cable. The store then drops in a predetermined nosedown attitude. It may be noted that the distance between the jackscrew and the aft end of the store determines the exact attitude of the store when dropped.

Two arming units are installed on a bracket and mounted to the fuselage behind each shackle. These arming units provide for semiselective arming of stores.

Loading of stores with a hoist requires the use of a boom assembly, which is attached to the fuselage directly above the station to be loaded. The hoist is then attached to the boom assembly and loading is commenced. (See fig. 5-7.)

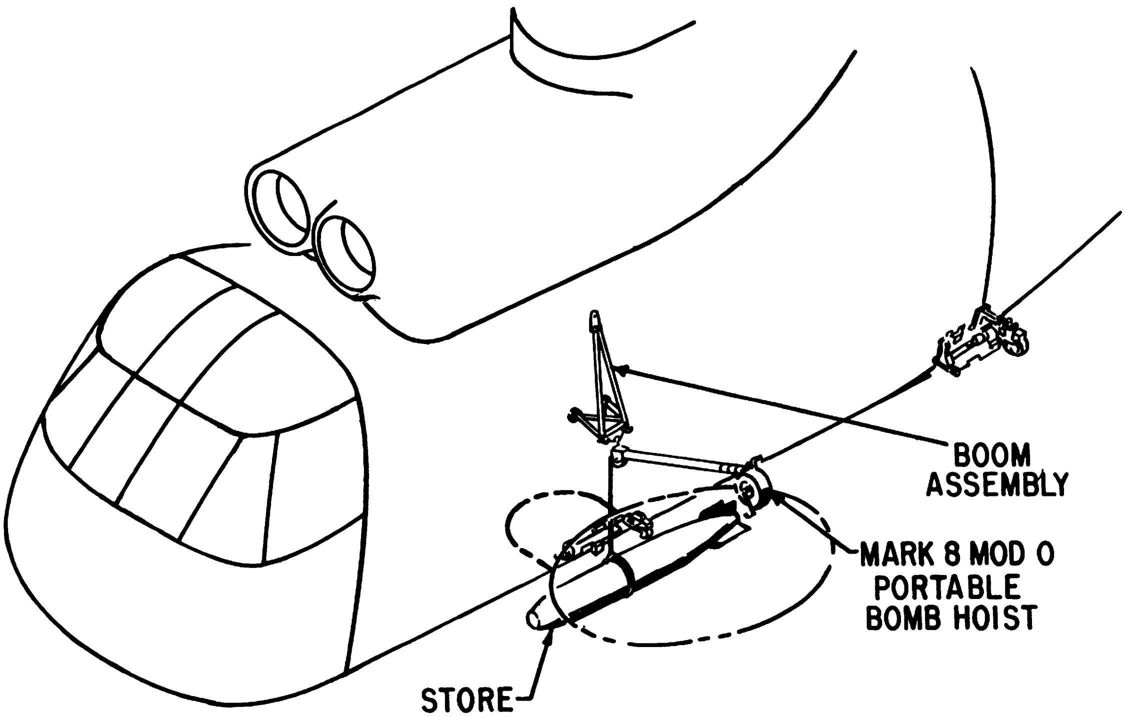


Figure 5-7. —Boom assembly.

Normal release of stores is accomplished in the following manner:

1. Close MASTER ARM and salvo circuit breakers.
2. Close MASTER ARM switch.
3. Select release mode (salvo/single).
4. Select stations to be released.
5. Arm stores. (NOTE: Stores may be released safe by emergency jettison only.)
6. Press either pilot's or copilot's release button. Selected stores will release.

Emergency jettison of stores is accomplished by closing the emergency circuit breaker, and pressing the emergency jettison button. All stores are released simultaneously. (NOTE: Stores may be released either armed or safe when jettisoned.)

CHAPTER 6

THE AVIATION WEAPONS OFFICER ASHORE

Shore duty locations throughout the Navy for the Aviation Weapons Officer (formerly called the Aviation Ordnance Officer) are numerous. The extent of his duties and responsibilities may vary in scope from an administrative billet within a staff organization to cognizance of numerous ordnance groups with multipurpose duties such as: general aviation ordnance shops, aircraft mine shops, aircraft torpedo shops, naval air station magazines, armories, and pistol and rifle ranges.

TRAINING AND ASSIGNMENT

This chapter discusses available or required training and some of the general duties and responsibilities within the various shore billets applicable to the Aviation Weapons Officer. A brief discussion of some of the training assignments and other pertinent and helpful information is also included.

Some of the billets and duties afloat to which the Aviation Weapons Officer may be assigned are discussed in chapter 7 of this text.

THE PROSPECTIVE AVIATION WEAPONS OFFICER

Normally, prospective Aviation Weapons Officers have had little opportunity to demonstrate or practice management functions. In addition to this, some recent findings have indicated a need for additional training for such officers in the areas of supervision and administration.

Chapter 3 of this text offers selected coverage of some of the various aspects of aviation ordnance management, and should be available as a handy basic reference. Also Limited Duty Officers (LDO's) and selected line officers who are ordered to Aviation Weapons Officer type duties are usually given an oppurtunity to attend a management course in ordnance administration. This course is presently located at Jacksonville, Florida.

A brief synopsis of the broad coverage of this course is contained in the following sections.

AVIATION ORDNANCE OFFICERS (MANAGEMENT) COURSE

The Aviation Ordnance Officers (Management) Course was established to provide Aviation Weapons Officers with a comprehensive, theoretical, and practical background necessary to the performance and administration of their future duties in the management aspects of aviation ordnance, ashore and afloat. This course includes coverage of the following publications: Navy Directives System, Classification and Security, BuWeps Publications, Navy Warfare Publications (NWP's), Navy Civilian Personnel Instructions (NCPI's), and other miscellaneous publications.

In the field of administration, the following subjects are covered: division officer duties, division management, Aviation Weapons Officer responsibilities, ordnance division/branch organization training, safety, and security. Coverage in the supply aspects of aviation ordnance are: chain of supply, classification and stock numbers, stock lists, equipment allowance lists, the ammunition distribution system, and associated records and reports.

The Aviation Ordnance Officer (Management) School is a 4-week course and quotas are filled and controlled by BuPers. Eligible applicants to this course are restricted to selected line, aviation ordnance, and limited duty officers.

This management course is an important phase of perparatory training for the Aviation Weapons Officer in ordnance administration. However, knowledge gained while on-the-job in an operational billet is also a very important aspect of the Aviation Weapons Officer's continued training. It behooves the Aviation Weapons officer to continue reading and studying technical, professional, and general materials throughout his Navy career. Consistent reading habits will enable him to do his job properly and to train himself for a more responsible position.

SUMMARY OF TRAINING AND DUTY ASSIGNMENTS

Normally, two major groups of personnel come into contact with aviation ordnance and armament equipment. These groups are as follows:

1. The users; that is, the naval aviators, bombardiers, air crewmen, and others concerned with using or expending airborne ordnance, armament, and ammunition.
2. The service group; that is, those working in support of, or service to, the ultimate users. This group includes those concerned with logistics and cognizant bureaus, at the shore activities, or in fleet units. It includes, in particular, those who render direct service or operational support to aircraft in the fields of aviation ordnance, armament, and aerial warfare.

Service functions, ashore or carrier-based, are administered by Aviation Weapons Officers. These officers, therefore, need technical training in the different phases of aviation ordnance, including aircraft ammunition, aircraft armament, aerial warfare, and ground training techniques.

Aviation ordnance units ashore are responsible for a growing number of airborne items including nuclear weapons, high-performance rockets, guided missiles, bombs, mines, torpedoes, fuses, guns, pyrotechnics, and chemical materials, together with all the devices used to handle and suspend these materials. The past few years have been highly productive of this type of material, and the technological age in which we are living indicates that many more will be developed in the future. All of this tends to make naval airborne ordnance more complex as time goes on.

So that they may perform their assigned duties adequately, Aviation Weapons Officers need training in the procurement, construction, operation, installation, employment, maintenance, overhaul, and disposal of aviation ordnance and armament materials. They also need a basic understanding of each ordnance item as it functions on naval aircraft. In addition, Aviation Weapons Officers should possess sufficient knowledge of aviation ordnance and armament to quality for assignments in research, development, planning, production, and testing and for other duties in logistic support of fleet aircraft.

BILLETS AND DUTIES

As indicated previously in this chapter, duty ashore for the Aviation Weapons Officer consists of a wide range of billets and duties. Operational duty ashore offers the Aviation Weapons Officer an opportunity to improve his technical and practical training. Such duty ashore will allow him to continue his on-the-job training by combining academical knowledge and practical skills.

As he progresses in rank, the complexity of his duties will increase. Therefore, it behooves the Aviation Weapons Officer to become proficient in both the technical and administrative duties of each subsequent billet.

A brief discussion of the billets and duties to be expected by the Aviation Weapons Officer ashore is presented in the following paragraphs. However, this is not to be construed as a complete list of possible shore billets and duties but rather the more predominant ones. Chapter 1 of this text describes the duties and responsibilities, as listed in the Manual of Navy Officer Billet Classification (NavPers 15839), of the Aviation Weapons Officer while serving in either the Squadron Armament Officer of Aircraft Maintenance Ordnance Officer Billet.

Aviation Weapons Officers fill three general types of billets—administrative, operational, and training. Representative assignments of these three general types are described. Operational duties are normally assigned to a large majority of Aviation Weapons Officers, and most of the following discussion is devoted to typical operational details.

ADMINISTRATIVE DUTY

A typical assignment involving duties of an administrative nature would be one to a section within a division of the Bureau of Naval Weapons. These duties would vary depending upon the specific subsection to which the officer is assigned and could consist of any of the following:

1. Action on directive summaries.
2. Program planning.
3. Processing of requisitions and shipment orders.
4. Inventory reports and control.
5. Estimating cost of equipment.

6. Contractor conferences.
7. Bureau and service conferences.
8. Visits to air stations, carriers, depots, and advance bases.
9. Action on reports of defective aviation armament/ordnance material.
10. Preparation of pamphlets, data, catalogs, directives, and notices and instructions.
11. Preparation of sketches, charts, drawings, and blueprints.
12. Preparing reports and correspondence.
13. Preparation of allowance lists and revisions.
14. Investigations of accident reports.
15. Assistance to ordnance training activities.
16. Personnel training within a subsection.
17. Technical library supervisor.
18. Security classification.
19. Supply and stowage of equipment or ammunition.
20. Liaison with related bureau sections.
21. BuWeps representative to boards, sea trails, and testing activities.
22. Project fiscal studies and reports.

Additional duties may be expected by Aviation Weapons Officers within the newer sections of BuWeps such as, special weapons, guided missiles, and the latest aircraft weapons systems. The Bureau of Naval Weapons is far reaching in scope and responsibility; therefore, it is impractical to list the numerous BuWeps billets assigned to and filled by Aviation Weapons Officers.

OPERATIONAL DUTY

Duty assignments with operating forces may be aircraft squadrons, naval air stations (assignments supporting operating activities), ships company aboard a carrier, or overseas shore activities.

Operational duty ashore for the Aviation Weapons Officer can usually be divided into three main types—a naval air station assignment, an operating squadron, or a staff billet.

Squadron duty and a staff assignment for the Aviation Weapons Officer are covered in this chapter even though these assignments can be located ashore, aboard ship, or at overseas shore activities.

Naval Air Station Duty

As outlined in the Organization Guide for the Naval Weapons Shore Establishment, BuWeps Instruction 5450.89, operational duty at a naval air station for the Aviation Weapons Officer may consist of assignment to one of three types of standard organizations depending on several factors. These factors are: the functions to be performed, the personnel available to perform them, available material resources, and the policies and philosophies of the management bureau and higher levels of authority.

The three prescribed standard organizations and the basic determining factors are discussed in the following paragraphs.

1. A separate aircraft maintenance department is established when the air station is authorized to perform intermediate aircraft maintenance. Consequently, such departments usually have a billet for an Aviation Weapons Officer.

2. A weapons department is established when 40 or more personnel are engaged in weapons functions. Therefore, a weapons department billet and the required division officer billets are normally established.

3. When fewer than 30 personnel are engaged in weapons functions, a weapons division within the air operations department is established. Hence, the weapons officer billet within the air operations department is to be expected under these circumstances. NOTE: Division/department status is optional for personnel engaged in weapons functions when the number of personnel assigned is between 30 and 40.

Therefore, the Aviation Weapons Officer assigned to naval air station duty may expect assignment to one of the following standard organizations.

1. A division officer within the weapons department.
2. A weapons division officer of the air operations department.
3. An ordnance division officer of the aircraft maintenance department.

(NOTE: The ordnance division officer's duties within the aircraft maintenance department is discussed in chapter 2 of this text under Aircraft Maintenance Organization.)

The division officer within the weapons department and the weapons division officer of the air operations department are discussed in the following paragraphs.

DIVISION OFFICER (WEAPONS) DEPARTMENT.—The Aviation Weapons Officer when assigned to a weapons department may expect

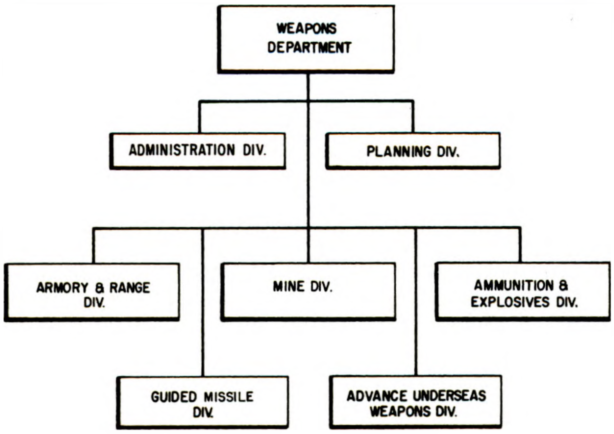


Figure 6-1.—Weapons department organization.

duties in any one of several billets. A structural organization of the weapons department is shown in figure 6-1 and is discussed in the following paragraphs.

WEAPONS DEPARTMENT. The officer in charge of the weapons department performs the following duties.

1. Initiates the procurement of and receives, stores, maintans, and issues all ordnance, weapons, missiles, ammunition, and explosives authorized the station for use and support of fleet units and tenants.
2. Operates the small arms firing ranges.
3. Provides special augmenting units for performance of test, repair, maintenance, overhaul, or assembly of weapons.
4. Provides weapons transshipment services and facilities.
5. Performs explosive ordnance disposal and nuclear weapons disposal, provided explosive ordnance personnel are assigned.
6. Supervises the various divisions working for him as shown in figure 6-1.

Possible division officer assignments are as follows:

Administrative Division. Provides administrative and clerical services for the department.

Planning Division. Plans and coordinates workload schedules for the department. Evaluates production methods, processes, and procedures and develops improvements. Coordinates requisitioning of materials. Controls utilization of assigned ordnance handling and transportation equipment, and maintains liaison with appropriate maintenance activities for its maintenance. Initiates requests to bring stocks to authorized levels. Coordinates department budget and maintains required financial records.

Armory and Range Division. Receives, stores, inventories, and issues ordnance, ammunition, and explosives assigned to the station. Operates armory and small arms firing ranges. Conducts physical inventories of material in store. Provides instruction in care and use of firearms. Disposes of, or renders safe, explosive ordnance material.

Mine Division. Receives, stores, inventories, inspects, tests, maintains, assembles, and issues mines. Preserves and stores mine firing mechanisms and accessories, special mine assembly tools, test sets, and equipment.

Ammunition and Explosives Division. As a principal source of supply for fleet units, receives, stores, inventories, assembles, renovates, and issues ammunition, ammunition components, and explosives. Maintains surveillance over ammunition and explosives in storage. Performs final inspection of ammunition and components renovated or assembled. Inspects and maintains gages and scales for renovation and general use.

Guided Missile Division. Receives, stores, inventories, inspects, tests, and maintains all ready-service and training guided missiles assigned the station. Assembles and issues guided missiles to fleet units and tenants. Provides training to supported squadrons in the maintenance of guided missile systems.

Advanced Underseas Weapons Division. Receives, stores, inventories, maintains, tests, and assembles assigned weapons, components, spare parts, and related equipment. Issues weapons to using activities. Performs transshipment of weapons. Maintains and repairs weapons test equipment and electronic equipment.

WEAPONS DIVISION OFFICER (AIR OPERATIONS DEPARTMENT).—As shown in figure 6-2, the Aviation Weapons Officer is directly under the air operations officer and is responsible for numerous ordnance associated functions. These duties include the initiation, procurement, receipt, stowage, maintenance, and issue of authorized ammunition and associated components. He is also responsible for many functions associated with the operation of small arms ranges. His responsibilities may include the above listed duties plus any other responsibilities as directed by the air operations officer.

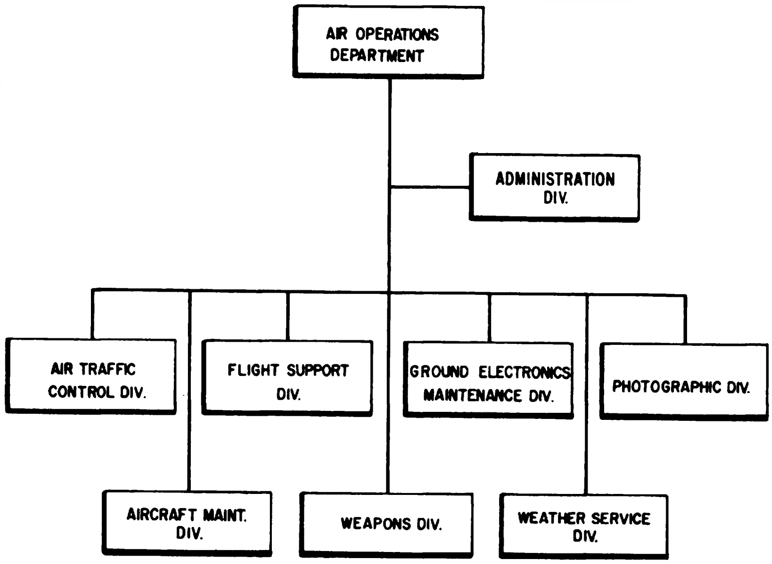


Figure 6-2. —Air operations department organization.

Squadron Duty

Squadron duty for the Aviation Weapons Officer may vary considerably, depending on the type of squadron and where the squadron is based. Also the squadron's mission determines the scope of the Aviation Weapons Officer's duties and responsibilities.

The duties and responsibilities of the Aviation Weapons Officer in an operating squadron are increasing in importance concomitantly with the mounting dependence of naval units upon electronic equipment. Equipment maintenance and operational problems resulting from the increasing number and complexity of electronic equipment being installed or scheduled for early installation in fleet aircraft, and from the shortage of experienced aviation ordnance personnel require that a maximum effort be directed towards efficient organization of the weapons division and towards a well integrated training program for aviation ordnance personnel.

KNOWLEDGE AND SKILLS. —The Aviation Weapons Officer of a squadron should have a thorough knowledge of the principles of operation and maintenance of aviation armament equipment, current weapons systems, aircraft ammunition, and associated handling equipment.

Other knowledge and skills required by the Aviation Weapons Officer include:

1. A working knowledge of squadron operating and aircraft handling procedures.
2. Complete knowledge of sources of technical information such as operation, inspection, and maintenance manuals, periodic publications, technical directives, aviation armament changes; he should also be skilled in the use and implementation of these publications.
3. Sufficient knowledge of the principles of construction, testing, and repairing of aircraft armament and weapons systems equipment to establish criteria for quality control of maintenance.
4. Working knowledge of the naval supply system, including supply catalogs, allotments, allowances, accountability, and requisition procedures.
5. Thorough knowledge of shop and line maintenance procedures of the Naval Aircraft Maintenance Program as contained in BuWeps Instruction 4700. 2.
6. Knowledge of naval air administration and office administration including compilation and submission of reports.

DUTIES. —The primary duty of all Aviation Weapons Officer is to contribute to the maximum availability and utilization of naval aircraft by supervising proper maintenance of the various units, systems, and ordnance equipment aboard the aircraft. Their secondary duty is to insure that maximum training of enlisted personnel and pilots in regard to aircraft ordnance equipment and weapons systems is accomplished.

All work performed by the rated aviation ordnance personnel in the division is subject to the direct supervision and responsibility of the Aviation Weapons Officer.

In order to insure that the maximum number of aircraft is always available, and the performance of an assigned mission is not limited or prevented because of failure or improper operation of armament or weapons systems equipment, the Aviation Weapons Officer is responsible for the following specific duties.

1. Supervising the proper establishment and equipping of the maintenance shops.
2. Maintaining a technical library, including all applicable publications pertinent to ordnance, bureau directives, and instructions originated and promulgated by the maintenance officer.
3. Establishing close cooperation and coordination between the weapons division and other divisions comprising the balance of the maintenance department.
4. Establishing and enforcing a line inspection system along with maintenance procedures to insure maximum availability of aircraft with properly functioning armament equipment and weapons systems.
5. Supervising the maintenance of aircraft ordnance equipment and weapons systems.
6. Insuring that proper test, alinement, and adjustment procedures along with the highest standards of workmanship and shop practice are employed in the maintenance and repair of ordnance equipment.
7. Maintaining adequate files, cross references, and records to insure compliance with directives and instructions from higher authority.
8. Insuring that required shops records and equipment logs are maintained in order to facilitate maintenance and obtain optimum equipment performance.
9. Evaluating failures and malperformance of ordnance equipment and preparing FUR reports as appropriate.
10. Analyzing and obtaining solutions to operational and maintenance problems beyond the capabilities of assigned personnel.
11. Coordinating work performed by the weapons maintenance group with other groups within the squadron to achieve maximum overall efficiency.
12. Determining the needs and coordinating with supply staff activities to insure adequate availability of material, test equipment, and facilities required for effective operation and maintenance of equipment, and for training of personnel.
13. Insuring that adequate technical publications are procured, kept current, properly stowed, and are continuously available to aviation ordnance personnel.
14. Establishing and executing a technical training program to qualify all assigned aviation ordnance personnel in the maintenance of assigned equipments and systems.
15. Organizing an interdivision training program to assist the Education and Training Officer in the planning and execution of a program to qualify enlisted personnel for advancement.
16. Maintaining qualification records and assigning personnel in accordance with rate and/or ability.
17. Insuring proper care of tools and test equipment.
18. Providing stowage facilities and security for all equipments.
19. Enforcing safety regulations (as are covered in various OP's and BuWeps Instructions) and, when necessary, establishing new instructions to assure maximum safety standards.

In order to accomplish the foregoing duties, responsibilities, and obligations, the Aviation Weapons Officer must be first, an administrator and second, a technician.

The squadron Aviation Weapons Officer must possess a thorough knowledge of the organization and facilities of the station weapons department, magazine, and shops in order to schedule exercises requiring joint use of shore facilities. A cordial relationship with fleet and shore supply activities will result in a workable system with regard to custody, procurement, issue, and followup requests for material. A followup practice eliminates shortages of required items and duplication of inventories. It also results in a strengthened supply activity and a greatly increased efficiency.

Depending on size and mission of the ordnance branch, the Aviation Weapons Officer may be concerned to a greater or lesser extent with the following types of ordnance crews and their activities:

1. Line operations troubleshooting crews.
2. Maintenance crews for armament equipment.
3. Tow target crews.
4. Arming and dearming crews.
5. Night maintenance crews.

6. Night operations crews (flight).
7. Rocket assembly/handling crews.
8. Loading crews for aircraft bombs, mines, and torpedoes.
9. Loading crews for nuclear weapons.
10. Guided missile handling crews.

Additional Operational Duties

The Aviation Weapons Officer may also be assigned to a Carrier Air Wing (CVW) or Fleet Air Wing (FAW) staff billet. His duties here consist of working closely with squadron ordnance officers to solve the various tactical ordnance problems as they arise.

The ordnance staff officer may be requested to help solve squadron problems involving modifications to aviation ordnance systems and equipment. He may also be required to assist with projects related to antisubmarine warfare, bomb type drops, missile equipment installations, nuclear weapons equipment, and numerous other special projects. All of these tasks involve close association with the squadron ordnance branches/divisions, with other fleet units, and with the cognizant bureaus in submission of reports on performance of equipment. Corrective actions should be accomplished ashore, when possible, because limitations of spare equipment, special tools, and time usually make them impracticable at sea. Requests for manufacture of special items should be handled in local aircraft repair shops when practical.

Other duties of the ordnance staff officer include the procurement of scarce ordnance items and establishment of a workable program for the selection of crews to load nuclear weapons. He must also supervise the promulgation and publication of staff safety regulations pertaining to aircraft armament, aircraft ammunition, associated equipment, and operational procedures. The ordnance staff officer may also be required to investigate and report aircraft accidents involving aviation ordnance ammunition and equipment.

PRECOMMISSIONING AND REACTIVATION DUTIES

An additional type of duty not too frequently assigned Aviation Weapons Officers (but a very important duty, nevertheless) is that of precommissioning or reactivating a carrier. In general the Aviation Weapons Officer is responsible for the following four major jobs:

1. Assembling all required aviation ordnance equipment.
2. Organizing and training ordnance crews.
3. Modifying (as needed) aviation ordnance assigned spaces and equipment.
4. Adapting aviation ordnance, armament, ammunition, and equipment to current carrier operations.

Even when these basic tasks are well on the way toward completion, continuous corrective work must be performed to adapt new types of airborne weapons and ammunition that have been perfected and will soon be operational. Aviation ordnance equipment requires that frequent overhaul and operational procedures be continuously revised to take care of new devices and techniques. Attention must be given to carrier handling equipment, ammunition stowage, bomb elevators, below-deck clearances, ammunition handling procedures, and other such important details.

TRAINING ASSIGNMENTS

Trained Aviation Weapons Officers are frequently assigned duties as phase officers or instructors in specialized technical schools or in mobile training units. Some of the duties to be expected within these training assignments are as follows:

1. Preparation of lesson plans.
2. Preparation of instructor guides.
3. Presentation of lectures.
4. Recitation supervision.
5. Construction of training materials and teaching aids.
6. Evaluation of other instructors.
7. Collecting appropriate technical references.
8. Maintaining informal correspondence with fleet units, outlying air stations, technical bureaus, and their field units.
9. Preparing field demonstrations of equipment.
10. Preparing and grading examinations and assignments.
11. Training enlisted assistants.
12. Reviewing courses with a view to eliminating obsolete materials and information.
13. Attending conferences.
14. Supervising field trips for students.
15. Preparing drafts of instructional publications.
16. Participating in curriculum changes.
17. Recommending students for further assignments of a technical nature.

CHAPTER 7

THE AVIATION WEAPONS OFFICER AFLOAT

The recently adopted term Aviation Weapons Officer (in lieu of Aviation Ordnance Officer) may be confusing especially to officers of the aviation ordnance field who are directly involved. Therefore to avoid confusion, the term Aviation Weapons Officer(s) is/are used when speaking of the aviation ordnance field in general. However, when specific billets and duties are discussed, the former titles are used; e.g., ordnance handling officer, aviation ordnance gunner, etc.

After Aviation Weapons Officers have completed their training ashore, they are likely to be assigned to duty afloat. Generally, duty afloat is aboard a carrier or seaplane tender. This chapter discusses some of the billets, duties, and responsibilities to be expected by Aviation Weapons Officers assigned afloat.

BASIC ORGANIZATION

The basic organization of naval air operating forces should be thoroughly understood. Therefore, Aviation Weapons Officers should be familiar with the pertinent sections of AirLant/AirPac CV Weapons Instruction 5400.1 and the BuShips Manual that apply to their assigned billets.

Aircraft carriers are the backbone of the fleet air arm, but seaplane tenders should not be overlooked as an important part of naval air operations. Seaplane tenders have proved valuable when used at advanced bases, especially in areas with inadequate shore facilities. These ships carry complete overhaul shops, aircraft supplies, and ordnance for servicing and maintaining seaplane patrol craft.

The type of ordnance and armament equipment found aboard a seaplane tender are in line with the seaplane's mission. The seaplane's mission includes all-weather antisubmarine warfare, aerial mining, patrol surveillance, and sea-air rescue (SAR).

Aboard an attack carrier, Aviation Weapons Officers are mainly concerned with servicing the embarked aircraft with the required ordnance and equipment necessary to fulfill their assigned missions. They are also concerned with the various aspects of procurement, handling, accounting, stowage, and maintenance of ammunition.

Aboard a seaplane tender, Aviation Weapons Officers are concerned mainly with loading the prescribed ordnance load on seaplanes. Therefore, duty aboard a seaplane tender is different from a carrier by reason of the scope of operations rather than the nature of operations.

Presently, approximately 80 percent of Aviation Weapons Officer billets afloat are aboard aircraft carriers, with a majority of these aboard attack carriers. Therefore, coverage of the aviation ordnance activities aboard an attack carrier is the basis of this chapter.

UNIT ORGANIZATION

The standard administrative organization for aircraft carriers, as shown in figure 7-1, depicts the weapons department directly under the executive officer of the carrier. The commanding officer, through the executive officer, delegates duties, responsibilities, and authority to the weapons officer as prescribed in U.S. Navy Regulations and in the Standard Ship Organization and Regulations Manual.

Billet assignments for Aviation Weapons Officers are within the weapons department. Aviation Weapons Officers (depending on their rank) may expect assignment in one of three billets as shown in figure 7-2.

The positions that are normally filled by Aviation Weapons Officers are the G Division Officer, junior G Division Officer, and the aviation ordnance gunner.

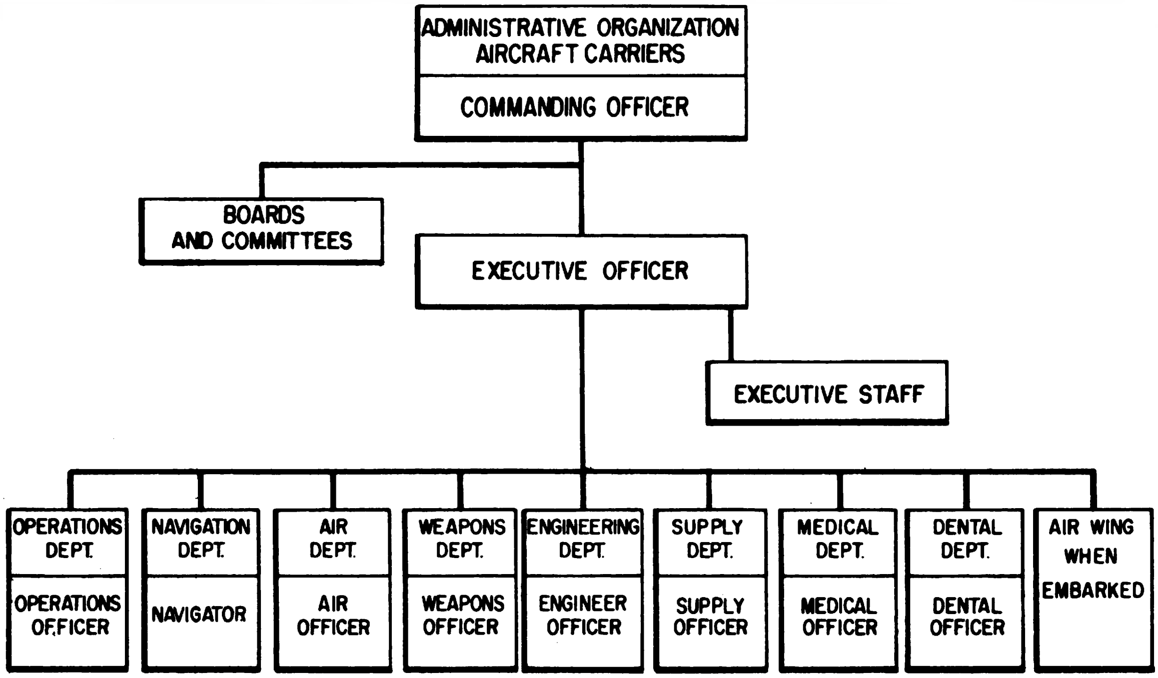


Figure 7-1.—Standard carrier organization.

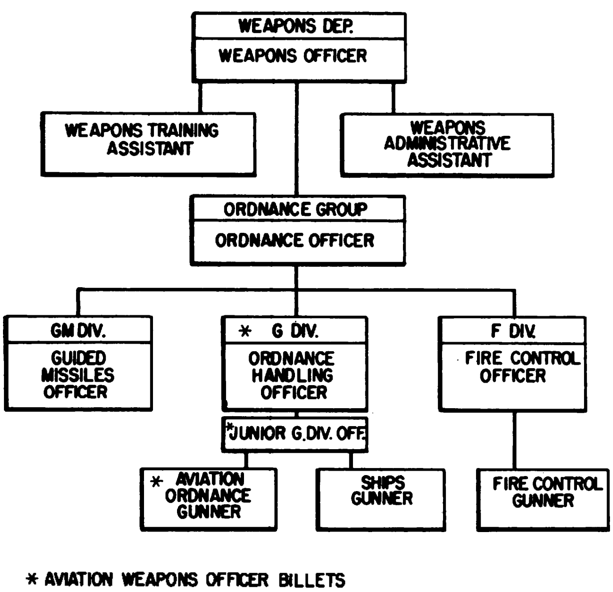


Figure 7-2.—Carrier weapons department organization.

The G Division consists mainly of personnel from the Aviation Ordnanceman rating and Gunner's Mate rating. The complement of the G Division aboard an attack carrier usually consists of 30 to 40 Aviation Ordnancemen (including strikers), and 10 to 15 Gunner's Mates (including strikers).

EFFICIENT SUPERVISION

To be an efficient supervisor, the Aviation Weapons Officer should be thoroughly familiar with his ship as well as its organization. Within his own group, he should know the abilities of the men under his supervision and be familiar with the aviation ordnance equipment, armament, and aircraft ammunition aboard. Carrier duty for the Aviation Weapons Officer demands resourcefulness and great adaptability, plus the ability to instill these same qualities in his men.

Often, last minute changes in daily breakout ammunition requirements and unforeseen emergencies, require accurate decisions that have to be made in a matter of moments while working at top speed. Few duties aboard ship test more completely an officer's skill and administrative competence.

The elements of combat operations are continually changing in line with new equipment, weapons, and aircraft as each are introduced and become operational in the fleet.

Each modification or new weapon and its associated equipment may introduce new problems even though basic accompanying instructions are diligently followed. Peculiarities in construction of the new items should be studied to determine the best methods for handling, assembling, and loading such items on the applicable aircraft. Frequently, instructions for new weapons and equipment are lacking or incomplete upon arrival. Consequently the Aviation Weapons Officer must rely on his training and ingenuity to establish new handling, assembling, and loading procedures to insure the proper use of ammunition and equipment. He must continually teach proper safety instructions and habits to all hands concerned, emphasizing the use of common sense in those phases of everyday work which in its very nature is hazardous. Pertinent information and safety lectures on new weapons, ammunition, and equipment, both to the men and to pilots, are helpful in this respect.

SPECIFIC DUTIES OF AVIATION WEAPONS OFFICERS

Aviation Weapons Officers of different rank are assigned billets with duties, responsibilities, and authority as discussed in the following paragraphs.

An Aviation Weapons Officer with the rank of Lieutenant may expect the general duties of a G Division Officer as prescribed in U.S. Navy Regulations and the Standard Ship Organization and Regulations Manual. He may also be assigned to the billet of ordnance handling officer.

ORDNANCE HANDLING OFFICER

The ordnance handling officer is responsible for the efficient operations and administration of all magazines, the ship's armory, advance underseas weapons shop, and the ship's saluting battery. He also directs aviation ordnance handling operations and may be designated the ship's nuclear weapons loading officer.

Actual duties, responsibilities, and authority of the ordnance handling officer are as follows:

1. Coordinate and direct the servicing of embarked aircraft with aviation ordnance.
2. Direct the procurement, handling, accounting, stowage, and maintenance of all ship and aircraft ammunition.
3. Maintain all armories, magazines, ammunition elevators, and all other assigned spaces.
4. Direct the maintenance and testing of all ammunition under his cognizance.
5. Maintain liaison with embarked squadron weapons officers to insure an efficient system of ammunition and armament supply.
6. Provide armories and an aviation ordnance issue room for use by squadron ordnance personnel.
7. Direct the proper arming and dearming of embarked aircraft, insuring that prescribed procedures and safety precautions are strictly observed.
8. Direct rearming drills and collaborate with squadron weapons officers for correction of discrepancies noted. (NOTE: The words "arming" and "rearming," as used in this chapter, denote the complete cycle of loading or reloading of an aircraft with a prescribed ordnance load. The cycle includes removal of the ammunition from stowage, through assembly, and ultimately suspension on the aircraft.)
9. Insure that operating procedures and safety precautions are promulgated and strictly observed.
10. Organize and instruct selected personnel of the G Division in loading and handling procedures for nuclear weapons.
11. Request deck spot as required and keep the aircraft handling officer informed of the readiness of serviced aircraft.
12. Maintain accurate records of all ammunition, keeping a current balance of expenditures and receipts of all types, and procure ammunition as necessary with the approval of the ordnance officer, to insure conformance with the ship's ammunition allowances or directives from higher authority.
13. Exercise overall supervision, under the direction of the weapons officer and ordnance officer, of ammunition handling parties, and personally instruct all key personnel in pertinent safety precautions prior to the conduct of such evolutions.
14. Inspect the magazines, magazine logs, ammunition logs, and surveillance test logs

daily to insure that the required magazine temperatures are maintained and the surveillance and magazine sprinkler systems tests are properly conducted.

15. Be responsible for the posting and enforcement of applicable safety precautions, operating instructions, and casualty procedures in assigned spaces.

16. Prepare instructions, train, and post the magazine security patrol and the armory watch.

17. Supervise the issuance of all ammunition.

18. Maintain custody of the magazine keys during the working day; and upon leaving the ship, personally turn the keys over to the weapons department duty officer.

19. Insure the preparation and submission of ammunition records and reports to the ordnance officer as required.

20. Act as division officer with respect to the ordnance handling division (G Division).

21. Supervise the accomplishment of OrdAlts (Ordnance Alterations) and major repairs to equipment under his cognizance.

22. Administer the operation and maintenance of the advanced underseas weapons (AUW) shop. Prepare instructions, train, and post the watch for the security of documents and material in the AUW shop.

23. Be responsible for procuring, accounting, testing, maintaining, and issuing mines and torpedoes, when carried.

24. Supervise the operation of the ship's armory, and the maintenance, repair, and accounting for the ship's small arms and other equipment under his cognizance.

25. Supervise the firing of all gun salutes and insure correct maintenance and repair of the saluting battery and its related equipment.

26. Procure, maintain, issue, and account for all landing party equipment under the cognizance of the weapons officer.

27. Initiate requisitions for armory and magazine supplies and materials within the budgetary limitations established by the weapons officer.

28. Requisition, under the supervision of the ordnance officer, ordnance spare parts and accessories not charged to the weapons department allotment.

29. Provide assistance as may be requested by the ordnance disposal officer for the rendering safe of any unexploded ordnance which constitutes a hazard to the ship.

30. Be responsible for procuring, accounting, and maintaining tools and equipment associated with ordnance disposal.

JUNIOR (G) DIVISION OFFICER

An Aviation Weapons Officer with the rank of LTJG or Ensign may expect the general duties of junior (G) Division officer with the basic functions as discussed in this chapter.

He assists the division officer in coordinating and administering the functions of the division and develops a thorough understanding of the functions, directives, and equipment of the division in preparation for assuming the duties of division officer.

In accordance with the division organization and the degree of qualifications demonstrated by the junior (G) Division officer, he may be assigned any or all of the following duties:

1. Supervise the preparation and maintenance of the Watch, Quarter, and Station Bill, and such other bills as may be necessary for the operation of the division.
2. Supervise the division in performing its dialy routine, and conduct inspections to insure that division functions are being properly carried out.
3. Aid in the administration of discipline within the division.
4. Aid in formulating and implementing policies and procedures for the operation of the division.
5. Evaluate individual performances of the personnel of the division in consultation with the leading petty officers and recommend annual marks and Navy job classification codes to the division officer.
6. Insure the maintenance of routine logs and records, and the preparation of reports required of the division.
7. Act as the division training assistant, being guided by the Standard Ship Organization and Regulations Manual.
8. Act as the division officer in his absence.
9. Perform such other duties as may be assigned.

AVIATION ORDNANCE GUNNER

An Aviation Weapons Officer with the rank of Warrant Officer is normally assigned to the billet of aviation ordnance gunner. His basic function is to assist the ordnance handling officer in insuring operational readiness of the ship's aviation ordnance and supervise the arming and dearming of embarked aircraft as required.

The aviation ordnance gunner's duties, responsibilities, and authority include the following:

1. Supervise the stowage and maintenance of aviation ordnance material under the cognizance of the weapons department, including bomb cranes, skids, and trucks. Supervise the upkeep of squadron armories when squadrons are not embarked.

2. Insure the security and maintenance of ready-service magazines, workshops, and assembly areas as assigned by the ordnance officer.

3. Supervise the aviation ordnance issue room in supplying squadrons with material for the maintenance of aviation ordnance.

4. Supervise the assembly, maintenance, and test of aircraft ammunition, and the delivery of ammunition to the flight or hangar deck via the bomb and torpedo elevators.

5. Supervise, as required, the arming and dearming of embarked aircraft, insuring the observance of safety precautions and proper procedures.

6. Supervise rearming drills, insuring coordination between the weapons department, air department, and squadron personnel.

7. Supervise the transfer of nuclear weapons to the flight deck via bomb elevators, and supervise loading of designated aircraft.

8. Supervise the loading team in the actual loading of nuclear weapons.

9. Insure the maintenance of records and the submission of reports as required by higher authority, including the preparation of data on the quality, quantity, and test results of aviation ordnance.

10. Insure the strict observance of all safety procedures and regulations relative to the handling of ordnance material.

11. Supervise the maintenance and cleanliness of all assigned working spaces.

12. In the event of deck crashes, provide personnel for inspection and removal of explosives as required by the ordnance disposal officer.

13. Supervise the maintenance and calibration of all assigned testing and handling equipment necessary for the preparation of squadron aircraft.

14. Perform such other duties as may be assigned.

GENERAL DUTIES

Aircraft armed for combat constitute the main offensive and defensive weapon capability of the carrier. To be safe and effective, everything associated with airborne ordnance and armament equipment must be kept in a ready condition for immediate use as required by the carrier's mission. As mentioned earlier in this chapter, the G Division of the weapons department has a normal complement of 2 or more officers and 50 or more Aviation Ordnancemen/Gunner's Mates and strikers (depending on the size of the carrier).

In the performance of their duties, these men have duty stations located on several decks, and the material with which they have cognizance may come from 40 or more compartments or spaces.

These ordnance locations include armories, magazines for high explosive type ammunition, ready-service magazines for aircraft gun ammunition, ready-service fuze lockers, gun cleaning spaces, aircraft mine spaces, aircraft torpedo workshop and stowage spaces, bomb elevators, inert stowage areas, and various offices and sleeping compartments. The assigned ordnance spaces and compartments listed are the responsibility of Aviation Weapons Officers, under the cognizance of the ship's weapons officer.

Although the Aviation Weapons Officer is under the weapons department, many of his duties are closely linked to aircraft, aircraft ammunition, and associated details. Therefore, various tasks and missions assigned to the air department will directly or indirectly concern the Aviation Weapons Officer.

DAILY ARMAMENT SCHEDULE

Offensive or defensive armed aircraft launching is undertaken according to basic operations plan prepared for the projected action, with each carrier air wing (CAW) assigned specific missions, tasks, and targets. To fill in the details of the overall operations plan, an operations schedule is prepared by each wing and, in turn, by each carrier. The carrier schedule takes the form of an operations flight schedule which plans all flights and stipulates the takeoff time, ordnance load, gas load, duration of flight, etc. The daily ordnance schedule grows out of, and is part of, the flight schedule.

The ordnance schedule is usually issued by the operations department in the late afternoon or early evening, and shows the intended ordnance loads for all flight operations for the following day. Careful planning is necessary in order to meet the timetable established for the aircraft assigned to their various missions.

Effecting the planned ordnance schedule is one of the most important daily responsibilities of the Aviation Weapons Officer while at sea. Consequently, it demands alertness, efficient organization, and constant supervision. The goal of the Aviation Weapons Officer should be to efficiently organize the ammunition-handling crews and the rearming crews on the flight and hangar decks so that no flight is delayed in its scheduled takeoff.

The success of an Aviation Weapons Officer depends upon beginning work on the ordnance schedule at the earliest practical time. Close cooperation with the operations department and others closely concerned with the schedule is a very important phase of the planning. A good practice is to hold a conference with the flight deck officer and squadron ordnance officer as soon as information is obtained concerning the next day's operation. The whole day's operation may then be simulated on the aircraft "spotting" board (located within the island) to show how the aircraft are to be "spotted," moved, and positioned for arming operations. Thus, loading can be more efficiently planned. This preliminary simulated operation allows key personnel to become familiar with the plan, thereby reducing misunderstanding as much as possible.

Any planning should anticipate emergencies and breakdowns. Typical advance planning, for example, would be to anticipate two bomb elevators temporarily out of commission on the day of the operation, and to outline alternate sites for the delivery and loading of ammunition.

As a preliminary measure in executing the schedule, either of two courses may be taken, depending upon the experience of the men and the smoothness of the organization. One course would be to discuss with assistants (as assigned) the details of rearming. Specific plans for the breakout of handling crews, assembly crews, and rearming crews are then formulated.

The second course requires that a routine be established for meeting rearming prblems. In that case, only on special occasions would a conference with key personnel be required. The breakout schedule is then formulated, keeping in mind the required shifting of equipment and other details prior to actual breakout of ammunition.

In order to provide ample room for loading large stores (nuclear weapons, etc.), the Aviation Weapons Officer (aviation ordnance gunner) should maintain close liaison with the flight deck officer as to the proposed spotting of these particular aircraft. If missiles or other large weapons are to be used, a passage to the spotted aircraft must be provided for them.

The most effective operation control point for the Aviation Weapons Officer (aviation ordnance gunner) is in or near flight deck control. If loading is by spot, the flight officer designates the total number and location of aircraft to be armed. However, quantities of ammunition per aircraft are prescribed by the operations department and must not be deviated from at the last moment. Weights of ordnance loads, etc., must be accurately written on each aircraft for use by the catapult officer.

Permission must be obtained from the flight deck control officer and the air officer for reserving certain areas of the flight deck for the temporary storage of aircraft ammunition prior to loading (if required). This arrangement should be provided for in the ship's regulations. The area forward of the island is perhaps the most protected one on the flight deck with regard to landing crashes and fire hazards, and it is close to the forward bomb elevator hatches, a factor which permits prompt removal of the ammunition if required.

A special crew should be assigned to each catapult area to plug in rockets before takeoff, or to dearm an aircraft in case of a "down." (A "down" aircraft is one that is declared by the pilot or maintenance officer as unsafe to fly.) Equipment and personnel for these operations should be centrally located for rapid and efficient operation.

BELOW DECK OPERATIONS

Aircraft ammunition assembly and disassembly operations below the main deck of a carrier depend on many things such as the following:

1. The type and quantity of ammunition involved.
2. Operational situation.
3. Practical assembly points (space requirements, availability, etc.).
4. The position of the aircraft to be armed.
5. Personnel required.
6. Other practical considerations.

The second or third deck (depending on the carrier type) is usually the assembly point for aircraft bombs, mines, rockets, missiles, and other large stores (except nuclear weapons) needing large assembly areas. This ammunition arrives at the assembly point from primary magazines by a forward or aft bomb elevator (three or more separate systems, depending on the class of the carrier). A system of upper-stage bomb elevators permits movement of assembled ammunition to the upper deck level. Consequently, this localizes the assembly operations to the forward and aft areas adjacent to the elevators.

The assembly of bomb type ammunition consists of removal of shipping plugs, caps, or thread protectors and attaching tail vanes and hoisting bands or slings if required. The assembled bombs are then secured onto bomb skids and placed on an upper-stage bomb elevator for transfer to the flight deck. The bombs are then taken over by the squadron rearming crews for loading on the aircraft. (NOTE: Under peacetime conditions, bombs, rockets, and mines are fuzed and arming wires are installed on the flight deck only.)

A similar procedure is followed with unpackaged rockets. The motor, head, and fuzes are assembled to form a complete round. The assembled rockets are then placed on bomb skids with suitable rocket adapters and moved to the upper-stage bomb elevator for passage topside. (NOTE: Missile assembly procedures are discussed in chapter 19 of this text.)

It cannot be overemphasized that a large accumulation of exposed explosives is as serious a hazard below decks as it is on the flight deck. All decks must be kept clear of ammunition except in minimum quantities essential to meet operational requirements.

To avoid congestion, there should be an assembly line procedure, whereby ammunition flows steadily from the magazines to the flight deck for immediate loading on aircraft, or in the reverse direction in case of dearming. This reduces the explosive hazard in the event of an enemy attack, or by fire breaking out in some nearby part of the ship.

To achieve this assembly line procedure, adequate and smooth-working crews are required in the magazines, assembly areas, topside, and at the bomb elevator controls (both lower- and upper-stage positions). The smoothness of the flow of the bomb and rocket supply from the magazines to the flight deck will largely determine the speed and success of any arming or rearming operation.

SUPERVISING REARMING ACTIVITIES

The following details are essential if the Aviation Weapons Officer is to supervise arming and rearming procedures with proficiency:

1. Thoroughly understand the entire operation.
2. Accurately determine the capabilities of the various crews under his jurisdiction.
3. Accurately estimate the rearming time of each type of aircraft with the required ordnance load.
4. Maintain close liaison with the other officers concerned with the operation.
5. Maintain close contact through reliable assistants with all phases of the arming and rearming process.
6. Be readily available on the flight deck to make safe, logical and rapid on-the-spot decisions.

It is essential that all squadron rearming crews are properly trained to load all types of ammunition on their respective aircraft. As the aircraft land for rearming, squadron ordnance personnel in charge of loading aircraft should be given immediate instructions as to the loading orders, numbers, and spot assignments of the next sortie.

Teamwork is a must in any arming or rearming operation. Regardless of where the bottleneck appears, the responsible officer must work out a quick, sensible, feasible, and safe solution.

REARMING TECHNIQUES

Various techniques are used in the arming and rearming of aircraft aboard present day carriers. One system utilizes the assigned squadron crew to load any and all types of ammunition by type of aircraft (such as fighter, heavy attack, and light attack). This method is designed to reduce confusion and to eliminate extra loading checks on a single aircraft.

Another system utilizes squadron ordnance crews to load only one type of ammunition such as rockets, bombs, or missiles. This system is designed to speed up operations by having more than one crew loading at the same time on the same aircraft.

A third system may require that the "ships company" aviation ordnance crew assist or even load certain aircraft in the event of numerous casualties or shortage of personnel in squadron ordnance crews. The choice as to the system used should be determined largely by prior observation (during arming and rearming drills) of the rearming crews and local considerations. However, any proficient system can be successfully used in combat, provided full cooperation is achieved at all levels of arming or rearming operations.

Several factors influence the techniques used for arming or rearming. They include the following:

1. Air wing's strict enforcement of timing of return flights according to schedule.
2. Speed of respots (rearming should continue during respot whenever possible).
3. Immediate status of returning aircraft made known to the rearming ordnance crews.
4. The corrective system used in regard to malfunctions of gun, rocket, bomb, missile, or other systems requiring corrective work.

Usually a period of 20 minutes to 1 hour is available for rearming a strike group. It is essential that all possible aids be used to speed up rearming. Such aids include special handling equipment, ready accessibility of ammunition, and efficient use of the bomb elevators.

To prevent rearming of aircraft that are "down," close cooperation between the aircraft maintenance officer and the rearming crews is essential. One method is to delay rearming until the maintenance officer receives word from his crews concerning the status of each aircraft ("up" or "down").

This method may call for rapid loading in the event the aircraft comes "up" just before launch.

TIMING FACTORS

It cannot be too strongly emphasized that timing difficulties rarely occur during arming and rearming of strike missions if assembled ammunition is made available on the flight deck as rapidly as the rearming crews can load the aircraft. The entire operation can be expedited by having nominal amounts of preassembled aircraft ammunition in prescribed spaces.

All possible assistance in regard to number of personnel, handling equipment, changes in ammunition requirements, etc., should be given to the responsible petty officers in the assembly area. The type of aircraft ammunition being used will determine many of the timing factors.

The responsible Aviation Weapons Officer must acquire accurate knowledge of the time required for the various rearming operations. During a day's activities when the required load may be changed suddenly and without notice, he may need to know how long it will take to rearm a group of aircraft with a modified or a complete change in ordnance load. It is essential that the time required be estimated within a few minutes; the ability to estimate the efficiency of crews at times when fatigue is an important factor is essential. Time studies should be made by holding numerous practice and training drills in which actual combat conditions are simulated.

Dearming may be ordered if an enemy raid appears imminent while a strike is loaded or partially loaded. At such a time, or when a fire breaks out, jettisoning of exposed ammunition may be ordered by the commanding officer in order to clear the flight and hangar decks for safety of the ship as well as personnel, particularly if time is insufficient to return ammunition to the magazines.

Under these conditions, speed is a vital factor. Whenever jettisoning is anticipated, such preparatory steps as rigging bomb jettison ramps, manning jettison stations, etc., should be accomplished as soon as practical. Ordnance personnel should be familiar with the location of jettisoning facilities. Each man should be impressed with the necessity for speed (but not carelessness) when a dearming order is issued.

CLOSE LIAISON WITH SQUADRON ARMAMENT OFFICERS

A closely knit working arrangement between the G Division and squadron personnel is of the utmost importance. The G Division organization on all carriers is designed to serve the respective squadrons based aboard. Aviation Weapons Officers have the responsibility to see that the best possible service is rendered to the embarked squadrons at all times.

On some carriers, squadron weapons officers are placed in charge of the armories while the air wing is based aboard; on other ships, these officers simply act as liaison personnel between the squadron commanders and pilots and the permanent Aviation Weapons Officers based aboard. It behooves the Aviation Weapons

Officer to maintain close contact with squadron weapons officers to ascertain that their needs and problems are resolved to the greater extent possible.

Aviation Weapons Officers should also be in close working contact with the individual squadron rearming crews through their assistants (chiefs, petty officers, etc.) to be constantly informed of the individual crew rearming progress as required.

OTHER DUTIES

Other duties that can be expected by Aviation Weapons Officers afloat include supervision of maintenance of aviation ordnance equipment, administrative duties, supervision of ammunition replenishment, and, of course, military duties including officer of the deck (OOD) watches, interdepartment duties, etc. The above listed duties plus other helpful information are discussed in the following paragraphs.

Whenever the ship makes port, replenishment of maintenance spare parts becomes a highly important duty and requires prompt liaison with the supporting activity ashore to insure that requirements are filled and that every obtainable item reaches the ship before departure. This may require direct contact with the shore supply personnel to ascertain that all priority requisitions are approved and filled.

An inventory record should be maintained by a responsible Aviation Ordnanceman and the ship's supply personnel to reflect the available stock of every aviation ordnance item. This is based initially on allowance lists and, if properly maintained, will show needed replenishments. Although a qualified Aviation Ordnanceman has been delegated this assignment, an Aviation Weapons Officer should maintain a close interest in the problem with special regard to stock numbers, new items, modifications, availability, and the differences in performance of certain items.

MAINTENANCE RESPONSIBILITY

As delegated by the carrier's weapons officer, maintenance responsibility of general aviation ordnance equipment rests with the Aviation Weapons Officers. This equipment includes such items as bomb containers, SCAR rails, hoists, slings, bomb skids, and missile skids. This may appear as a minor responsibility at first; however, present attack carriers require well over 200 skids of various sizes alone, not to mention the numbers of other equipments required. A working arrangement to provide a periodic system of preventive maintenance of this equipment should be devised and carefully followed.

Although aircraft armament maintenance responsibility is vested in the respective squadron weapons officer, ships company Aviation Weapons Officers are duly concerned with any major problems or deficiencies that may occur within an attached squadron, that may lessen the carriers overall offensive potential.

The importance of maintaining aviation ordnance and armament equipment in first class combat condition at all times (import or at sea) cannot be overemphasized.

Making a maintenance program effective requires constant on-the-job supervision and either daily or periodic visual inspections by those delegated maintenance responsibilities.

ADMINISTRATIVE DUTIES

Administrative duties of Aviation Weapons Officers afloat or ashore are enormous in variety and scope. These duties range from routine paperwork to detailed step-by-step voluminous requisitions, records, reports, and other management responsibilities.

The administrative duties of the Aviation Weapons Officer afloat are similar to his duties ashore. In an effort to avoid duplication of outlining similar administrative duties afloat and ashore, coverage of administrative duties is not included in this chapter. Consequently, the reader is referred to chapter 3 (Aviation Ordnance Management) of this text for detailed coverage of this subject.

AMMUNITION REPLENISHMENT RESPONSIBILITY

Replenishment of aircraft ammunition is basically the responsibility of the ship's weapons officer. However, delegated responsibility and authority require an Aviation Weapons Officer to render any assistance needed. He can best do this by being acquainted with pertinent aircraft ammunition allowance lists and BuWeps Instructions dealing with current allowances. He should also be familiar with the locations of all magazines and should know their normal contents.

The Aviation Weapons Officer should be prepared to give assistance to the ship's weapons officer in working out the following details of replenishment:

1. Amount and types of ammunition to order.
2. Order of loading.
3. Assignment of G Division personnel to working parties.
4. Arrangement for stowage of the most commonly used ammunition in the most accessible magazines.

MILITARY DUTIES

An Aviation Weapons Officer is normally assigned as the weapons department duty officer once every 4 or 5 days. At sea, this duty ordinarily involves supervising the assignment of weapons department personnel to working parties when required, and in making the necessary reports to the weapons officer.

In port, when frequent working parties are essential for the loading of stores, arranging for the weapons department quota of such parties will take more time and attention. The weapons department duty is normally for 24 hours, or as the ship's executive officer designates.

In port, the Aviation Weapons Officer may stand officer of the deck watches. This is normally a 4-hour tour which requires knowledge of shipboard routine and involves duties such as the problems of military courtesy and of scheduling liberty boats for the men and motor launches for shore leave for officers, both from and to the ship.

Another important military duty is keeping all spaces clean and shipshape. Daily inspections of most assigned spaces, especially berthing spaces, are required. One method of meeting this requirement is to delegate some of the responsibility for these inspections to senior petty officers. It is essential that the Aviation Weapons Officer be thoroughly familiar with all assigned spaces, including passageways, ladders, cages, etc. A report on the material condition of all assigned spaces is submitted weekly to the weapons officer.

Frequent inspections of the crew at quarters are also desirable to maintain a neat appearance of the personnel of the various divisions of the weapons department.

DELEGATION OF RESPONSIBILITY

In the foregoing outline of duties, questions may arise as to how delegation of the various responsibilities can be assigned to key personnel. Any assignment of responsibility must be flexible and subject to revision whenever desirable for efficient operation of the division. One rule is that all division matters should be cleared by the officers and chiefs assigned particular responsibility. By respecting this chain-of-command principle, full cooperation and continuity of action and responsibility can be maintained.

MISCELLANEOUS RESPONSIBILITY

The Aviation Weapons Officer has cognizance of all aircraft pyrotechnics (which includes aircraft flares, signal cartridges, drift signals, smokescreen equipment, etc.). He is also responsible for maintaining some of the equipment employed for their release or discharge and also the above deck stowage spaces for pyrotechnics. The air wing commander ordinarily makes pyrotechnic requirements known to the Aviation Weapons Officer who, in turn, obtains them as needed for installation in aircraft. Requirements for pyrotechnics may also appear in the daily flight schedule.

Aircraft frequently return to the ship with unexpended bombs, rockets, missiles, etc. When this occurs, such unexpended ammunition is defuzed and removed from the aircraft. The various components are then disassembled and returned to the appropriate magazines. Occasionally, because of malfunctioning of the equipment, aircraft return with "hung ordnance." These may drop from the aircraft on landing and, if they detonate, may cause severe injury to personnel and material damage.

It is the duty of the bomb disposal officer, or his assistants, to determine the condition of damaged ammunition and dispose of it in the manner prescribed.

Elevators must be checked periodically to maintain them in prime condition. During a rearming operation requiring bombs and rockets, one or more of the bomb elevators may fail mechanically or electrically. Failure may occur when foreign objects such as bomb truck handles, tail vanes, wind-blown objects, etc., are jammed under the elevator platform. Serious consequences follow if the time element is vital and the burden of delivering the needed ammunition to the flight deck falls on the remaining elevator or elevators.

PERSONNEL RELATIONS

Regardless of how pressing technical, tactical, or supply problems become, the Aviation Weapons Officer should not forget the personal welfare of his men. Men usually respond generously when small wants are cared for; they particularly appreciate receiving food and protective clothing when needed and recognition when is it deserved.

Details that seem trifling on the surface may appear large in the minds of men who are unavoidably called upon to give long hours and extra effort during ordnance flight operations. A positive check that G Division personnel have been issued the required special clothing and in the correct sizes and quantities aids crew morale greatly. Such clothing includes foul-weather gear, lifebelts, helmets, proper jerseys, flashproof clothing, goggles, noise suppressors, heavy underwear, and other essentials for comfort and safety.

Working parties should always be equitably assigned; such assignments can occasionally be used in disciplining personnel, who continuously commit minor infractions of the ship's regulations.

The Aviation Weapons Officer is responsible for insuring that the enlisted personnel in his unit receive proper training to enable them to advance in rating. This requires extra effort, thought, planning, personal interviews, and an integrated training program. Personal needs such as adequate berthing, recreational facilities, emergency leave, liberty, regular leave, time off to attend church services, and individual personal problems of his men will require much of the Aviation Weapons Officer's attention and time.

CHAPTER 8

EXPLOSIVES AND AMMUNITION

In the Navy the term ammunition applies to:

1. All component parts and substances which when assembled form a charge, a complete round, or a cartridge for a small arm, gun, cannon, or for any other weapon; or for explosive actuated device, impulse device, torpedo warhead, mine, bomb, depth charge, fuze detonator, projectile, rocket, or guided missile.
2. All solid propellants.
3. Hypergolic (capable of spontaneous combustion on contact) liquid propellent systems.
4. All other hazardous materials applied to ordnance uses and/or requiring surveillance for reasons of explosive safety.
5. JATO boosters, sustainers, military pyrotechnics, and offensive type chemical warfare materials.

To understand the composition and function of a complete round of ammunition, a basic knowledge of the characteristics and uses of military explosives is necessary. The demands for ammunition capable of fulfilling the many requirements of the Navy necessitates the employment of several kinds of explosives. Each explosive performs in a specific manner. Thus, the explosive used to burst a forged steel projectile would not only be unsuitable for ejecting and propelling projectiles and missiles, but also would be highly dangerous. Similarly, the explosive used in initiators, such as in primers and fuzes, are so sensitive to shock that only small quantities can be used safely.

Personnel not familiar with ammunition, or untrained in its use and handling, are normally afraid of the possibility of an explosion. However, when handled in accordance with the prescribed regulations, ammunition is relatively safe. Safety regulations are set forth in numerous publications such as U.S. Navy Regulations, Ordnance Publications (OP's), pertinent BuWeps Instructions, etc. Many of the regulations and precautions embody the lessons learned as a result of actual disasters. They must be obeyed without exception and cannot be changed or disregarded.

EXPLOSIVES

BuWeps Ordnance Pamphlet OP 4 (Ammunition Afloat) defines the word explosives, if used without further qualification, as those substances or mixtures of substances which, when suitably initiated by flame, spark, heat, electricity, friction, impact, or similar means, undergo rapid chemical reaction resulting in the rapid release of energy. The release of energy is almost invariably accompanied by a rapid and pronounced rise in pressure. The rise in pressure usually, but not necessarily, is a consequence of the rapid generation of gas in much larger volume than that originally occupied by the explosive. Thus, the word explosives when used in this broad sense includes propellants, high explosives, primary explosives, incendiary compositions, priming mixtures, booster explosives, pyrotechnic compositions, dynamites, and others.

An explosion is defined as a practically instantaneous and violent release of energy. It results from the sudden chemical change of a solid or liquid substance into gases. These gases, expanded by the heat of the chemical change, exert tremendous pressure on their container and surrounding atmosphere.

CHARACTERISTICS

The chief characteristic which distinguishes an explosion from ordinary combustion, such as the burning of coal, is the high velocity of the explosive reaction.

Each explosive has different characteristics, which have been analyzed and studied in great detail by experts. In this text the characteristics with which we are mainly concerned are rate of detonation and sensitivity.

Rate of Detonation

The rate of detonation of an explosive is an important characteristic and may be defined as its burning speed. Some explosives burn slowly while others burn very rapidly. Explosives that burn very rapidly are said to detonate and are called high-order explosives. Explosives which burn slowly are called low-order explosives; however, they are slow only when compared with explosives which detonate.

Although the word burning is used to describe an explosion, the process is quite different from burning of the usual sort. Ordinary burning, such as the flame of a match, can only take place in air, or more exactly, in the presence of oxygen which constitutes 20 percent of air. Explosives and propellants are manufactured so that the oxygen necessary for the burning is contained in the explosive proper and is in a very concentrated form.

The reaction of an explosive depends considerably on the conditions under which the explosion takes place. Factors that affect the burning rate or velocity of detonation include the size and shape of the explosive, temperature, moisture content, age, etc. An explosive that burns under one condition may detonate under other conditions. When a low-order explosive burns, it builds up pressure slowly and at a controllable rate, whereas, when a high-order explosive detonates, pressure is built up instantaneously.

Sensitivity

Sensitivity which is of great importance in military explosives may be defined as the ease with which an explosive can be detonated. Explosives must be safe to handle and in some cases, able to withstand severe shock before the start of the chemical reaction or detonation. The strength of the impulse required to explode or set off an explosive may vary considerably. Some may be exploded by the slightest touch; others require a moderate blow or flame, and still others require a violent blow and cannot be exploded in the open by a flame. However, if a substance is so unstable as to react in response to a slight blow, friction, or pressure, it cannot have a practical application as a military explosive.

It was once considered that the power of an explosive was measured by its sensitivity and that the most powerful explosives were quite sensitive. It has been found, however, that insensitive explosives can be produced which are also quite powerful, and that the safest explosives are those which, under ordinary circumstances, require a detonator to initiate the reaction.

EXPLOSIVE TERMS

High-order detonation—a complete detonation of a mass of high explosive at maximum rate.

Low-order detonation—an incomplete detonation of a mass of high explosive, or one which progresses at a low rate of detonation. Causes of low-order detonations are: improper initiation, improper confinement of the explosive, deterioration of one component of the explosive mixture, poor contact between the steps of the explosive train (fuze, detonator, booster, etc), low density of the shell filler (manufacturing defect), exudation or oozing out of an oily liquid component of the explosive. A low-order explosion may be detected by the color of the smoke produced: white or yellow smoke for low order and black smoke for high order.

Brisance—the shattering ability of a high explosive. When it is desired that a projectile explode and scatter lethal fragments, an explosive with high brisance is needed. Shatter ability depends more on rate of detonation than on strength, or power, which is measured by the quantity of heat or gas given off. The more brisant an explosive is, the weaker it is as a general rule.

Stability—the ability of the explosive to remain unaffected by storage conditions. Some explosives (like smokeless powder) decompose with age, even under the best of conditions, and require frequent checking.

Power—the power of an explosive is its rate of doing work. It is dependent on the velocity of detonation and strength.

Strength—an explosive's ability to do work. It is the amount of energy liberated by the explosion. In military applications, strength is measured by the amount of material it can move or displace.

Load density—the weight of the explosive per unit volume. A cast explosive has a high load density—you can put more of it in a given space than if it were in powder form.

Hygroscopicity—the tendency of a material to absorb moisture. Since moisture reduces the sensitivity of an explosive, or affects it adversely in other ways, explosives must be protected from moisture absorption to prevent deterioration.

Blast—the shock wave (usually).

Shock—the values of pressure, etc., at the front of the shock wave. Different targets, both above and below the surface, respond mainly to either the shock front or to the whole shock wave.

CLASSIFICATION

At one time, explosives were commonly divided into two categories, designated high explosives and low explosives. High explosives were those which could be made to detonate and whose use depended on this characteristic. Low explosives were those which could be made to detonate only by application of very strong shocks, or not at all, and whose use depended on some other characteristic, usually that of burning in a rapid, controllable, and reproducible manner. This classification of explosives is no longer used in connection with strictly military applications. However, this classification has been retained in connection with commercial shipping regulations where a high explosive is defined as one which can be detonated by a commercial blasting cap, a low explosive as one which cannot. In military applications, the term high explosive is still used but with a somewhat different meaning. Many of the explosives formerly called low explosives are now called propellants, but the term propellant is not synonymous with low explosive.

Classification of explosives thus far has been based on characteristics. A more practical classification from the standpoint of the Aviation Weapons Officer is based on their military use. These classifications are:

1. Propellants.
2. Initiators.
3. Auxiliary charges.
4. Filler charges (main or burster).

Propellants

The primary function of a propellant is to provide pressure which, acting against an object to be propelled, will accelerate the object to the required velocity. This pressure must be so controlled that it will never exceed the strength of the container in which it is produced, such as guns, rocket motor housings, pyrotechnic pistols, line throwing guns, etc. In addition, propellants must be comparatively insensitive to shock.

If the burning speed could be controlled, it would be possible to use any explosive for propellent purposes. Since this is impossible, low explosives are used exclusively for propellants.

Propellants may be either liquid or solid in form. Many solid propellants have a nitrocellulose base. Various organic and inorganic substances are added to the nitrocellulose base during manufacture to give improved qualities for special purposes.

Propellants are classified by such terms as single-base, double-base, and composite. Single-base propellants include compositions that are principally gelatinized nitrocellulose and contain no high explosive ingredient such as nitroglycerin. Double-base propellants are mainly compositions that are predominantly nitrocellulose and nitroglycerin. Composite propellants are compositions that contain mixtures of fuel and inorganic oxidents but do not contain a significant amount of nitrocellulose or nitroglycerin. There are also combinations of composite and double base propellants.

Solid propellants are manufactured in the form of flakes, balls, sheets, cords, or perforated cylindrical grains. They are made in various shapes to obtain different types of burning actions. The cylindrical grains are made in various diameters and lengths, and with various numbers of holes or perforations. (See fig. 8-1.) The different types of burning actions are degressive, neutral, and progressive.

A propellant is said to be degressive burning when the surface area of the grains decrease as they burn. An example of a neutral burning grain is a single perforated grain whose inner surface increases and its outer surface decreases as it burns. The result of these two actions is that the total surface remains the same. As a multiperforated grain burns, its total burning area increases since it burns from the inside and outside at the same time. Thus, it is called progressive burning.

There are six predominant propellants generally used by the Navy at the present time. They are:

1. Black powder.
2. Smokeless powder.
3. Pyro powder.
4. Ballistite.

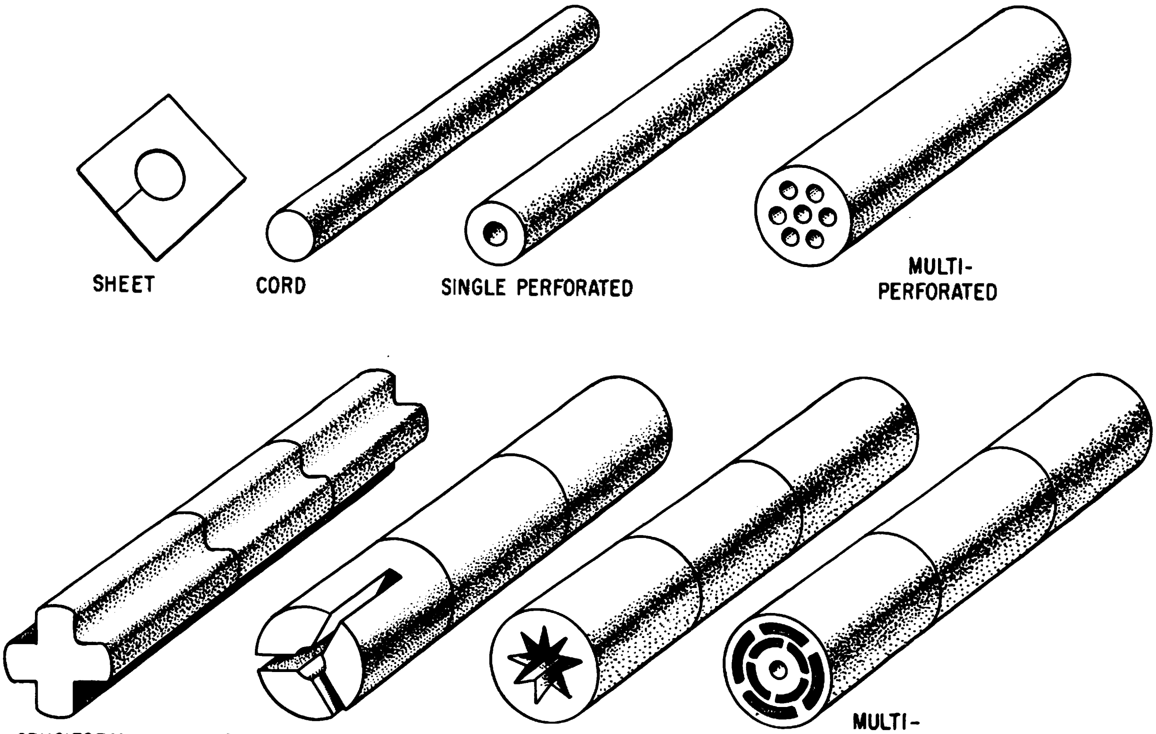


Figure 8-1.–Shapes and forms of propellent grains.

5. Cordite N (SPCG).
6. Composites.

Initiators

As the term implies, initiators are used to initiate combustion of low explosives or to detonate high explosives. Depending upon their use they are called primers or detonators. The primary high explosives mentioned previously in this chapter are employed in initiators. When initiating explosives are acted upon by heat, impact, or friction they explode whether they are confined or not. They also differ considerably in sensitivity, brisance, and amount of heat given off. Currently used initiating explosives are mercury fulminate, lead azide, lead styphnate, tetracene, and diazodinitrophenol.

PRIMERS.–A primer is a device used to initiate the burning of a propellent charge by means of a flame. It consists of a small quantity of extremely sensitive high explosives. In general primers are classified in accordance with the method of initiation, such as percussion, electric, friction, chemical, etc. A percussion primer, upon being struck by the firing pin of a gun, will detonate and thus produce the flash of flame needed to ignite the propellent charge. All primers function in a similar manner when initiated. Primers may also be used to initiate detonators.

DETONATORS.–Detonators are used in initiating high explosive bursting charges as opposed to propellants. They are similar to primers inasmuch as they also contain a small quantity of extremely sensitive high explosives. Detonators are also classified in accordance with the method of initiation.

Auxiliary Charges

In many instances an intermediate or auxiliary charge is needed between the initiator and the main charge of explosive to insure successful initiation. Thus, the principle of chain reaction is often used in setting off explosives and is called the explosive train. There are two main types of explosive trains, depending upon whether the main charge is a propellant or a bursting charge. Therefore, two types of auxiliaries are used which are called igniters and boosters.

IGNITERS.—For a large propellent charge, the auxiliary is called an igniter. When the primer is set off, the flame from it ignites the charge in the igniter which produces enough flame to engulf the propellant. Thus, the explosive train used with a propellant consists of a primer, an igniter, and a propellent charge. Explosives used in igniters are perchlorate pellets, black powder, and various other combinations.

BOOSTERS.—An auxiliary charge when used with a bursting charge is called a booster. It consists of a moderately sensitive high explosive to increase the shock of the detonator. They are necessary because of the relative insensitivity of the main charge used in some projectiles. Explosives used in boosters are granular TNT, tetryl, PETN, and tetrytol. (NOTE: Explosives used as boosters in large projectiles may serve as bursting charges in smaller ones.)

The basic high explosive train consists of the detonator, booster, and bursting charge. However, high explosive trains are often compounded by the addition of auxiliary boosters, time delays, and primers. Such a train might be as follows–primer, delay pellet, detonator, booster, auxiliary booster, and main bursting charge. However, this example is the extreme. (See fig. 8-2.)

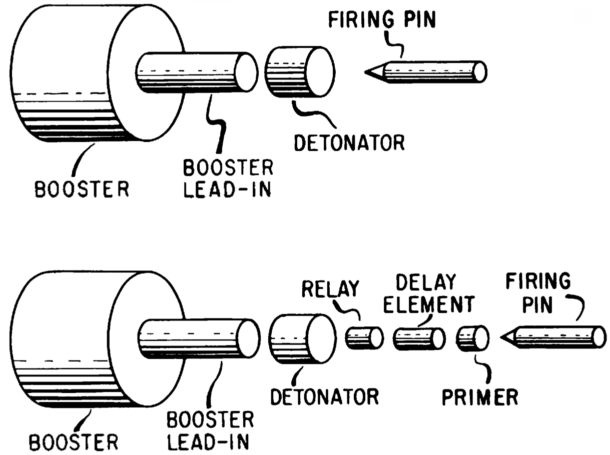


Figure 8-2.—Typical high explosive trains.

Filler Charge

The filler charge (bursting) for projectiles or various type bombs, mines, torpedo warheads, and other bomb type ammunition is always a high explosive. Filler substances must fulfill certain requirements for military use. In general, they must do the following:

1. Be insensitive enough to withstand the shock of handling, of being fired from a gun, and of impact against armor.
2. Have maximum explosive power.
3. Have stability to withstand adverse storage conditions.
4. Produce proper fragmentation.
5. Be inexpensive and easy to manufacture from readily available materials.

The substance most nearly fulfilling all of these conditions might be considered the best filler explosive; however, the specific purpose to be served must be considered. For example, a filler charge used in a projectile must fulfill all of the foregoing conditions, whereas a mine or torpedo warhead filler need not be so insensitive as to withstand armor impact. However, for mines and torpedoes, the tendency of the filler not to absorb moisture and its maximum power would be the most important characteristics.

Thus, compromises have to be made to a certain point, provided no safety factor requirement is overlooked.

High explosive charges are loaded into their containers by one of three methods: cast-loaded, press-loaded, and extrusion. Cast loading is performed by pouring the substance as a liquid into a container and letting it solidify. Explosives having no liquid form must be press-loaded, or pressed into their container. The combining of certain explosives result in plastic mixtures that can be loaded only by the extrusion method. The extrusion method employs a pressure system for forcing the plastic mixtures into the various types of projectiles and bomb castings. A simple analogy of the extrusion method is the use of a grease gun in forcing heavy grease into the joints of an automobile.

SERVICE EXPLOSIVES AND THEIR USE

Service explosives as used in the Navy are varied and are constantly undergoing changes. However, there are certain basic explosives that have become fairly standard throughout the Navy. A few of the more pertinent explosives and their uses are discussed in the following paragraphs.

PROPELLANTS

In this section some of the low explosives used by the Navy as propellent agents are discussed. All of these propellants are solid substances; each with specific properties and uses. The propellants discussed are black powder, smokeless powder, pyropowder, ballistite, and cordite N (SPCG). The latter three propellants are a form of smokeless powder.

Black Powder

Black powder, the oldest explosive known, is a uniform mechanical mixture of finely pulverized proportions of: saltpeter (potassium nitrate or sodium nitrate)–75 percent; charcoal–15 percent; and sulfur–10 percent. Prior to the development of nitrocellulose propellants, black powder was the only propellent explosive available. Potassium nitrate (or sodium nitrate) is currently used in most military black powders. It ignites spontaneously at about 300°C (572°F) and develops a fairly high temperature of combustion (2,300° to 3,800°C) which causes erosion in the bore of weapons Black powder is usually in the form of small, black grains that are polished by glazing with graphite. It is hygroscopic and subject to rapid deterioration when exposed to moisture. If kept dry, it retains its explosive properties indefinitely. It is one of the most dangerous explosives to handle because of the ease with which it may be ignited by heat, friction, or sparks.

Although black powder has been replaced by single-base, double-base, and composite propellants, it is used by the Navy for the following purposes:

1. Delay elements in fuzes.
2. Igniters (in large-caliber gun ammunition and jet propulsion units).
3. Impulse charges for surface torpedo tubes and depth-charge projectors.
4. Saluting charges and pyrotechnics.

CAUTION: Black powder is particularly sensitive to shock, friction, heat, flame, or spark. It is the most dangerous explosive in service use and must be handled with extreme caution.

Smokeless Powder

The first smokeless powder was made by a Major Schultze, of the Prussian Artillery in 1864. It was made of nitrated wood impregnated with saltpeter. The basic component of modern smokeless powder is vegetable fiber (generally cotton), nitrated, purified, mixed with ether and alcohol, molded into grains and dried. The resulting powder is a low explosive which will burn instead of detonate.

Smokeless powder is used almost exclusively as the propellant for gun and rocket ammunition. The powder is generally considered to be of three types: single-base, double-base, and multibase powder. Pyropowder, ballistite, and cordite N, respectively, are examples of each.

Smokeless powder is obviously a more effective propellant than black powder, and is far less sensitive, tricky, and dangerous to handle. It has the following characteristics:

1. Burns evenly.
2. Noncorrosive; it does not react to metals.
3. Gives off large quantities of gas during burning, which is highly desirable in a propellant.
4. Leaves little residue or ash.
5. Is somewhat hygroscopic and tends to deteriorate as it becomes moist.

There are certain volatile ingredients in smokeless powder which tend to evaporate when the powder is exposed. It must be stored in airtight, moisture-proof containers. Powder magazines should therefore be checked daily, for condition of powder containers, for maintenance of proper temperature (below 90°F–ideal storage temperature is 60°F), and for evidences of deterioration of powder.

Other recent developments have resulted in several new classifications of smokeless powder; notably, smokeless powder nonhygroscopic (NH) (which does not absorb water readily) and smokeless powder flashless nonhygroscopic (FNH).

Pyropowder

Pyropowder is a single-base powder composed of cellulose obtained from highly purified cotton. The nitration process turns the cotton into an explosive compound which is called by various names—pyrocellulose, nitrocellulose, or guncotton.

Newly made pyropowder has a hard, hornlike finish and varies in color from a light ivory to a fairly dark brown. It tends to darken with age; however, this is not necessarily a sign of deterioration. Softness or mushiness is a sign of deterioration.

Pyropowder is superior in almost every way to black powder. Its relatively slow burning produces steady gas pressures that "follow through" on the projectile all the way through the gun bore. It is less sensitive to shock, flame, and moisture. It makes less smoke and flame and has far less tendency to leave unburned residue to foul the gun bore.

Excessive heat has an unfavorable influence upon the stability of smokeless powder. At temperatures below 60° F, the stability is not appreciably affected, but at temperatures above 70° F, the rate of decomposition rises quickly. It becomes high at 90° F and dangerously high above 100° F. Precautions must therefore be taken to insure the maintenance of a uniformly low temperature in the magazines where it is stored.

Ballistite

Ballistite is a double-base powder used as a rocket propellant. It is composed of two explosive substances blended together—60 percent nitrocellulose, 39 percent nitroglycerin, and 1 percent diphenylamine, which acts as a stabilizer. It burns with a considerable amount of flash and smoke, and generates a great volume of gas. Ballistite burns progressively but at a slower rate than gunpowders. The rate of burning is dependent upon the composition and physical characteristics of the powder grain, the temperature of the powder grain before ignition, and the pressure during reaction. It is produced in various shapes to fit the rocket motor housing, and is ignited by the flash of a black powder charge which in turn is ignited electrically. Obvious disadvantages are the telltale flash and black smoke.

Ballistite is less hygroscopic than single-base powders and is relatively insensitive to shock and friction. Its natural color is amber to gray-green to black. However, its color may be altered by the addition of coloring.

One to four grains of ballistite propellant are used as the propelling charge in a rocket motor. The grains are designed to burn at a uniform rate to provide a uniform thrust during burning. The cruciform grains are provided with suitable plastic inhibitor strips to maintain a constant burning area or limit the burning area. The inhibitor strips are bonded to the grains. The star perforated and multiperforated propellent grains are inhibited with a plastic wrap, cemented as it is applied.

Cordite N (SPCG)

Cordite N is used as a propellant in aircraft gun ammunition. Cordite N is a third type of smokeless powder often called SPCG. It differs in composition and color from pyropowder, which contains but one explosive component, and is termed a triplebase powder. It actually contains three main explosive components. These components are nitroguanidine 55 percent, nitrocellulose or pyrocotton 19 percent, and nitroglycerin 18.7 percent. The remaining 7.3 percent is the stabilizer, called carmite or ethyl centralite. Cordite N is very cool burning with little smoke and no flash, and has a higher velocity or burning rate than ballistite.

Cordite in its original form was developed by the British. However, this old type of cordite had the serious disadvantage of a high burning temperature, which caused excessive erosion of the gun bore and chamber. Cordite N (SPCG) avoids this drawback because its composition includes a relatively large proportion of nitroguanidine, a cool-burning explosive. This reduces the burning temperature to a value comparable to that of pyropowder.

SPCG is made in the same grain sizes and perforations as pyropowder, and gives similar performance ballistically. In general, SPCG is handled and governed by the same regulations as other smokeless powder, except for the routine tests made to ascertain its condition. SPCG is chalk-white and opaque when new and yellows slightly with age. After prolonged deterioration, SPCG darkens to brown and tends to scale off. However, SPCG deteriorates at a much slower rate than diphenylamine-stabilized powder.

INITIATING EXPLOSIVES

The explosives used as initiating explosives are the primary high explosives mentioned previously in this chapter. The high explosives are used in varying amounts in the different primers and detonators employed by the Navy, and therefore differ considerably in sensitivity, brisance, and the amount of heat given off. The explosives discussed in this section are mercury fulminate, lead azide, lead styphnate, tetracene, and diazodinitrophenol (DDNP).

Mercury Fulminate

Mercury fulminate is a heavy, practically nonhygroscopic, crystalline solid. When dry it is very sensitive to heat, friction, spark, flame, or shock. The sensitivity is so great that accidents, especially in manufacture, are numerous. When wet it is not exploded by a spark or by ordinary shock but wet fulminate may be detonated by the explosion of dry fulminate and other explosives. Mercury fulminate is soluble in pyridine, potassium cyanide, ammonia, concentrated hydrochloric acid, sodium thiosulphate, hot alcohol, and only slightly soluble in water.

Mercury fulminate does not react readily with metals. However, the free mercury, which is always present in it in small quantities, amalgamates with copper and brass, especially in the presence of moisture. Mercury fulminate detonates completely and with great violence on ignition by means of flame or by means of an electrically heated wire. Compared to high explosives, it has lower power and brisance, a fact which is indicated by its velocity of detonation of 16,500 fps. Its color is white when pure, but ordinarily it has a faint brownish yellow or grayish tint.

In primers, mercury fulminate may be mixed with other flame-producing materials, such as potassium chlorate and antimony sulfide. The melting point of mercury fulminate is much too high for it to be cast, and it is press-loaded into caps. It is usually compressed at pressures of approximately 3,000 to 10,000 psi.

Mercury fulminate can be kept for long periods both dry and wet without appreciable change, provided it is properly manufactured and stored. However, when subjected to elevated temperatures in either the wet or the dry state, gradual deterioration takes place and by the end of three years it may have become useless.

Lead Azide

Lead azide has a high temperature of ignition and is less sensitive to shock and friction than mercury fulminate. The brisance of lead azide increases as the pressure applied to it increases. It is less brisant and has less explosive power than mercury fulminate.

Lead azide is poisonous, slightly soluble in hot water and in alcohol, and very soluble in a dilute solution of nitric or acetic acid in which a little sodium nitrate has been dissolved. Lead azide reacts with copper, zinc, cadmium, or alloys containing such metals, forming an azide which is more sensitive than the original lead azide. Lead azide does not react with aluminum, and detonator capsules for lead azide are made of this metal. The hygroscopicity of lead azide is very low. Water does not reduce its impact sensitivity, as in the case with mercury fulminate. Ammonium acetate and sodium dichromate are used to destroy small quantities of lead azide. The velocity of detonation of lead azide is approximately 17,500 fps. Its color varies from white to buff.

Lead azide may be used where a detonation is caused from flame or heat. Lead azide has been adopted as the detonator of major-caliber base detonating fuzes, or point detonating fuzes, and of auxiliary detonating fuzes. It is also used in priming mixtures.

Lead azide is completely stable in storage even at elevated temperatures.

Lead Styphnate

There are two forms of lead styphnate: the normal which appears as six-sided monohydrate crystals; and the basic which appears as small rectangular crystals. Lead styphnate is particularly sensitive to fire and the discharge of static electricity; when dry, styphnate can be readily ignited by static discharges from the human body. The longer and narrower the crystals, the more susceptible the material is to static electricity. Lead styphnate does not react with metals. It is less sensitive to shock and friction than mercury fulminate or lead azide. Lead styphnate is slightly soluble in water and methyl alcohol and may be neutralized by a solution of sodium carbonate. The velocity of detonation is approximately 17,200 fps. The color of lead styphnate varies from yellow to brown. Lead styphnate is used as a component in primer and detonator mixtures. It is stable in storage even at elevated temperatures.

Tetracene

Tetracene is a colorless or pale yellow material. It is soluble in strong hydrochloric acid but practically insoluble in alcohol, water, benzene, ether, and carbon tetrachloride. Tetracene is only slightly hygroscopic. It explodes readily from flame, producing a large amount of black smoke. Tetracene is slightly more sensitive to impact than mercury fulminate. The brisance of tetracene, if it is used alone, is greater when the tetracene is not compressed. Tetracene is more brisant when initiated by tetryl or mercury fulminate than when self-initiated by fire.

When used as a detonator, tetracene is mixed with other initiating explosives to increase the sensitivity of the latter to flame or heat.

Tetracene is stable at ordinary temperatures either in the wet or dry state.

Diazodinitrophenol (DDNP)

Diazodinitrophenol (DDNP) is a yellowish brown powder. It is soluble in acetic acid, acetone, strong hydrochloric acid, and most of the solvents, but insoluble in water. A cold sodium hydroxide solution may be used to destroy it. DDNP is desensitized by immersion in water and does not react with it at normal temperatures It is less sensitive to impact but more powerful than mercury fulminate and lead azide. The sensitivity of DDNP to friction is much less than that of mercury fulminate but approximately the same as that of lead azide.

DDNP is used with other materials to form priming mixtures, particularly where a high sensitivity to flame or heat is desired.

DDNP is stable in storage even at elevated temperatures.

BOOSTER EXPLOSIVES

The explosives used as booster explosives are less sensitive than the primary high explosives which are employed in initiators, primers, and detonators. However, they are generally more sensitive than those high explosives used as filler charges or bursting explosives. As high explosives used for booster purposes, they fall in the intermediate range of sensitivity. The explosives discussed in this section are tetryl, tetrytol, pentaerythritetranitrate (PETN), and granular TNT.

Tetryl

Tetryl is a derivative of methyl-aniline and is classified as a nitroaromatic compound. Tetryl is a fine crystalline material practically insoluble in water, but soluble in acetone, ammonia, ether, carbon tetrachloride, and benzol. Tetryl melts at about 130°C. Heated above its melting point, it undergoes gradual decomposition, and explodes when exposed to a temperature of 260°C for 5 seconds. Tetryl will corrode steel when in the dry or moist state. It is practically nonhygroscopic (after proper drying), but moisture does interfere with its effectiveness. Tetryl is chemically stable at ordinary temperatures. It is more sensitive to shock or friction than TNT, and more powerful than TNT. Tetryl is more sensitive to detonation by mercury fulminate or lead azide than TNT and is readily exploded by penetration of a rifle bullet. Tetryl can be initiated from flame, friction, shock, or sparks; burns readily; and is quite likely to detonate if burned in large quantities. The velocity of detonation of tetryl is approximately 24,400 fps. When pure, tetryl is light yellow, but is usually gray after loading because of the graphite mixture used in the loading process.

Tetryl is sensitive to mechanical shock, and it is used as a booster charge between the fulminate of mercury or lead azide detonators and the high explosive bursting charge. Tetryl is also used as a filler in small-caliber projectiles. Tetryl is loaded in pellet form, the pellets being pressed after being mixed with small quantities of graphite which serves to lubricate it while it is being pressed.

Tetryl is poisonous when taken internally and causes dermatitis on contact with the skin. Precautions are therefore necessary regarding the handling and packing of the dry material.

Special precautions must be taken to prevent ignition or explosion from friction or blows resulting from rough handling. Tetryl should be kept dry and protected from high temperature and sparks.

Tetrytol

Tetrytol is a cast mixture of tetryl and TNT; 70/30 is a frequent composition. It is designed to obtain a tetryl mixture that may be cast for boosters and demolition charges.

Tetrytol possesses satisfactory storage properties. It is slightly less powerful and less sensitive than tetryl. When dry, tetrytol will corrode aluminum to a slight extent. When moist, it will corrode copper, aluminum, brass, and steel. The melting point of tetrytol varies from 67°C to 116°C, depending on the composition. It is soluble in acetone. The velocity of detonation is approximately 24,000 fps. The color is yellow.

Tetrytol is used in burster tubes for chemical bombs, in demolition blocks, and in cast shaped charges. It cannot be used where the loaded item is immersed in hot explosive, because it will be remelted by the heat and separation of the ingredients will result. It is approved for use in all other boosters.

Pentaerythritetranitrate (PETN)

PETN is nonhygroscopic and possesses satisfactory storage properties. It is appreciably more sensitive to percussion and impact than tetryl and is, therefore, not used alone as a booster. PETN resembles RDX in its characteristics. It is somewhat more sensitive, but almost equal in power and brisance. The tendency of PETN to burn is much less marked than that of similar explosives. The melting point of PETN is 141°C. Since bulk PETN is considered as an initiating explosive by the Interstate Commerce Commission, it must be packed wet. PETN corrodes brass slightly when wet. It is soluble in acetone and can be decomposed by a boiling solution of ferrous chloride. The velocity of detonation of PETN is approximately 26,000 fps. The color of PETN is white.

The main use of PETN alone, in the service, is in primacord. When used alone, PETN is combined with a small quantity of wax to desensitize and lubricate it, and it is loaded by pressing. It is important to know that PETN as loaded in primacord is very insensitive to flame, shock, and friction, and therefore must be detonated by a cap. PETN is being used as a base charge in some compound detonators.

TNT

TNT when in the granular form, rather than crystalline form, is often used as a booster explosive. The detailed discussion of TNT is presented in the section on filler explosives since TNT is also used for that purpose.

FILLER EXPLOSIVES

There are several high explosives currently used by the Navy as fillers for bombs, torpedoes, mines, and shells. The principal explosives are TNT, RDX, and explosive D. These explosives when combined in various percentages and combinations, produce numerous high explosives with varying degrees of sensitivity, brisance, rate of detonation, and other pertinent characteristics. The principal explosives and some of the more common derivative explosives are discussed in the following paragraphs.

Trinitrotoluene (TNT)

TNT is a crystalline substance. The importance of TNT as a military explosive is based upon its relative safety in manufacture, loading, transportation, and storage, and upon its powerful, brisant, and explosive properties. Manufacturing yields are high and production relatively economical. Chemical names for TNT are trinitrotoluene and trinitroluol and other commercial names are Trilit, Tolite, Trinol, Trotyl, Tritolo, Tritone, Trotol, and Triton.

TNT is toxic, odorless, comparatively stable, nonhygroscopic, and relatively insensitive. When pure it varies from white to pale yellow in color and is known as grade A TNT. When the proportion of impurities is much greater, the color is darker, often being brown, and this is known as grade B TNT. It may be ignited by impact, friction, spark, shock, or heat. TNT does not form sensitive compounds with most metals. The melting point varies between 80.6°C for grade A (refined TNT) and 76°C for grade B (crude TNT). TNT does not appear to be affected by acids but is affected by alkalies (lye, washing soda, etc.), becoming pink, red, or brown, and more sensitive. Like most other explosives, but to a greater extent, it is adversely affected by sunlight, becoming darker in color and deteriorating in melting point and purity. It is practically insoluble in water, but soluble in alcohol, carbon tetrachloride, ether, benzene, carbon disulphide, acetone, and certain other solvents. The velocity of detonation is approximately 22,300 fps.

TNT is readily melted and cast into bursting charges for projectiles, bombs, depth charges, warheads, mines, rocket heads, and so forth. Cast TNT is rather difficult to detonate. It usually requires a booster charge of refined, granular TNT or tetryl to insure complete high-order detonation. For fuzes and boosters, a refined, granular TNT is used.

TNT is graded in accordance with Federal Specifications. At the present time, the following grades and forms of TNT are used in the Navy: recrystallized (purified crystals), granular grade A, flaked grade A, and granular grade B. Any of these grades may be melted and cast to become cast TNT, grade A; or cast TNT, grade B. Due to improvements in manufacturing processes and greater ease and economy in producing grade A, little or no grade B TNT is now manufactured.

In a granular or crystalline form, and when unconfined, TNT burns freely and may burn without detonation. However, there are a few instances on record of large quantities detonating after having burned for awhile. In the cast form it will almost invariably detonate in a fire. Thin-walled ammunition such as bombs, depth charges, mines, warheads, and similar ammunitions containing TNT bursting charges; containers of bulk TNT; and demolition charges are subject to sympathetic detonation or detonation en masse. This property makes it necessary to separate TNT storage from other types of explosive storage, especially fuzes and detonators, and from fire hazards which may initiate a detonation. Contrary to the beliefs of many, TNT is not so insensitive that it can be treated roughly with impunity. Instances are on record where small globules have been detonated by scraping them with a knife and where a pipe plugged with TNT detonated when hammered.

Exudate has been known to separate from cast TNT. It may appear pale yellow to brown in color and vary in consistency from an oily liquid to a more viscous one. The amount and rate of separation is dependent primarily upon the purity of the TNT and secondarily upon the temperature of storage. A grade B, low-melting-point TNT may exude considerable liquid and generate some gas. This exudation is accelerated with an increase in temperature.

Pure TNT will not exude, since exudate consists of impurities which have not been extracted in the refining process. Exudate is a mixture of lower melting isomers of TNT, nitrocompounds of tuluol of a lower nitration, and possible nitrocompounds of other aromatic hydrocarbons and alcohols. It is flammable and has high sensitivity to percussion when mixed with absorbents. Its presence does no appreciable harm to the stability, but somewhat reduces the explosive force of the main charge. In some ammunition an inert wax pad is used in the loading operations and in some cases this waxy material may ooze from the case. It should not be confused with the TNT exudate described above. This material should, however, be tested for TNT to confirm its actual composition.

TNT exudate mixed with a combustible material, such as wood chips, sawdust, or cotton waste, will form a low explosive which is highly flammable and ignites easily from a small flame. It can be exploded in a manner similar to a low grade of dynamite, but the main danger is its fire hazard. Accumulation of exudate is considered a great risk, both explosive and fire, and should always be avoided by continual removal and disposal of the exudate as it occurs. Frequent inspection of all cast TNT ammunitions should be made to see that exudate is not present.

The exudate is soluble in carbon tetrachloride, acetone, or alcohol. One of these solvents (taking care to provide adequate ventilation) or clean hot water should be used to facilitate removal and disposal of the exudate. Under no circumstances should soap or other alkaline preparations be used to remove this exudate, as the addition of a small amount of hydroxide, caustic soda, or potash will sensitize TNT and cause it to explode if heated to 160°F.

Amatol

Amatol is not a manufactured product, but a mixture of melted TNT and ammonium nitrate made at the time of loading. The proportions vary from 40/60 to 80/20 ammonium nitrate and TNT, respectively. The power and brisance of amatol decrease with the increasing percent of nitrate, and its sensitivity decreases at the same time.

Amatol is relatively insensitive to friction but can be detonated by severe impact. It has the disadvantage of being hygroscopic and must be protected from moisture. Amatol has good storage properties if it is kept dry. When dry it will corrode steel very slightly; if moist, it will corrode copper alloys. The melting point of 50/50 amatol is 81°C. The velocity of detonation of 50/50 amatol is approximately 19,700 fps. The color varies from buff to yellow.

Amatol has been used mostly as a substitute for TNT. The 80/20 mixture of amatol cannot be cast, since it is not fluid enough to pour even when TNT is molten, and therefore it is usually extended into the ammunition containers by a helical screw.

Pentolite

Pentolite is a cast mixture of TNT and PETN, usually 50/50.

Pentolite has a melting point varying from 76°C to 120°C. When dry, pentolite will corrode steel and zinc-plated materials. When moist, it will corrode copper and brass very slightly. Pentolite is soluble in acetone. Its brisance and power are equivalent to those of composition B. It is not as stable as TNT in storage, and separation of PETN may occur. Efforts should be made to keep it cool. Its sensitivity is such that it would be initiated if drilled. Therefore, where fuze cavities in shells must be drilled, the portions of explosive charge involved are poured with a 90/10 mixture of TNT and pentolite to reduce sensitivity. The velocity of detonation is approximately 24,000 fps. The color is yellow to white.

The chief uses of pentolite have been in small projectile loading, in grenades, and in cast shaped charges. It has a very high shaped charge efficiency.

Tritonal

Tritonal is composed of 80 percent TNT and 20 percent aluminum powder. Tritonal is noncorrosive, toxic, and possesses satisfactory storage properties. Its melting point is 81°C and it is soluble in acetone. The velocity of detonation is approximately 18,000 fps. The color is gray.

Tritonal is used primarily in general purpose bombs where maximum blast effect is desired. Tritonal is cast, segregation of the aluminum being prevented by a pellet loading technique.

Cyclonite (RDX)

RDX is the most powerful and brisant of the military high explosives, and it is considered much too sensitive to be used alone. RDX is being used extensively in mixtures with other explosives and inert ingredients which reduce the sensitivity but retain a very high brisance and power because of the RDX content. Other names for RDX are cyclonite, cyclotrimethylenetrinitramine, and hexogen.

RDX has excellent storage qualities but, because of its sensitivity, it must be shipped immersed in water like an initiating explosive. RDX is white in color, nonhygroscopic, melts at 202°C, and is not corrosive unless the acid content is high. The velocity of detonation is approximately 28,000 fps.

Incorporated with other explosives or inert material at the manufacturing plants, RDX forms the base for the following common military explosives: composition A, composition B, composition C, and HBX.

Composition A

Composition A is a wax-coated, granular explosive, consisting of 88-91 percent RDX and 12-9 percent plasticizing wax. The wax content is sufficient to desensitize the mixture and lubricate it enough to allow it to be pressed into projectiles.

Composition A is not melted or cast. It is nonhygroscopic and possesses satisfactory storage properties. When dry, it may corrode brass and steel to a slight extent. When moist, composition A will corrode copper, brass, steel, and magnesium to a slight extent. The melting point of composition A varies from 200°C to 230°C. It is soluble in phenol. Composition A is less sensitive than TNT in both the laboratory impact test and the bullet impact test. Composition A is appreciably more brisant and powerful than TNT as is indicated by its velocity of detonation of approximately 27,000 fps. Its color may be white or buff, depending upon the color of the wax used to coat the powdered RDX.

Composition A is used as a filler in projectiles which contain a small burster cavity such as antiaircraft projectiles. Three varieties of Composition A have been developed, designated Composition A-1, A-2, and A-3. They can also be used as compressed fillers for medium-caliber projectiles.

Composition B

Composition B-1 is a mixture of 59 percent RDX, 40 percent TNT, and 1 percent wax. Composition B-2 is a mixture of 60 percent RDX and 40 percent TNT. The TNT reduces the sensitivity of the RDX to a safe degree and lowers the melting point, thereby allowing the material to be cast-loaded.

Composition B might be detonated at low order by bullet impact. The total energy of blast in air of Composition B is about 116 percent of that of TNT. Composition B is nonhygroscopic and remains stable in storage. The melting point of Composition B varies from 81°C to 100°C. Composition B will slightly corrode steel, magnesium, copper, and copper alloys. It has an extremely high shaped charge efficiency. The velocity of detonation is approximately 24,500 fps. Its color is yellow to brown.

Composition B has been used as a more powerful replacement for TNT in the loading of some of the large size general-purpose bombs, fragmentation bombs, rifle grenades, and some rocket heads. It can be used where an explosive with more power and brisance is of tactical advantage and there is no objection to a slight increase of sensitivity.

Composition C

Composition C-3 is one of the Composition C series now in production but it is rapidly being replaced by C-4, especially for loading shaped charges. However, quantities of Composition C-1 and Composition C-2 may be found in the field. Composition C-1 is 88.3 percent RDX and 11.7 percent plasticizing oil. Composition C-3 is 77 percent RDX, 3 percent tetryl, 4 percent TNT, 1 percent Nitrocellulose, 5 percent MNT (mononitrotoluol), and 10 percent DNT (dinitrotoluol). The last two compounds, while they are explosives, are oily liquids and plasticize the mixture. The essential difference between Composition C-3 and Composition C-2 is the substitution of 3 percent tetryl for 3 percent RDX, which improves the plastic qualities. The changes have been made in an effort to obtain a plastic, putty-like composition that would meet the requirements of an ideal explosive for molded and shaped charges and that would maintain its plasticity over a wide range of temperature and not exude oil.

Composition C-3 is about 1.35 times as powerful as TNT. The melting point of Composition C-3 is 68°C, and it is soluble in acetone. The velocity of detonation is approximately 26,000 fps. Its color is light brown.

The plastic properties of Composition C-3 allow it to be used in demolition charges and shaped charges.

HBX

HBX is not a manufactured product but is a cast mixture composed of 40 percent RDX, 38 percent TNT, 17 percent aluminum powder, and 5 percent desensitizers. This substance has a tendency to form hydrogen and nitrogen gases if not completely free of moisture and causes distortion of the ammunition in which it is loaded. Therefore, 0.5 percent by weight of neutral calcium chloride has been added to form a new mixture called HBX-1.

HBX is a noncorrosive, chemically stable explosive. Tests indicate that prolonged exposure to unusually high temperatures may result in the loss of a small part of the wax used as a desensitizer. This wax may appear as exudate. However, the wax is not explosive and should be cleaned off by normal means. The melting point of HBX varies from 80°C to 90°C. It is soluble in acetone. HBX has a velocity of detonation of approximately 24,300 fps. Its color is slate gray. HBX is used primarily in underwater ammunition.

Another explosive has been developed which has been designated H-6. It is used in bomb-type ammunition and is a cast filler similar to HBX but is considered superior to it. Details on the specific formula and the detailed use of H-6 are contained in classified publications issued by the Bureau of Naval Weapons.

Explosive D

Explosive D is a high explosive usually derived by nitration of phenol followed by ammoniation of the produced picric acid. In bulk, explosive D appears in the form of finely divided crystals. Explosive D stains human hair and skin yellow. It has two major disadvantages:

1. Its melting point is too high for it to be melted and cast, and it therefore must be loaded by pressing.
2. It reacts, if not entirely free of traces of unammoniated picric acid, with certain metals such as lead, potassium, copper, and iron to form sensitive compounds and must be protected from direct contact with such metals.

The chemical name for explosive D is ammonium picrate.

Explosive D is soluble in water and alcohol. Its melting point is 265°C. Explosive D is not hygroscopic when dried to specified moisture content (0.2 percent). It is very difficult to detonate and difficult to ignite. While its powes and brisance are slightly inferior to those of TNT, it is much more insensitive to shock and will stand impact on armor plate without deflagrating. The velocity of detonation is approximately 21,300 fps. The color varies from yellow to orange brown.

The principal use of explosive D is as a bursting charge for projectiles.

OTHER HIGH EXPLOSIVES

There are various other explosives utilized in the Navy that are a combination of the basic explosives. High explosive compounds are often mixed with the principal explosives to produce additional explosives such as ammonium nitrate, nitroguanidine, and picric acid. These explosives and dynamite, due to their wide use in the Navy, are discussed in the following paragraphs.

Ammonium Nitrate

Ammonium nitrate is a crystalline powder varying in color from almost white to brown. It has a melting point of 170°C. It usually cannot be detonated by heat or friction but may be exploded by a sufficiently heavy initiation by booster explosives. It may be exploded by relatively light initiation if it has been sensitized by certain impurities, among which are many carbonaceous materials. Ammonium nitrate is not flammable at normal temperature. In fires involving large quantities of ammonium nitrate, the material becomes an explosive hazard. The explosive hazard is accentuated by conditions of partial confinement and buildup of a certain degree of pressure in the gases of decomposition. When ammonium nitrate is in contact with copper-bearing metals, it may form sensitive compounds. When granulated in a special form or coated with certain noncombustible materials, ammonium nitrate is widely used as an efficient nitrogenous fertilizer.

Ammonium nitrate is used in mixtures with TNT to form amatol. It is also combined in various proportions with aluminum powder, barium nitrate, RDX, or combinations of these substances to form explosives such as Baranol, Minol, Minex, and Amatex. Packed in various sized sheet metal cans for use with a small priming of TNT, it is marketed as the commercial, patented explosive, Nitramon.

Nitroguanidine

Nitroguanidine is a powerful high explosive which, when incorporated in propellants in appreciable quantities, results in a propellant that burns in a gun with a temperature so cool that no muzzle flash is produced.

Nitroguanidine, under moderate temperature and humidity, is acceptably stable. It is comparable in strength to TNT and its sensitivity is somewhat less than that of TNT. The velocity of detonation of nitroguanidine is approximately 24,400 fps. The color is white to yellowish.

Nitroguanidine is incorporated in multibase propellent powders.

Picric Acid

Picric acid is a nitrated product of phenol. It has been used as a military high explosive, to a greater or lesser extent, by almost all countries. The chemical name for picric acid is trinitrophenol.

Picric acid is a toxic, odorless, bitter tasting, pale yellow to yellow-red, crystalline powder. It is somewhat soluble in water and dissolves readily in alcohol, ether, or chloroform. Picric acid melts at about 250°F, ignites at about 552°F, and is classed as a dangerous explosive when dry. In combination with all metals except aluminum and tin, it forms picrates which are much more sensitive and explosive than picric acid itself. Picric acid is nonhygroscopic and entirely stable. It has no tendency to decompose at ordinary storage temperatures. Picric acid has about the same sensitivity to shock or friction as TNT and is somewhat more readily detonated by means of a detonator. The velocity of detonation is approximately 23,200 fps.

The tendency of picric acid to form sensitive picrates when in contact with metal has somewhat limited its usefulness as an explosive. It is most generally used in the converted form of ammonium picrate, or explosive D. Picric acid has also found use as a booster explosive and as a substitute for a part of the mercury fulminate charge in detonators.

Bulk picric acid should not be stored or used where it will come into contact with metals, lime, plaster, ammonia fumes, or oxidizing agents such as sodium nitrate or potassium chlorate.

Picric acid is not as toxic as TNT, but care must be exercised to avoid poisoning caused by inhaling and swallowing large amounts of picric acid dust. In addition to the toxic hazard, picric acid is also a fire and explosive hazard.

Dynamite

Dynamites and blasting gelatins are explosives procured from commercial sources. Their sensitivity and keeping qualities are of a different order than those of standard military explosives. Therefore, special conditions for handling and storage are mandatory. Dynamite is more hazardous in storage than other high explosives because:

1. It may exude nitroglycerin which is a greater fire and explosion hazard than other types of exudate.
2. It deteriorates more rapidly than other high explosives. Therefore, it is the policy of the Bureau of Naval Weapons not to store dynamite and blasting gelatins in large quantities at naval activities handling ammunition or explosives except on the specific approval of the Bureau of Naval Weapons in each instance.

AMMUNITION

Ammunition is an all-inclusive term, embracing almost every explosive combination or device that burns or detonates with great rapidity and violence. As far as guns are concerned, ammunition includes everything needed to fire a shot; but since the term also includes such weapons as hand grenades, rockets, bombs, and depth charges, the final definition must be broader. The term applies to the complete charge for any type of weapon involving explosives, and to all the components of the charge.

No one weapons officer would be expected to be familiar with all the types of ammunition used by the Navy. However, basic ammunition responsibilities of the various bureaus, offices, officers, etc. are important to the Aviation Weapons Officer in the performance of his duties.

RESPONSIBILITY FOR

The Bureau of Naval Weapons exercises technical control of all ammunition material. The Bureau of Naval Weapons also exercises technical guidance and direction, including responsibility for all functions relating to safety of all ammunition material. The Bureau of Supplies and Accounts (BuSandA) administers the supply aspects of the conventional ammunition segment which is also a part of the Navy supply system. The Ordnance Supply Office (OSO) is responsible for performance of those functions relating to the inventory management of conventional ammunition material.

Commanding officers of ships, aircraft units, and shore stations are responsible for the proper surveillance, accounting, and expenditure of all explosives or ammunition, in strict accordance with U. S. Navy Regulations, BuWeps Instructions, OSO Instructions, and other current directives from higher authority.

Magazines, afloat and ashore, are under the direct custody of the weapons officer (or officer detailed to perform such duty), who is responsible to the commanding officer for the proper handling, safe storage, preservation, inspections, tests, and accounting for all such material.

The responsible officers personally must make thorough and detailed inspections of ammunition, explosives, and magazines to insure that unsafe conditions and violations of instructions are not permitted to exist. To guard against accident and to discover evidence of deterioration, it is essential that inspections and examinations be conducted in a painstaking manner by competent personnel.

Further coverage on the duties and responsibilities of the various bureaus, offices, and officers, (including the Aviation Weapons Officer) pertaining to ammunition, is provided in chapter 17 of this text.

TYPES OF AMMUNITION

Ammunition is classified by the type stowage as follows:

1. Gun ammunition.
2. Bomb type ammunition.
3. Rocket type ammunition.
4. Guided missiles.
5. Pyrotechnics.
6. Chemical ammunition.
7. Demolition material.
8. Miscellaneous.

Each class is stowed in separate magazines and should not be intermixed.

Gun Ammunition

Gun ammunition comprises four types: bag, semifixed, fixed, and small arms. The distinction between the first three depends on the manner in which the charges are assembled. In bag ammunition, the primer, propelling charge, and projectile are separate units. In semifixed ammunition, the primer and propelling charge are contained in one unit, while the projectile is separate. In fixed ammunition, all three components are assembled in one unit. Small-arms ammunition is covered in chapter 9 of this text.

Bomb Type Ammunition

Bomb type ammunition is characterized by thin-walled containers, loaded with relatively large bursting charges. This ammunition depends for its effect upon the destructive blast of the explosive, rather than any penetrating qualities of the container. Included in the group are torpedo warheads, mines, depth charges, and aircraft bombs. Bomb type ammunition is discussed in more detail in chapters 11 and 12 of this text.

Rocket Type Ammunition

Rocket ammunition includes rocket motors, heads, and fuzes. The motor contains a propellant and igniter, while the head may be a high explosive, chemical, or practice head. The fuze normally contains a detonator or booster. Different types of rocket ammunition may or may not be stowed together, depending on the types of ammunition involved and the safest and most feasible stowage facility available.

Guided Missile Ammunition

Guided missile components consist of a variety of ordnance material such as rocket motors (solid or liquid propellant), igniters, fuzes, warheads, and possibly boosters or auxiliary rockets. These various components may or may not be assembled before storing. The assembled or unassembled units may or may not be stored together, depending on the safest and most feasible storage available.

Pyrotechnic Ammunition

Pyrotechnic ammunition may be classified according to use into three types as follows:

1. Signaling
2. Illuminating.
3. Marking.

Pyrotechnic materials are mixtures of oxidizing agents and combustibles (powders such as magnesium and chlorate mixtures) to which other compounds may be added for such particular purposes as to color the flame or smoke. Pyrotechnics are discussed in detail in chapter 13 of this text.

Chemical Ammunition

Included under this classification are all projectiles, bombs, grenades, candles, or other containers of compounds, the purpose of which is to produce, when liberated, gas, smoke, or fire. Also, free fluids or gases released from aircraft tanks, projectors, or sprayers are designated as chemical agents.

Chemical ammunition may be designated according to the type of containers, as projectile, bomb, or grenade. However, the more usual classification, and the one used for storage purposes, is according to the nature of the filling.

Demolition Material

Explosives intended for such uses as blasting eliminating hazards to navigation and obstacles to amphibious landing, and destroying gear to prevent capture by the enemy, comprise demolition materials.

Half-pound demolition charge blocks, consisting of either pressed TNT or cast TNT and tetryl, are issued to ships for general use. Charges of this type are detonated by means of blasting caps, set off by electric current.

Miscellaneous Types

Under this heading are grouped a variety of types for special purposes such as impulse ammunition, blank ammunition, trench warfare ammunition, and dummy ammunition.

An impulse charge is a propelling charge designed to project a missile a short distance. It usually consists of black powder and is assembled in a cartridge case with primer. Torpedoes are propelled from above-water torpedo tubes by impulse charges. Impulse charges are also used for propelling depth charges.

Trench-warfare ammunition, still so designated in spite of the change in the concept of trench warfare, includes hand and rifle grenades and mortar ammunition. It is issued to Marines and special landing forces.

Blank ammunition contains no projectile but consists of a cartridge case with primer and powder charge. It is used to make a noise for saluting, or a smoke for signaling, and for training exercises.

Dummy ammunition includes any type of ammunition or any ammunition detail assembled without explosives. This type is used for training and test and is carefully marked so that it will not be confused with service ammunition.

20-MM AIRCRAFT GUN AMMUNITION

Future aircraft will probably require few if any aircraft guns. Therefore, only the 20-mm aircraft ammunition currently used with Aircraft Guns Mk 11 and Mk 12 (both types of guns use identical ammunition) is discussed. The complete round weighs approximately 0.59 pound and is 7.22 inches in length. The projectile is 0.784 inch in diameter and the cartridge case tapers from a 1.04-inch diameter near the neck to a 1.165-inch diameter at the rim. All types have matched ballistics, are electrically primed, and the shape, length, and weight are approximately the same. The muzzle velocity is about 3,300 fps and chamber pressure is 58,000 psi.

Components

The components of the electrically primed 20-mm round of ammunition are the same as those for small-arms ammunition, except for the addition of the fuze element to the projectile. The propellant is a form of smokeless powder, loaded loosely in the case. Exact weight of the propellant is varied as necessary by the loading depots to meet the ballistic requirements of each type of round.

PRIMER.—The round utilizes an electrical firing primer and is fired by an electric current flowing from the firing circuit to the firing pin, which comes in contact with the primer. Passage of the current through the primer generates sufficient heat to fire the round.

The primer consists of an open-ended brass cup containing a brass button insulated from the cup by a plastic liner. This button, which the firing pin strikes, is in contact with the ignition charge which consists of a conductive explosive mixture. The charge is retained by a paper disk and a metal support cup. The whole assembly is press-fitted into the primer chamber in the base of the cartridge case. In operation, electric current flows from the firing pin to the brass button and through the conductive mixture to the walls of the cup, thus igniting the primer.

The explosive element in the primer can withstand the shock received in normal handling. However, this element is sensitive to electrical energy and care should be exercised to prevent the primer button from coming in contact with electrical wiring, static charges that may build up on the human body, or other sources of electricity.

FUZE.—The Mk 78 and Mods nose fuzes are instantaneous percussion fuzes of the impact type. They are issued assembled to the Mk 12 Mod 0 high explosive incendiary projectiles used in the Mk 106 and Mods ammunition.

The fuze is armed by centrifugal force and acceleration (set back). The detonator is contained in a rotor. A soft copper shear wire prevents the rotor from rotating the detonator into line with the firing pin until the round is fired. The fuze remains unarmed during its travel in the barrel and for a distance of approximately 12 inches from the muzzle. At this point the fuze becomes armed and will instantly initiate the high explosive charge upon impact with a target.

A close-fitting windshield is crimped over the nose of the fuze to protect the firing pin.

The major difference between the Fuze Mk 78 Mod 0 and the Fuze Mk 78 Mod 1 is that the Mod 0 has an aluminum windshield and the Mod 1 has a cadmium-plated steel windshield.

Fuzes

Fuzes are stamped with mark and mod numbers, contractor's initials, and date of loading.

CAUTION: Fuzes should not be disassembled. Any attempt to disassemble fuzes in the field is dangerous and is prohibited.

Classification

Aircraft gun ammunition, like small-arms ammunition, may also be classified as either service or special. There are several types of rounds under each classification as indicated below:

	Service	
Target practice	(TP)	Mk 105
High-explosive-incendiary	(HEI)	Mk 106 Mod 0, 1
Armor-piercing-incendiary	(API)	Mk 107
Armor-piercing-tracer	(APT)	Mk 108
	Special	
High-pressure test	(HPT)	Mk 101
Low-pressure test	(LPT)	Mk 102
Dummy rounds		Mk 103, Mk 104
Firing circuit test round		Mk 109

Identification

Ammunition may be identified by the color of paint on the projectile and by the lettering on the body of the projectile. The lettering is stenciled in waterproof marking ink around the body of the projectile after it is painted. The first line of lettering consists of the caliber and type of round, such as 20-mm (HEI). On the next line (or two lines if required) appears the lot number. The lot number is made up of a prefix (ZP, ZQ, etc.), the serial number (assigned by calendar year), the loading plant's initials, and the last two digits of the year of loading. On the last line appears the mark and mod of the round. The following identification markings are stenciled or stamped on the components of all rounds:

On projectile (stenciled).
1. Kind and type of projectile.
2. Caliber and model designation.

On projectile (stamped on rotating band).
1. Lot number.
2. Year of manufacture.
3. Manufacturer's initials.
4. Caliber and model designation.

On head of cartridge case (stenciled).
1. Ammunition lot number.
2. Loader's initials.
3. The letters ELEC. (on electrically fired primer only).

On head of cartridge case (stamped in metal).
1. Designation and caliber of case.
2. Manufacturer's initials or symbol.
3. Year of manufacture, in full.

On fuze (stamped in metal).
1. Model and designation of fuze.
2. Manufacturer's initials or symbol.
3. Loader's lot number.
4. Year of loading.

The projectile color code identification system is shown in table 8-1.

Description of Rounds

In this section, service and special rounds employed in the electrically fired 20-mm aircraft guns are discussed. It should be noted that all rounds containing a charge use the Mk 5 Mod 0 cartridge case and Mk 47 Mod 0 primer.

Table 8-2 shows the component makeup of each type of round.

HIGH- AND LOW-PRESSURE TEST ROUNDS.—The High-Pressure Test (HPT) Round Mk 101 Mod 0 and the Low-Pressure Test (LPT) Round Mk 102 Mod 0 are used primarily for testing new production of the Mk 12 guns. The projectiles contain no explosive charge. The projectile of the HPT round is loaded with cast powdered lead. The projectile of the LPT round has no filler. Both types use the Mk 47 Mod 0 electric primer.

DUMMY ROUNDS.—The Mk 103 Mod 0 dummy round contains no explosive charge in either the projectile or cartridge case. It is used for loading practice, belting practice, functional testing of feed mechanisms, etc. The cartridge case for the dummy round may be one that has

Table 8-1.–Projectile color code.

Type round	Color	Lettering	Lot prefix
TP Mk 105	Green	Black	ZS
HEI Mk 106	Red and yellow	Black	ZQ
API Mk 107	Black and blue	White	ZT
APT Mk 108	Black and yellow	White	ZR
HPT Mk 101	Green	Black	
LPT Mk 102	Green	Black	
Dummy Mk 103 and Mk 104	Brown	White	

Table 8-2.–Table of round components.

Type round	Primer	Case	Projectile	Fuze pocket
HPT Mk 101	Mk 47 Mod 0	Mk 5 Mod 0	Mk 11 Mod 0	Plug
LPT Mk 102	Mk 47 Mod 0	Mk 5 Mod 0	Mk 12 Mod 0	Plug
Dummy Mk 103	———	———	Mk 11 Mod 0	Plug
Dummy Mk 104	———	———	———	Plug
TP Mk 105	Mk 47 Mod 0	Mk 5 Mod 0	Mk 11 Mod 0	Plug
HEI Mk 106	Mk 47 Mod 0	Mk 5 Mod 0	Mk 12 Mod 0	Mk 78 Mod 0
API Mk 107	Mk 47 Mod 0	Mk 5 Mod 0	Mk 13 Mod 0	Incendiary filler
APT Mk 108	Mk 47 Mod 0	Mk 5 Mod 0	Mk 14 Mod 0	Windshield
Test Mk 109	Mk 47 Mod 0	Mk 5 Mod 0		

been rejected for service because of minor imperfections. If so, the primer hole is plugged with a brass plug, or an empty primer cup may be staked in place. However, the cartridge case may have been manufactured for this purpose. If so, it will have no primer cavity. In either assembly, the cartridge case is loaded with inert material to bring it up to standard weight, and is crimped to the same type projectile used in the HPT round.

Dummy Round Mk 104 does not have a separate cartridge case and projectile but is machined in one hollow cylindrical piece requiring only the addition of a nose plug and a base plug to make a complete unit. No loading with inert material is required.

TARGET PRACTICE ROUND.—The Mk 105 Mod 0 target practice (TP) round has no explosive filler in the Mk 11 Mod 0 projectile. A dummy nose plug is used in place of a fuze. (See fig. 8-3.)

HIGH-EXPLOSIVE-INCENDIARY ROUND.—The Mk 106 Mods 0 and 1 high-explosive-incendiary (HEI) round (fig. 8-4) utilizes the Mk 12 Mod 0 projectile. The projectile is loaded with tetryl and incendiary composition to give the combined effect of the blast of a high-explosive charge plus fire-starting ability. It is armed with an instantaneous percussion fuze of the impact type designated Mk 78 Mod 0 or 1.

ARMOR-PIERCING-INCENDIARY.—The Armor-Piercing-Incendiary (API) Round Mk 107 Mod 0 has a solid projectile body machined from steel. (See fig. 8-5.) The ogive is sharply rounded to a short blunt nose. This shape increases the ability of the projectile to penetrate armor instead of ricocheting. A steel adapter (false ogive) and an aluminum nosepiece containing an incendiary filler added to this projectile body give it the conventional length and contour. The incendiary charge is designed to ignite upon impact with the target to set fire to combustible materials (fuel, etc.) and does not detonate. API projectiles have no fuzes or tracers. The projectile body with assembled nosepiece and adapter is designated Mk 13 Mod 0.

ARMOR-PIERCING-TRACER.—The Armor-Piercing-Tracer (APT) Round Mk 108 Mod 0 is similar to the API round except that a cavity is machined in the back of the projectile body to receive a tracer mixture. Instead of a false ogive and loaded nosepiece, a hollow windshield is used to bring the stubby projectile body up to standard length and contour. The windshield folds back when the projectile strikes the target and acts as a guide to prevent ricocheting off the target. The tracer body contains a pyrotechnic mixture designed to burn with a red glow during the projectile's flight. The round does not have a fuze, but the tracer mixture is ignited by the heat or pressure of the propellent charge and will burn for approximately 2 seconds, during which time the projectile will travel 1,270 yards.

FIRING CIRCUIT TEST ROUND.—The Mk 109 firing circuit test round was designed for use in testing the electrical circuit of the 20-mm Aircraft Gun Mk 12. This round is comprised of a cartridge case and a primer of the same design as used in the regular ammunition, and is suitable for training or testing. This firing circuit test cartridge is inserted in the chamber of the gun. The gun circuits are then closed and energized. The firing of the primer of this cartridge indicates that the gunfiring circuit is functioning.

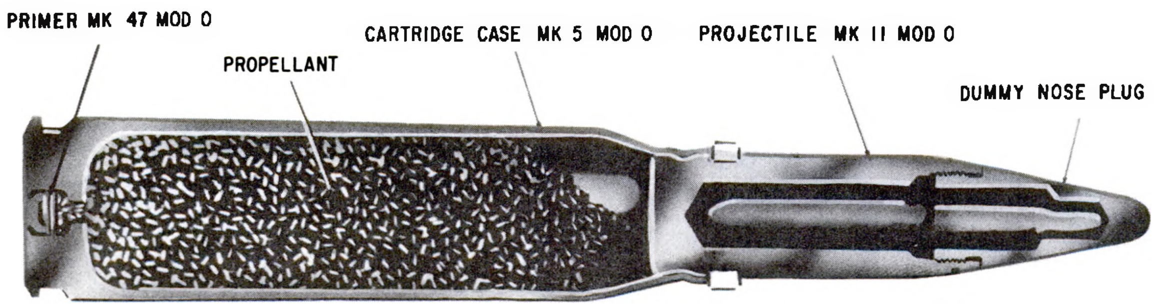


Figure 8-3.—TP Round Mk 105.

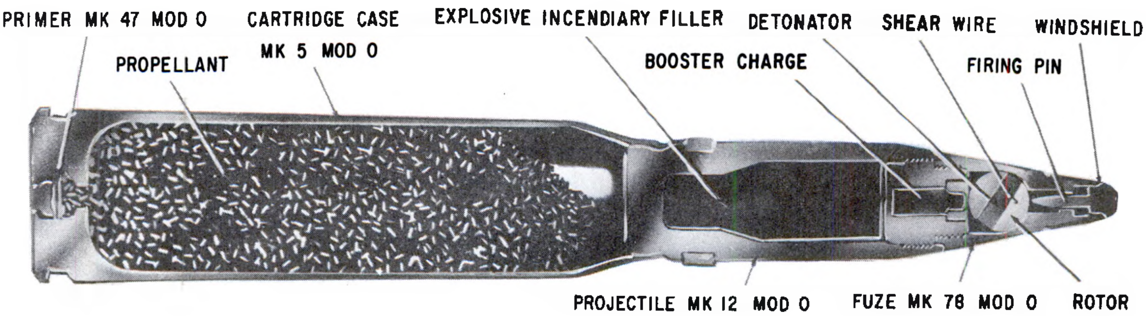


Figure 8-4.—HEI Round Mk 106 section view.

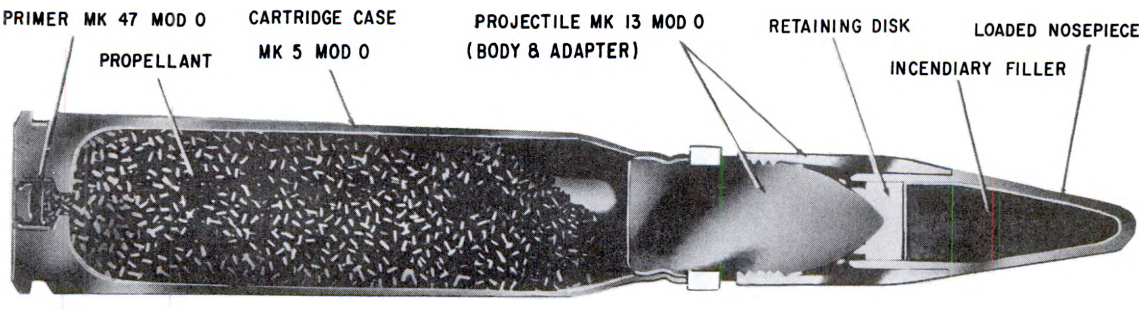


Figure 8-5.—API Round Mk 107 Mod 0.

SAFETY PRECAUTIONS FOR AMMUNITION

The need for safety precautions was recognized early in the Navy and became a part of the Navy Regulations in 1818. Since that date, the Navy has improved upon and maintained established safety procedures, and has required strict adherence to these safety practices in the handling, stowing, and loading of all ammunition and ammunition components.

A few of the publications containing safety precautions with which the Aviation Weapons Officer should be familiar and should have readily available are as follows:

1. OpNav 34P1, U. S. Navy Safety Precautions.
2. BuWeps Instruction 5100.1.
3. OP 1014, Ordnance Safety Precautions.
4. OP 4, Ammunition Afloat.
5. OP 5, Ammunition Ashore.
6. OP 2210, Aircraft Rockets (rocket safety precautions).
7. OP 2216, Aircraft Bombs, Fuzes, and Associated Components (bomb and fuze safety precautions).

HANDLING AND STOWAGE

The dangerous nature of ammunition requires the observance by all personnel of rules designed to safeguard life and property. Strict adherence to these rules may mean the difference between life and death, health or serious injury. Safety precautions are to be strictly enforced by all activities (ashore or afloat) concerned with the handling, shipping, or stowage of ammunition or explosives.

Although it is difficult to cover every possible emergency or dangerous condition that may arise, an attempt should be made to grasp the intent of safety instructions so that, in the event a situation arises which is not specifically covered, the proper action will be taken instinctively.

Excerpts from publications contained in the preceding list, particularly those which apply to an aviation ordnance activity, are presented in the paragraphs following.

To avoid danger of casualties, the observance of the following safety precautions is mandatory. The Bureau of Naval Weapons must be informed of any circumstances which conflict with these safety precautions, or which for any other reason require changes in or additions to them.

When in doubt as to the exact meaning of a safety precaution, an interpretation should be requested from the Bureau of Naval Weapons.

Safety devices provided must always be used as designated to prevent the possibility of an accident, and must be kept in good condition, in order, and operative at all times. All instructions promulgated by competent authority to insure safe operation or handling of equipment must be strictly observed.

Changes, modifications in, or additions to, ordnance material, or other material used in connection therewith, must not be made without explicit authority from the bureaus concerned.

No ammunition or explosive assembly must be used in any gun or appliance for which it is not designated.

As familiarity with any work, no matter how dangerous, is apt to lead to carelessness, all persons who may supervise or perform work in connection with the inspection, care, preparation, use, or handling of ammunition or explosives must:

1. Exercise the utmost care that all regulations and instructions are rigidly observed.
2. Carefully supervise those under them and frequently warn them of the necessity of using the utmost precaution in the performance of their work.

No relaxation of vigilance must ever be permitted.

Except in cases of emergency, ammunition must not be transferred during fueling operations.

All ammunition, powder, and explosives must be protected from abnormally high temperatures. If so exposed, they must be handled in accordance with current BuWeps instructions. Permissible maximum stowage temperatures must be prescribed by the Bureau of Naval Weapons.

To minimize the risk of fire, explosion, and damage to ammunition and its containers from accidental causes, ammunition should be handled as little as practicable. As the action of denting thin-cased high explosive ammunition is known to have caused detonation of the explosives in some instances, special care must be exercised to insure that such ammunition is never struck, dropped, or bumped.

Magazines must be kept scrupulously clean and dry at all times. Nothing should be stored in the magazines except explosives, their containers, and authorized magazine fittings, and equipment. No greasy rags or other foreign materials susceptible to spontaneous combustion should be stored in them.

Naked lights, matches, or other flame-producing apparatus must never be taken into magazines or other spaces used primarily as magazines while those compartments contain explosives.

Before performing any work which may cause either an abnormally high temperature or an intense local heat in a magazine or other compartment used primarily for a magazine, all explosives must be removed to safe stowage until normal conditions have been restored.

The Aviation Weapons Officer should insure that his men are familiar with, and adhere to, all pertinent regulations and precautions dealing with the types of ammunition used by his activity. Excerpts relating to safety precautions that are pertinent to local operations are usually collected from appropriate publications and consolidated into a more manageable local instruction.

Some publications that give safety regulations, primarily for handling of ammunition, are:

OP 4, Ammunition Instructions for Naval Service Afloat.

OP 5, Ammunition Ashore.

OP 1120, Care of Ammunition at Advanced Bases.

OP 2150, Ordnance Safety, Operation, and Maintenance.

LOADING

Due to the varied loading techniques required for different types of ammunition and different types of aircraft, loading safety precautions are covered in each chapter as the respective ammunition item is covered. Normally loading safety precautions are found in the basic publication that deals with the particular type of ammunition being loaded.

CHAPTER 9

AIRCRAFT GUNS AND SMALL ARMS

DEVELOPMENT OF AIRCRAFT GUNS

World War I was well along before anyone visualized the fighting power of an aircraft equipped with automatic guns. During the first part of this period, aircraft were used only for observation purposes and were unarmed. The only protection the pilot or observer had was his sidearm.

Rifles were later carried and fired by the observer, who stood erect in the cockpit. This was so difficult that it was not long until mounted automatic weapons were being used in combat. These early guns were adaptations of automatic ground weapons, speeded up in rate of fire and fitted with recoil mechanisms to assist in absorbing shock.

The Lewis Machinegun caliber .30 was the first automatic weapon to be used in combat aircraft. Still later, the Browning Machinegun caliber .30 made its appearance, followed a little later by the caliber .50 Browning.

In the meantime, the French Hispano-Suiza 20-mm Automatic Gun made its appearance. Our Armed Forces began intensive development of a 20-mm aircraft gun about 1937; and a short time later, purchased the Hispano-Suiza design from the French. The 20-mm gun was selected as the ideal size aircraft weapon because it was light and compact enough to be mounted in fighter type aircraft, yet it was large enough to fire a high explosive projectile.

Our first model was designated the M1; but before it was ever used, several changes were made, and it became the M2. The M2 was first installed in naval aircraft in 1943 and saw extensive service during the remainder of World War II. However, by this time it had already been decided that a faster firing gun was necessary to compensate for the speedier aircraft that the enemy was producing. This led to the development of the M3, a weapon which came into wide use in 1945. In 1948 when jet aircraft came into use, the Armed Forces realized that a weapon with a higher muzzle velocity and faster rate of fire was necessary. A more effective means of timing gunfire was also desired.

With the above ideas in mind, several new weapons were developed. However, of this group only the Mk 12 is currently used by the Navy.

It is an interesting fact that the United States did not introduce, except in experimental quantities, any new type of aircraft machinegun during World War II. The reason for this was the long and tedious program required to develop, refine, and produce a new and reliable service weapon. Our mainstays were the .30 and .50 caliber Browning, and the 20-mm AN-M2 (Hispano-Suiza) aircraft machinegun. Development proceeded on superior automatic aircraft weapons, but the conflict did not last long enough for any to see combat use. Refinement and improvement of the existing machineguns did bring material results. Even today no machinegun in the world can compete with the .50 caliber Browning for reliability.

In the last few years, aircraft weapons have been developed that can very effectively handle certain types of targets that were formerly attacked with guns. Nevertheless, under certain tactical conditions and against certain targets, guns are still the optimum weapon. However, their performance requirements are so demanding, only a very outstanding aircraft gun can fulfill the requirements of today's aerial warfare. Today the firepower per gun and the firepower per pound of gun must be much greater. The most obvious reason for this is that aircraft speeds have more than doubled in the last 10 years.

The adaptation of pods for the carrying of guns is in line with the present day trend of multiple external stores capability of aircraft. This trend exists in most high performance aircraft where a variety of stores appear as pods. The gun pod adds to the versatility of an aircraft by permitting interchangeability of its armament, such as guns, bombs, rockets, and guided missiles. By the use of gun pods, another variable choice of weapons is available to complete the tactical assigned mission.

TYPES OF AIRCRAFT GUNS

Advances in aerial weapons such as high-speed rockets and guided missiles have limited the use of aircraft guns in current aircraft considerably. Therefore, the coverage of aircraft guns in this text is limited to two guns, the 20-mm Aircraft Gun Mk 11 Mod 5, which is a part of the Gun Pod Mk 4 Mod 0, and the 20-mm Aircraft Gun Mk 12 and Mods.

GUN POD MK 4 MOD 0 (WITH 20-MM AIRCRAFT GUN MK 11 MOD 5)

The Mk 4 gun pod with the Mk 11 gun is a 20-mm gun system firing 4,000 rounds per minute. This weapon is known as the HIPEG system. It is 22 1/2 inches in diameter, 16 1/2 feet long, and attaches to external 30-inch racks such as the Aero 7A rack on the A-4 aircraft. Loaded with 750 rounds the pod weighs 1,285 pounds. It is electrically controlled from the aircraft and is self-powered. Charging, clearing, and ammunition boost functions are powered by a 3,000 psi pneumatic supply inside the pod. Alternate lower rate of fire and automatic charge are optional features.

Aircraft installation features provided by the Mk 4 gun pod are: reduced gunfire blast and vibration, positive clearance of expended cases and links from aircraft, improved accuracy due to a single mount harmonization, quick turnaround, and safety from gun hazards such as gun gas, double feed, hangfire, and cookoff.

The pod can be flown and fired at speeds up to Mach 1.2 at 10,000 feet and Mach 2.2 at 60,000 feet.

General Information

The HIPEG system consists of the Gun Pod Mk 4 Mod 0 (fig. 9-1) and Mk 6 Mod 4 link, and Mk 100 series ammunition. The 20-mm Aircraft Gun Mk 11 Mod 5 (fig. 9-2) is part of the gun pod, and in turn is made up of two items: the 20-mm Gun Mechanism Mk 11 Mod 5 and the 20-mm Gun Loader Mk 2 Mod 1. The Mk 11 gun is located on the centerline of the pod, with the barrels in a plane through the mounting lugs.

For proper orientation of the Mk 4 gun pod, terminology such as "top," "bottom," "left," and "right" will conform to the gun pod hanging from the aircraft and viewed from the rear.

In referring to the gun, this terminology is referenced to the upright position of the gun as shown in figure 9-2 and viewed from the rear. Rotation of the gun cylinder is determined by viewing it from the rear, so it is always spoken of as having "right-hand" or clockwise rotation. The gun is mounted upside down in the pod suspended from the aircraft.

The gun is designed so that one barrel always fires the first shot of a burst. This barrel is termed the "first-fire" barrel. Likewise, the opposite barrel is termed the "last-fire" barrel, since it fires the last shot in each burst. Except for the first and last shots, the gun fires two shots simultaneously in each cycle.

Recoil motion is rearward motion of the sliding parts; i.e., the breech, cylinder, barrels, and minor parts, relative to the stationary receiver. Counterrecoil motion is forward motion. The sliding or recoiling parts begin counterrecoil motion at the point where they start forward, and they are in counterrecoil until they stop moving forward.

Description of the Mk 4 Gun Pod

The Mk 4 pod (without gun) is made up of five subsystems plus feed chutes, ejection tubes, gun gas combustion provisions, blast deflector, and boresight accommodations. The five systems are structure, ammunition magazine, feed, pneumatic, and electrical.

STRUCTURE.—The structure of the Mk 4 pod is a typical semimonocoque structure. The pod can tolerate vertical accelerations of 10 g and side accelerations of 6 1/2 g. It can stand catapult and arresting loads of 9 g. The gun may be fired while acceleration loads of up to 6 g are acting on the pod; it may also be fired without regard to airspeed. The bottom of the pod is reinforced for cradling and hoisting. Two removable quick-release main doors provide easy access for loading the magazine, and servicing the gun, and loader. There are two small inspection doors and two inspection

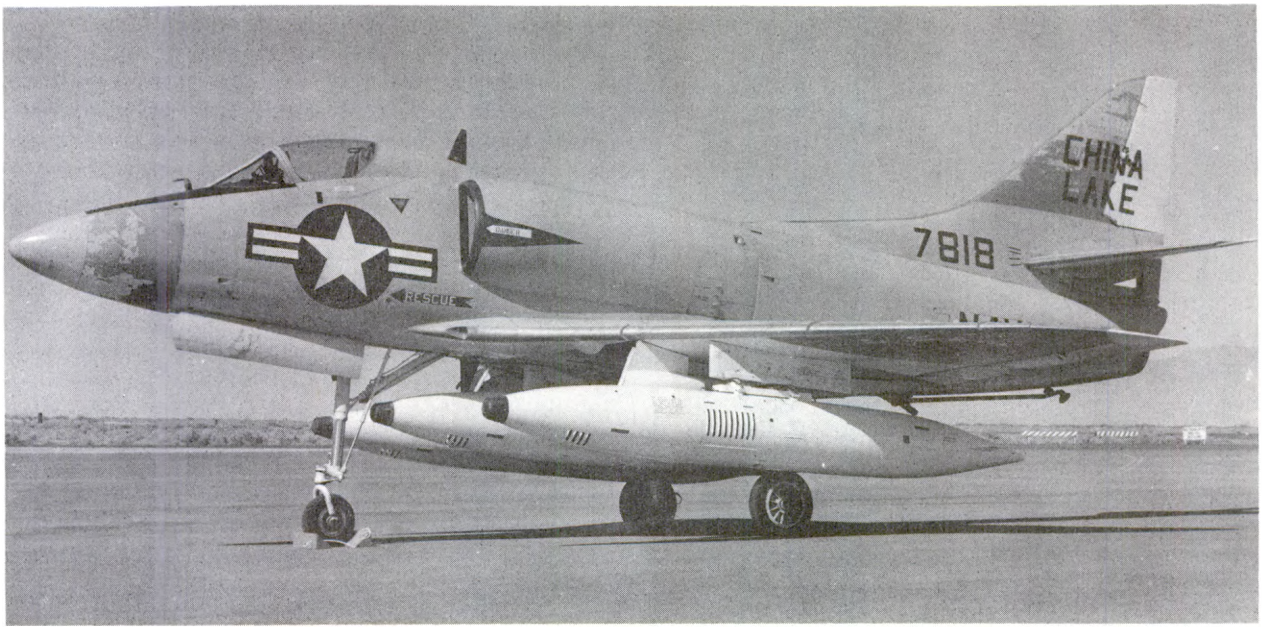


Figure 9-1.—Gun Pod Mk 4 Mod 0.

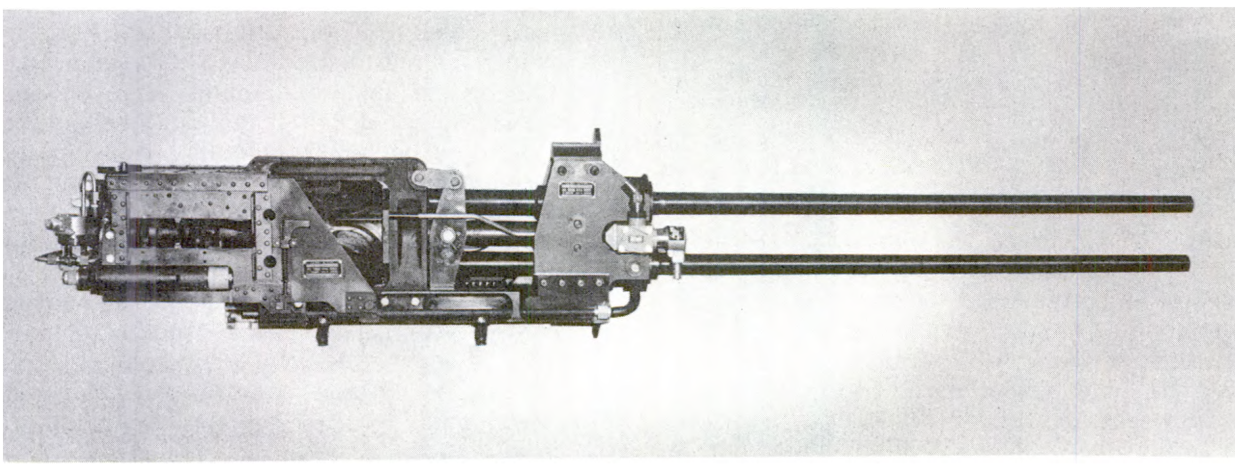


Figure 9-2.—20-mm Aircraft Gun Mk 11 Mod 0.

windows, which prove of value when the magazine is being loaded. The pneumatic system service door that provides access to the air reservoir is in the tail cone. The reservoir may also be serviced by removing the tail cone. The nose may be removed for access to the forward end of the gun or for removing the gun. Nose and tail are of the quick-release type.

AMMUNITION MAGAZINE.—The ammunition magazine contains the 750 rounds loaded in the gun pod. The two belts that feed the Mk 11 gun are loaded into the magazine symmetrically about the axis so that the two segments from which belts are being withdrawn at any moment are diametrically opposite each other. After all of the belt is withdrawn from one segment; withdrawal from the next segment begins automatically. While the ammunition is being withdrawn, the magazine is slowly rotated by a power drive assembly. The speed of rotation is synchronized with the rate of withdrawal of the belt so that the segment from which ammunition is being withdrawn is always in line with the feed throat. The magazine rotates one-half turn from full to empty.

The ammunition in the magazine is controlled under all g-load conditions. Each cartridge has a place and it cannot move from that place until it is withdrawn by the feed system. The magazine is designed so that only a short loop of each belt, rather than the entire mass of ammunition in the magazine, need be accelerated when the gun starts firing. The belt is withdrawn from the magazine in such a way that the magazine is balanced at all times. The magazine can be partially loaded, if desired, by leaving some of the segments empty.

The magazine is loaded by reversing the flow of ammunition through the feed system. Auxiliary loading chutes leading in through the main access doors may be attached in place of the feed chutes that lead to the gun. The belts are fed into the magazine by the feed system sprockets, to which handcranks are engaged for this operation. Time to reload is approximately 10 minutes.

AMMUNITION FEED SYSTEM.—The ammunition feed system is located in the forward side of the bulkhead between the magazine compartment and the gun compartment. It consists of two feed sprockets that engage the belts, and a pneumatic motor and gearbox that power the sprockets.

The pneumatic motor is energized when either the charge or firing circuit is closed. The gearbox transmits the power to the sprocket shaft and also drives the magazine, at very low speed, through a worm gear reduction. When the magazine is being loaded with ammunition, it is desirable to be able to rotate and position the magazine independently of the feed sprockets. Under these conditions, a manually operated clutch is disengaged, separating the ammunition drive and magazine drive portions of the gearbox. A small handcrank is then engaged with the magazine drive worm, and the feed sprocket and magazine can be rotated independently.

PNEUMATIC SYSTEM.—The pneumatic system provides an air supply to the ammunition drive and to charge the gun. Charging is provided so the aircraft may take off without a loaded gun and the cartridges then moved into firing position when the weapon is readied for firing. It is also used to clear the gun of any misfired rounds encountered and to clear the gun of live ammunition before the aircraft lands.

The pneumatic system is self-contained and is completely independent of the aircraft. It has a reservoir that is charged to 3,000 psi when the pod is being serviced on the ground. The spherical, high pressure reservoir is located within the tail cone. Compressed air travels from this reservoir to the gun compartment through a 3/8-inch OD (outside diameter) line. The hand-operated cutoff valve is closed except when the gun pod is being prepared for removal from the aircraft. This valve minimizes leakage by isolating the high pressure reservoir from the downstream end of the system. The 3,000-psi air is reduced to 1,500 psi at the regulator and stores in a small reservoir immediately adjacent to the air-consuming devices. A 5/8-inch OD line runs to the large solenoid valve on the gun mechanism, and 1/4-inch OD lines run to the loader and pneumatic motor. A manually operated dump valve allows the gun and loader to be depressurized for removal without emptying the main reservoir. The cutoff and dump valves are mechanically coupled and interlocked with the left main access door to insure correct positioning prior to flight. Pneumatic quick disconnects are provided on the gun and loader so that removal does not require tools.

ELECTRICAL SYSTEM.—Cockpit controls consist of the trigger, connection to the master armament switch, and a ready/clear switch. The cockpit controls are connected to a receptacle in the top of the pod through a cable and single plug within the fairing of the external stores rack pylon. A lanyard connects this quick disconnect plug for jettison release. From the aircraft come 28-volt d-c signals to control the operations of the gun pod and 120-volt 400-cycle a-c pulses for firing the ammunition. The gun itself is self-powered.

The most important element of the electrical system is the gun control box. This box controls the firing, charging, and clearing functions of the gun. During firing, the control box sequences the firing of one barrel at the beginning and the other barrel at the end of a burst; and the firing of both barrels simultaneously on all other cycles. It controls charging of the gun by sending signals at the proper time to the solenoid valves that charge the gun. The box automatically initiates a charge cycle when it senses a misfired round. The automatic charging feature may be cut off, if desired. The control box also takes care of the automatic clearing of the gun when the pilot presses a CLEAR switch. If a switch on the pod junction box is opened, the control box will reduce the rate of fire to 750 rounds per minute.

Electrical quick disconnect plugs are used throughout the gun pod to facilitate removal of components. All electrical cables are encased in flexible metal conduit to shield circuits against electromagnetic energy, heat, and handling abuse.

AMMUNITION FEED CHUTES.—Two ammunition feed chutes guide the ammunition from the magazine to the loader. They are identical and rigid, and are attached between the loader and magazine with quick disconnects. The chutes are removed for reloading the magazine.

EJECTION TUBES.—Two ejection tubes are attached between the loader and pod structure to duct the spent cartridge cases and links overboard. The two ejection tubes are of different length, since one must travel farther to reach the bottom of the pod. The case-link "package" travel through these tubes base first, entering the tubes at an average speed of 75 fps and exiting from the pod at about 50 fps. The packages are directed downward and rearward at an angle of about 30° from the vertical. Each of these packages is made up of one case inside one link, this unit being separated from the rest of the belt.

This high velocity ejection of separate dense packages means that the jettisoned material moves rapidly away from the aircraft and the pod, eliminating the possibliity of strikes along the underside of the pod or on any part of the aircraft. This method of ejection also handles the negative g-load problem satisfactorily.

GUN GAS COMBUSTION.—Gun gas control is a safety provision integral to the pod structure. This feature allows the gun gas to ignite at random and burn safely within the pod. The pod doors and nose are provided with louvers of correct areas to relieve the pressure. None of the pod elements are damaged by the transient flame.

BORESIGHT.—The alinement of the gun relative to the aircraft armament datum line is an important consideration with a gun pod. In the Mk 4 gun pod, the need of adjusting this alinement and the complexity of checking it to boresight panels with boresight tools at time of attachment has been eliminated. This feature is provided so that maximum advantage may be taken of the ability of the weapon to be kept ready on standby and then attached to an aircraft in seconds. All pods are interchangeable and it is not necessary to reserve a pod for any one aircraft, or a particular gun for any pod. To make this possible the gun mounts are very accurately installed in the pod at the time of manufacture.

Since mounting racks, attaching hooks, and sway braces vary for different types and models of aircraft, the pod mounted lugs and associated hardware are supplied in kit form with the pod. This makes it possible to supply a basic pod for several types of aircraft, and provide the flexibility for the variety of racks. Each lug system is designed to provide ±1° of aim freedom around the aim line for the particular aircraft. This makes it possible to adjust elevation for various tactics and to provide for harmonization when multiple pods are installed.

Elevation and azimuth adjustments are made at the lugs for simplicity and ease of adjustment. Elevation control is provided at the front lug and azimuth at the aft. Both are calibrated so they may be indexed for a specific tactic prior to installation of the pod on the aircraft. Since the actual adjustments are divorced from the gun and the gun is held to close tolerance within the pod, the aim line is independent of the particular gun installed in the pod.

BLAST DEFLECTOR.—A blast deflector is provided at the nose of the pod to minimize vibration and prevent skin damage to the aircraft during gun firing. The deflector consists of two plenum chambers into which the muzzle blasts are exhausted.

Weight and Location

The fully loaded pod, complete with Mk 11 Mod 5 gun, 750 rounds of linked ammunition, and full air charge in the pneumatic reservoir, weighs 1,285 pounds. The weight without ammunition and air charge, but with gun, is 690 pounds. The center of gravity moves forward 15.9 inches as the ammunition is consumed. In the takeoff condition, the center of gravity is 19.75 inches behind the front suspension lug.

The gun is located centrally in the pod, with space on all sides. Visual inspection of right and left sides presents no difficulty, and the relative accessibility of the sides makes it possible to maintain the gun mechanism and remove the loader while it is in the pod. The gun slides in and out of the front of the pod on auxiliary tracks.

NOTE: In an emergency the pod may be jettisoned. The pod is designed to accept the thrust produced by the rack ejector piston. The fins shown in figure 9-1 are designed for jettisoning the pod from the A-4 aircraft.

Description of the Mk 11 Gun

The Mk 11 gun is a self-powered, twin barrel revolver weapon employing the Marquardt gun cycle. It fires at 4,000 ±200 rounds per minute and is fed by two ammunition belts. The Mk 11 Mod 5 gun described here is the production configuration. It weighs 225 pounds ready to fire, is 78.5 inches long, and has a life exceeding 100,000 rounds. The Mk 11 gun delivers projectile energy at a rate of 5,000 horsepower and at an energy density of 22 horsepower per pound. Muzzle velocity is 3,300 ±50 fps. The Mk 11 gun fires the standard Mk 100 series ammunition (as used in the 20-mm Mk 12 gun).

The two most important factors that contribute to the high cyclic rate of the Mk 11 gun are: (1) Six operations are being performed simultaneously on six cartridges on each cycle; (2) the counterrecoiling elements are not damped to a halt in battery before the next two rounds are fired.

GUN MECHANISM FUNCTION.—Its three basic operations—ramming, firing, and case ejection—are performed simultaneously on three different pairs of rounds at three different revolver stations. Each of the operating stations is duplicated to support the two barrels. The revolver cylinder contains a total of eight chambers, six of which are in use in any one cycle. The barrels do not revolve, but remain fixed while the cylinder revolves relative to them.

At the start of a burst a single shot is fired. The recoiling parts are thus given a momentum of one shot, and they still retain substantially the momentum of one shot as they return toward battery position, since the counterrecoil motion is undamped. The gun now fires two shots simultaneously just before the battery position is reached. The impulse of one shot stops the forward motion of the gun and the impulse of the other shot cycles the gun. Thus the gun recoils with the momentum associated with only one shot. The dual-shot cycle is repeated until the end of the burst, when a single shot is fired, which brings the gun to a halt in battery. This principle is referred to as "momentum cancellation."

It can be seen that in theory the cyclic recoil load delivered to the gun mount is only half of what might be expected when two shots are fired, and that the counterrecoil load is zero. Actually, friction and the addition of some gun gas recoil boost prevents this simplified picture from being strictly true. Nevertheless the effect of momentum cancellation in reducing the cyclic recoil load is very significant.

The Mk 11 gun uses a kinetic energy interchange arrangement as a recoil mechanism and therefore does not require a recoil spring. Elliptical cams cut into the surface of the revolver cylinder convert the linear motion of the recoiling parts into rotary motion of the cylinder. All the energy of recoil is transferred to the cylinder, which stores it momentarily in the manner of a flywheel. The recoiling parts are thereby smoothly decelerated to a halt in full recoil position. At this point, the cams act to reconvert the kinetic energy of rotation into linear counterrecoil energy, thus forcing the gun back toward battery position. When all the energy of one cycle has been transferred from the revolver cylinder it comes to rest in a new angular position, each firing chamber having been indexed 45° to the next station.

LOADER FUNCTION.—Ammunition is conveyed to the gun in cylindrical links, which are connected together to form a belt. Two belts feed the weapon, one on each side. The gun is self-feeding; the belts are fed through the loader by the intermittent rotation of the feed sprocket that is splined to the revolver cylinder shaft. The belts, the feed sprocket, loader, and the feed entrances in the loader frame do not recoil.

At the two diametrically opposite ramming stations, gas-operated rammers simultaneously ram rounds forward out of the links into two empty chambers of the cylinder. On the next cycle, these two rounds are indexed into positions directly behind the barrels and fired. On the following cycle the two empty cases are indexed to the ejection stations, where gun gas is introduced into the front of the chambers, blowing the empty cases to the rear and into their waiting links. Each returning case relinks with sufficient velocity to disentegrate the link from the belt, and this case-link "package" travels rearward out of the weapon.

The feeding, ramming, and ejecting elements are built into a loader assembly, which is easily removed from the gun after disengagement of its quick-release fastenings. Energy for the ramming and ejection is obtained by tapping off a small amount of gas from the first-fire barrel. While two projectiles are passing through the barrels the gun gas is providing energy for ramming two new rounds into the chambers and for ejecting the two empty cases that resulted from the previous cycle. The piston type rammers project the cartridges into the chambers at a velocity of 50 to 60 fps.

The loader assembly is designated as the 20-mm Gun Loader Mk 2 Mod 1. When it is combined with the 20-mm Gun Mechanism Mk 11 Mod 5, the complete unit is defined as the 20-mm Aircraft Gun Mk 11 Mod 5.

CHARGER FUNCTION.—It is sometimes necessary to cycle the gun without firing. Air at 1,500 psi operates a pneumatic cylinder (around the last-fire barrel) that drives the gun into recoil and thereby indexes the revolver cylinder. Simultaneously, air ejects the cases from the two chambers at the ejection stations and operates the two rammers. This entire operation, which is known as "charging," is initiated by an automatic circuit in the control box whenever the gun remains in the battery longer than 80 milliseconds. This takes care of problems such as are presented by misfired rounds. Charging is extremely fast. Typically, the entire operation of sensing the problem and completing the charge cycle takes less than two-tenths of a second. Also, at the completion of the charge cycle the gun does not have to be brought to a halt in battery and started off again with a single shot. The counterrecoil velocity at the end of a charge cycle is the same as that at the end of a firing cycle, so the gun can fire two shots "on the fly," just as in a regular firing cycle. This action puts the gun back into action fast.

GUN MOUNTS.—The loads produced by the gun are taken out at three nonrecoiling mounting points. The recoil load is taken out at the top and bottom front mounting pads. The overturning moment (relatively low) is taken out at the rear (bottom) pad. There is a forward load at the start of each cycle from the recoil velocity boosters. There can also be a forward load at the end of a cycle should a misfire occur in the last-fire barrel. The gun is equipped with a counterrecoil damper that absorbs the counterrecoil energy under this condition and delivers a load to the front mounting pads. Recoil loads at the gun pod lugs are 2,500 pounds average and ±5,000 to 8,000 pounds cyclic.

Reliability, Maintenance, and Life

The reliability requirement of the Mk 4 gun pod is 7,000 rounds per stoppage (95% fireout). Current level achieved is approximately 3,500 rounds per stoppage (90% fireout).

Gun maintenance is performed after each 3,000 rounds (four podfuls) fired. Pod maintenance is very low, with no scheduled servicing, and overhaul indicated after each 50,000 rounds fired.

Component life is as follows:

Mk 11 Gun	130,000 rounds
Mk 4 Gun Pod	130,000 rounds
Mk 2 Loader	65,000 rounds
Barrels (2)	5,000 rounds

NavWeps OP 2719 (preliminary), first revision, contains a complete description of operation and maintenance of the Gun Pod Mk 4 Mod 0 (with 20-mm Aircraft Gun Mk 11 Mod 0) including numerous art illustrations, and should be consulted for more detailed information.

20-MM AIRCRAFT GUN MK 12 AND MODS

The 20-mm Aircraft Gun Mk 12 and Mods (fig. 9-3) is similar in operating principles to the 20-mm Automatic Gun M3 which was used during World War II. However, the Mk 12 gun fires electric-primed ammunition containing a lighter projectile and a larger power charge, at a higher rate of fire and an increased muzzle velocity.

The 20-mm aircraft gun is intended for both air-to-ground and air-to-air combat.

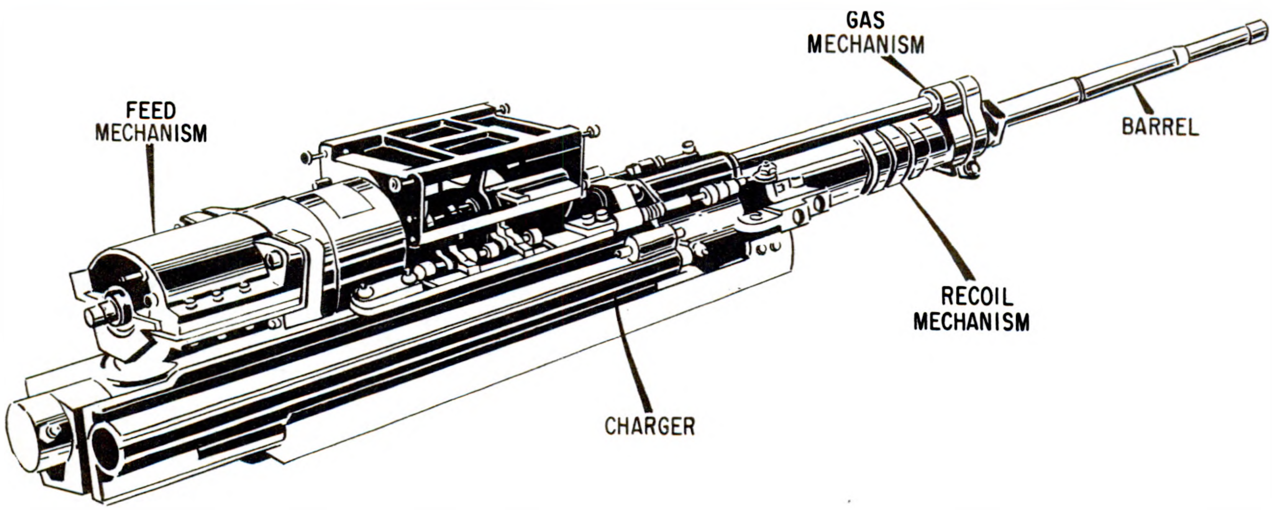


Figure 9-3.—20-mm Aircraft Gun Mk 12 with Feed Mechanism Mk 9 Mod 4 installed.

The 20-mm Aircraft Gun Mk 12 is currently manufactured in three Mods—Mod 0, Mod 2, and Mod 3. The differences between the 20-mm Aircraft Gun Mk 12 Mod 0 and the Mk 12 Mod 2 are in the design of the gun barrel and the diameter of the hole in the vent plug.

Another primary difference is that the Mk 12 Mod 0 uses the 20-mm Gun Barrel Mk 11 Mod 2, 3, or 4, while the Mk 12 Mod 2 uses the 20-mm Gun Barrel Mk 16 Mod 3 or 4. The design difference between the 20-mm Aircraft Gun Mk 12 Mod 0 and the 20-mm Aircraft Gun Mk 12 Mod 3 are in the recoil mechanism and the receiver body.

The 20-mm Aircraft Gun Mk 12 Mod 0 and 2 use the pneumatic Feed Mechanism Mk 7 Mod 2, whereas the Mk 12 Mod 3 uses the recoil operated Feed Mechanism Mk 9 Mods 2, 3, 4, and 5. Both feed mechanisms are discussed later in this chapter.

The Mk 12 gun is an air cooled weapon and operates on both the gas and blowback principles. The gun is electrically fired and continues to operate as long as the firing circuit is closed and ammunition is available. The weapon includes an integral pneumatic charger which is used to operate the breechblock for first round loading, to clear the weapon in case of a misfire, and to safety the gun on completion of firing.

The 20-mm Aircraft Gun Mk 12 is normally considered to be composed of two major units, the barrel and the gun mechanism. However, for purpose of this discussion the weapon is divided into seven major components:

1. Gun barrel.
2. Receiver assembly.
3. Recoil mechanism assembly.
4. Gas mechanism assembly.
5. Breechblock assembly.
6. Buffer assembly.
7. Charger assembly.

These assemblies include all the elements necessary for chambering a round, closing and opening the breech, extracting an empty case, and controlling the recoil and counterrecoil actions. In addition, the gun requires two accessories to make it a complete combat weapon. They are a synchronizing switch, to complete the firing circuit of the weapon, and a feed mechanism which feeds the ammunition into the weapon. The seven components and two accessories are discussed in this chapter.

Gun Barrel

The barrel is attached to the receiver of the gun by the threads on the breech end of the barrel, and is secured to the receiver by a locking pin which prevents rotation of the barrel after installation. The breech end of the gun bore is internally machined to the shape of the cartridge to form the chamber. The walls of the chamber are smooth to insure proper gas sealing and extraction. Rifling grooves in the bore extend from just forward of the chamber to the muzzle, interrupted only by the gas port drilled through the top of the barrel.

The exterior of the barrel is tapered in steps from the breech to the muzzle end. An external thread is machined near the center of the gun for attaching the gas bracket and retaining the recoil mechanism. To the rear of this thread is the gas port. An external thread at the muzzle end of the barrel is provided to attach a flash hider, blast suppressor, or barrel support.

Receiver Assembly

The receiver houses or supports all working parts of the gun mechanism, and provides attaching surfaces for the feed mechanism. The receiver body is a hollow, rectangular-shaped member, partially open at the top and bottom and completely open at the rear. It is threaded to receive the barrel. At the front on top is a threaded hole for attachment of the gas cylinder guide. The breechblock locking key is mounted in oval-shaped transverse slots in the sides of the body just aft of the ejection slot. The synchronizing switch is mounted on a machine surface on the left forward side of the body. There is a longitudinal cylinder (bored in the right side of the body) which houses the gun charger assembly. At the rear of the body are two dovetailed slots for attaching the buffer.

The receiver plate is a machined rectangular part attached to the bottom rear of the receiver to provide a sliding surface for the breechblock. The receiver slides are thin plates bolted to the inner forward sides of the receiver body. They guide and support the breechblock in conjunction with the receiver plate and the breechblock locking key. A protruding cam at the rear of each slide assists in forcing the breechblock lock down as it nears the Battery position.

The breechblock locking key is a solid metal block that fits into the slots in either side of the receiver body. The key provides bearing surface for the breechblock and acts as an abutment for the lock during firing. A spring pin holds the key in place.

Recoil Assembly

The recoil mechanism (fig. 9-4) is a spring mechanism that checks the movement of the recoiling parts of the gun and returns them to battery. The unit consists of an external recoil spring assembly and a housed spring assembly.

The recoil spring is a flat helical spring positioned around the gun barrel between the

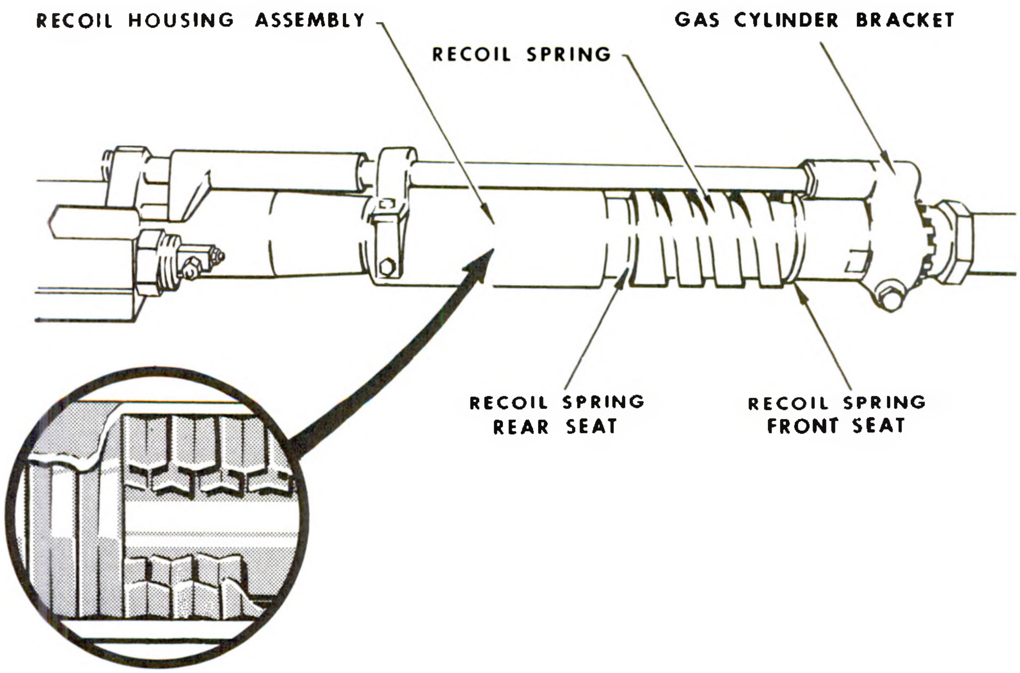


Figure 9-4.—Installed arrangement of the recoil and gas mechanism assemblies.

front and rear recoil spring seats. During recoil, the front seat, positioned between the recoil spring and the gas cylinder bracket, is moved back to compress the spring. As the spring is compressed, the front recoil seat contacts the rear recoil seat. The rear recoil seat and spacer then compress the ring spring.

The recoil housing is a cylindrical steel tube concentric with the gun barrel. It is secured to the aircraft mount by horizontal cylindrical trunnions at its rear. The ring spring (fig. 9-4) is an arrangement of internal and external rings which form a friction type spring. During recoil, these rings are forced together, expanding the outer and compressing the inner V-shaped rings, with the resulting high friction forces stopping the final recoil movement. These springs are held in position by followers enclosed in the housing forward and aft of the ring springs. The forward follower transmits the recoil load from the recoil spring rear seat to the ring spring. In recoil, the rear follower functions as a spring seat as it is held by the sleeve. In counterrecoil, the rear follower transmits the counterrecoiling forces from the gun barrel shoulder to the ring spring. Two rear followers are used for the Mod 3 gun instead of one and no spacer is used. Also the front recoil spring seat is slightly longer and has no flat on the forward top surface. These changes, plus a 0.002 inch larger venthole in the plug of the gas cylinder bracket, are required to establish proper phasing and recoil of the Mod 3 gun for operating the Mk 9 feed mechanism. The sleeve is an externally threaded cylinder that screws into the rear of the housing. It preloads and retains the ring springs in the recoil housing.

Gas Mechanism Assembly

The gas mechanism unlocks the breechblock and starts it to the rear immediately after a round has been fired. The gas bracket nut secures the gas bracket assembly to the shoulder of the gun barrel. A key fitting into slots in the bottom of the bracket and the gun barrel secures the bracket in its proper angular position on the barrel. The bracket nut is also locked by the same key. The cylinder extension of the bracket guides and supports the piston end of the gas cylinder sleeve assembly. The piston and piston ring form a gas seal between the sliding sleeve and the chamber of the gas bracket. This action insures full effect of the gas pressure admitted through the vent plug. The rear of the sleeve assembly is directed by the guide attached to the top forward end of the receiver. This guide also acts as a stop for the gas cylinder sleeve spring. As the sleeve is forced to the rear by the gas pressure, it contacts a push rod on either side of the receiver. These push rods are alined with the breechblock slides and unlock the breechblock as they are forced to the rear by the gas cylinder sleeve.

A forged housing with a hollow cylinder extending towards the rear top side forms the gas bracket. The vent plug is attached to a drilled and tapped hole in the upper part of this hollow cylinder. The drilled gas hole in the barrel is situated directly under the hollow cylinder of the gas bracket. The vent plug is cylindrical and is drilled to permit passage of the necessary gas pressure for breechblock unlocking.

The gas cylinder sleeve is a piston and piston rod and extends between the gas bracket and the guide mounted on the receiver. The piston end of the sleeve in the gas bracket is actuated by the firing gases to move the sleeve rearward. The yoke arms at the rear of the sleeve contact the push rods which move the breechblock slides. This arm action unlocks the breechblock and starts it moving rearward.

The gas cylinder guide is a short cylinder attached to the receiver which guides the sleeve. The sleeve spring exerts pressure against the face of the guide. A 3-wire, twisted-strand spring (sleeve spring) fits inside the sleeve and exerts pressure against the sleeve guide to force the sleeve forward.

Breechblock Assembly

The breechblock is the reciprocating assembly that loads a round into the barrel chamber, closes the breech, fires the round, and removes the empty case. Its component parts are the bolt, breechblock slides, firing pin assembly, extractor, and the breechblock lock. (See fig. 9-5.)

The bolt is the main component of the breechblock. It closes the breech when firing and houses the firing pin group. Two horizontal slots are milled in the bolt (one forward and the other halfway aft) to provide an opening for assembly of the forward and aft slide keys. These slots are elongated to provide movement (forward and aft) during the locking and unlocking

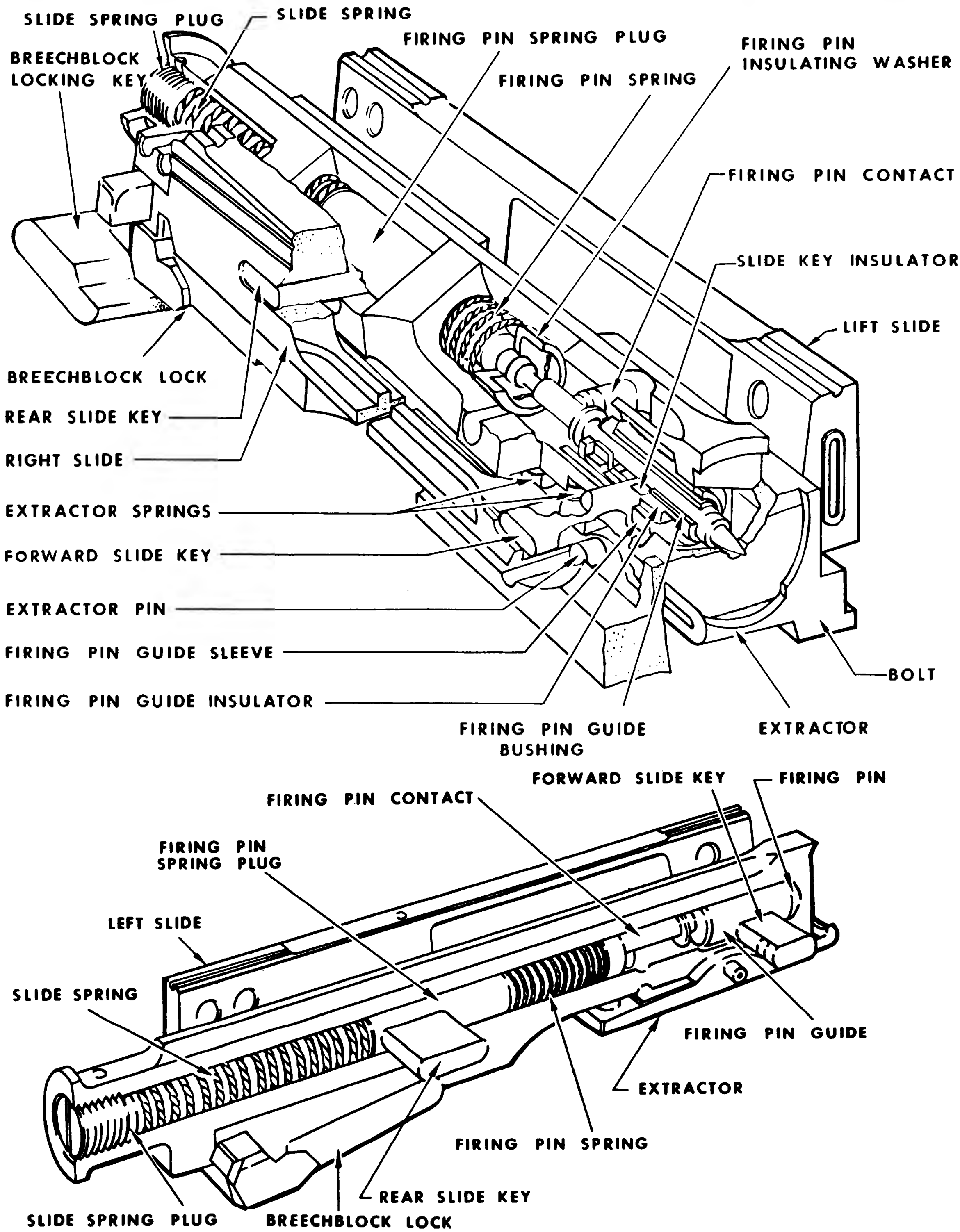


Figure 9-5.—Breechblock assembly.

of the breechblock. The firing pin, slide spring, and slide spring plug are contained in a central hole drilled the length of the bolt. A taper in this hole is provided near the forward end to permit protrusion of the firing pin tip. Two long shoulders, one on each side of the bottom of the bolt, form bearing surfaces for the breechblock assembly. A machined surface in the bottom of the bolt provides a pivot for the breechblock lock. The left side is grooved at the forward end to receive the firing pin contact.

Breechblock slides, one on each side of the bolt, support and guide the bolt in the receiver. They interlock firing and breechblock locking actions. A lug at the rear of the right-hand slide contacts the charger latch to actuate the breechblock. A contact which is insulated from the slide is located on the forward end of the left breechblock slide. This contact engages two prongs of the synchronizing switch as the breechblock slide assembly approaches its battery position.

The firing pin group completes the electrical circuit for firing the round of ammunition. The group consists of the firing pin, guide, contact, sleeve, spring plug, and spring. These components are housed in the bolt. (See fig. 9-5.) The firing pin contact connects the firing pin to the synchronizing switch. The firing pin is arranged within the bolt so that is is electrically insulated from the bolt at such times as the firing pin is retracted or the bolt is in battery with a round in the chamber. The firing pin is retracted by the forward slide key. The key extends between the breechblock slides, through the firing pin guide. When the slides are moved rearward by the gas mechanism, the firing pin carries the firing pin to a retracted position. The breechblock slides move forward on return to battery, releasing the firing pin and allowing it to be extended by the firing pin spring.

The extractor is pivoted at the bottom of the breechblock. In normal operation it aids in positioning the round during chambering, and assists in ejecting a fired round (empty case). During clearing of a misfired round, the extractor removes the round from the chamber as the breechblock is moved to the rear by the charger. The extractor is held in place on the bolt by a pin through the bolt and a two-leaf flat spring. This spring allows the extractor to pivot, thereby permitting the lips of the extractor to engage the extracting groove of the round.

The breechblock lock is rectangular, flat, and of thin cross section. The forward edge is rounded to fit into a similarly shaped slot in the rear underside of the bolt. There are two cams on the lock which engage the receiver slide cams and force the lock down as the bolt assembly comes forward into battery. The breechblock lock is then held in place by the rear of the breechblock slides bearing down on the top of the lock lugs.

Buffer Assembly

The buffer assembly is pneumatically operated. Its function is to absorb the force of the rearward movement of the breechblock, stop this motion, and return the breechblock to battery. It consists of a housing, piston, sleeve, air inlet fitting, check valve, and bleeder valve. Compressed air is admitted to the rear of the piston by the air inlet fitting and the check valve. As the breechblock moves aft and contacts the buffer piston, the check valve closes and traps this air behind the piston. The trapped air is compressed. This retards the rearward motion of the breechblock; and as the breechblock movement is stopped, the trapped air expands and drives the breechblock forward.

The buffer housing contains the piston, sleeve, and check valve. Two holes are drilled in the housing to receive the air inlet fitting and the bleeder plug. The entire housing fits into dovetail slots in the rear of the receiver and is secured by a lock plunger. The air inlet fitting and the bleeder plug may be interchanged to make either a right- or left-hand assembly.

An O-ring and two leather backup rings on the buffer piston make a snug fit of the piston in the buffer housing. The assembly is held in the housing by a sleeve screwed into the front of the housing chamber.

The check valve consists of a valve seat, a ball, and a spring. When the buffer air in the chamber needs replenishing, the ball is unseated by pressure from the aircraft's supply. The ball automatically seats to prevent loss of buffer air when the piston is moved to the rear by the breechblock.

Charger Assembly

The charger is a pneumatic mechanism which provides power operation of the breechblock for loading the first round or safetying the gun. The charger piston is actuated by compressed air from the aircraft. Its operating pressure is 1,000 psi. The components of the charger are the charger tube, piston, ram head, and a dumping valve. The entire assembly is housed in the charger tube on the side of the receiver. The forward end of the charger tube fits into the charger housing. Six holes are drilled near the rear of the tube to provide air inlets to the piston tube. (See fig. 9-6.) Compressed air is passed into the rear of the piston tube through an air hose connected to the charger housing. O-rings seal both ends of the charger tube to prevent escape of the compressed air. The dumping valve assembly is screwed into the forward end of the tube.

The piston consists of a hollow tube with a piston head at the forward end and a ram head at the other end. As the piston is actuated by compressed air, the ram head at the other end of the piston tube engages a lug on the right-hand breechblock slide. This action charges the gun. A lug on the bottom of the ram head rides in a groove inside the charger housing to prevent rotation of the piston and the ram head.

The dumping valve is located in the forward end of the charger tube, and releases the trapped air in front of the piston so that the piston is able to move forward on its return stroke. The valve assembly consists of a nylon valve seat, a valve, and a shuttle. As compressed air is admitted to the cylinder (tube) to drive the piston rearward, the valve and shuttle are also forced to the rear. This allows air to enter the forward end of the charger housing, and the shuttle seats against the valve seat to prevent air from escaping. When the pressure is cut off, the pressure trapped behind the piston moves the piston forward. Air trapped in front of the piston moves the valve and shuttle forward to close off the air inlet and open the forward chamber to the outside air.

Cycle of Operation

The discussion of the cycle of operation is predicated on the weapon being loaded and ready to fire. This operation begins with the firing of the chambered cartridge. For purposes of this text the firing cycle of operation of the Aircraft Gun Mk 12 and Mods is divided into six actions. These actions occur in the following order:

1. Recoil.
2. Slide unlocking.
3. Bolt movement to the rear.
4. Counterrecoil.

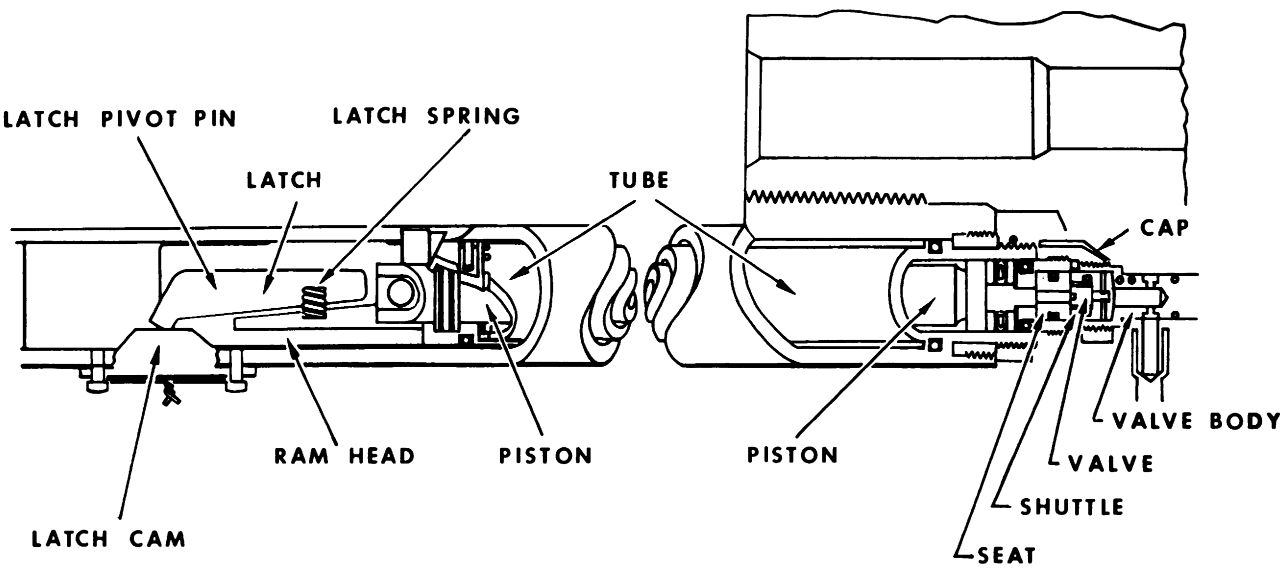


Figure 9-6.—Charger assembly.

5. Bolt movement forward.
6. Slide locking.

The six actions are discussed in the following paragraphs. Most of the actions that take place are related to the breechblock. which is the key to understanding the operation of the weapon.

When the gun is fired, the pressure of the propellent gases in the barrel forces the gun to recoil to the rear During the recoil of the gun, two important functions are performed—the unlocking of the breechblock and the opening of the breech, including case ejection.

After the gun has fired, the next action in the firing cycle is that of unlocking the breechblock. When the breech is closed, the breechblock is held forward by the breechblock lock, which bears against the breechblock locking key in the receiver. The breechblock slides prevent the breechblock lock from disengaging until after firing. After the projectile is driven past the gas port, the propellent gases are allowed to enter the port and move the gas cylinder sleeve assembly to the rear.

As the gas cylinder assembly moves to the rear, it forces the push rods back, also moving the breechblock slides rearward. As the breechblock slides move to the rear, the forward slide key retracts the firing pin, and the rear slide key retracts the firing pin spring plug to compress the breechblock spring. As the slides approach the end of the unlocking stroke, the rear end of the lock is uncovered, allowing it to rise clear of the locking key, thus unlocking the breechblock. At the end of its stroke, the gas cylinder sleeve strikes the receiver and is returned to its original position by the gas cylinder sleeve spring.

When the unlocking operation is complete, the breechblock is driven to the rear of the receiver primarily by the blowback action of the expanded gases that remained in the gun barrel. As the breechblock moves rearward, the case of the expended cartridge is carried with it by the extractor. Blowback action also aids in extracting the case from the chamber.

Near the end of the breechblock's rearward movement, the expended cartridge case is contacted by the ejector on the feed mechanism. This action forces the case down and out of the weapon through the ejection slot in the receiver. The extractor, which is forced down during ejection, is returned to its normal position by spring action.

When the weapon approaches the point of maximum recoil, both the recoil spring and the ring spring start to recover from the recoil action and begin to expand. The spring expansion starts the counterrecoil action which returns the gun to battery. However, the breechblock is still traveling rearward when the counterrecoil action begins. The breechblock continues its rearward travel until it strikes the piston of the pneumatic buffer. (NOTE: The counterrecoil of the gun moves the buffer forward as the breechblock is traveling rearward, thus increasing the closing speed of the two components.)

The buffer, which is connected to a continuous supply of compressed air, absorbs the force of the breechblock and stops its rearward movement. However, as the buffer piston is forced rearward, the check valve prevents the escape of the air from the buffer and the pressure within the buffer is greatly increased. Expansion of the compressed air within the buffer forces the buffer piston forward, starting the breechblock forward to close the breech. When the battery position is reached, a shoulder on the gun barrel contacts the rear follower of the ring spring, thereby compressing the ring springs and absorbing the counterrecoil energy.

The accelerating force provided by the expanding air in the buffer is sufficient to move the breechblock to its battery position. However, as the breechblock moves forward, it picks up the round from the feed throat of the feed mechanism. As the breechblock continues forward, it carries the round with it and positions it in the chamber of the gun. As the round is chambered, the lip of the round is engaged by the extractor and thus is ready for extraction after firing.

When the breechblock reaches the end of its forward motion, it seats against the rear face of the gun barrel, closing the chamber. Simultaneously, the breechblock lock is forced to rotate downward by the action of the cam surface on the end of the receiver slides and the pressure of the breechblock slides. The pressure exerted by the breechblock slides is the result of the inertia of the slides and the expansion of the slide spring, housed within the breechblock.

When the breechblock is approximately 1/8 inch out of battery, the firing pin contact engages the A ignition squib (fig. 9-7) of the synchronizing switch. As the breechblock slides

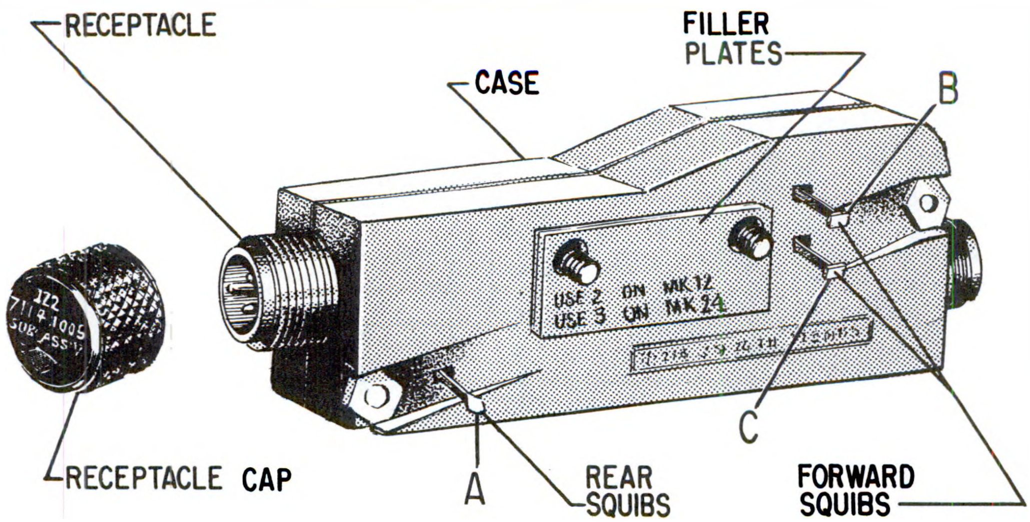


Figure 9-7.—Synchronizing Switch Mk 1 Mod 1.

continue to move forward, after the breechblock has reached its battery position, the firing pin guide is carried forward by the forward slide key. This allows the firing pin spring to place the firing pin into contact with the electric primer 1/4 inch before the slides have reached their full forward position. Simultaneously, the breechblock slide contact located on the forward end of the left breechblock slide, bridges the gap between the synchronizing switch squibs B and C as shown in figure 9-7. When the three synchronizing switch contacts are closed and the firing pin is in contact with the primer, the round may be electrically fired. The weapon then goes back into the recoil phase of its operation.

Figure 9-8 shows the wiring of a single free-firing gun installation. Current from the aircraft supply flows through pin C of the receptacle to squib C of the synchronizing switch. When the left breechblock slide nears its locked (battery) position, contact is made through squibs B and C and the bolt contact completes the circuit through squib A.

Figure 9-9 shows two guns wired for synchronized firing and free firing of either gun. Current is supplied to squib C of the synchronizing switches of both guns. By moving the breechblock of gun number 2 into battery ahead of gun number 1, the current flows from squib C of gun number 2 through its breechblock slide contact to squib B and then to squib A of the synchronizing switch of gun number 1. The breechblock of gun number 1 then comes forward, and the current supply to its synchronizing switch at squib C is allowed to flow through to squib B. Simultaneously, the bolt contact (breechblock slide contact) completes the circuit to its firing pin from squib B in gun number 2, and the current from squib B in gun number 1 flows through squib A of gun number 2. This allows both guns to fire together.

If there is a jam or other casualty in either gun while firing, the FREE-SYNC switch in the firing circuit should be turned to the FREE

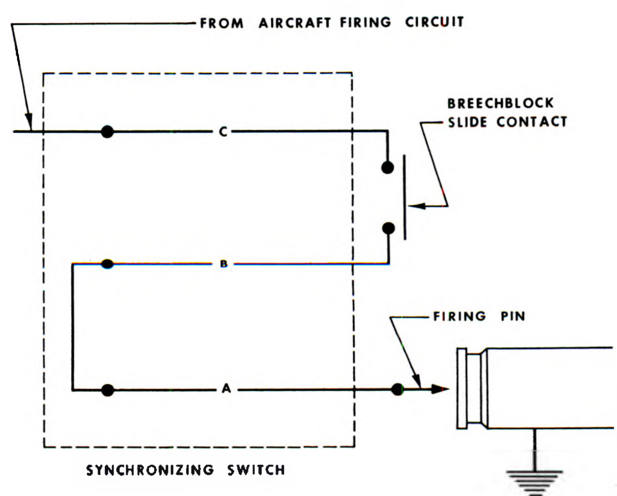


Figure 9-8.—Schematic diagram of firing circuit for a single gun.

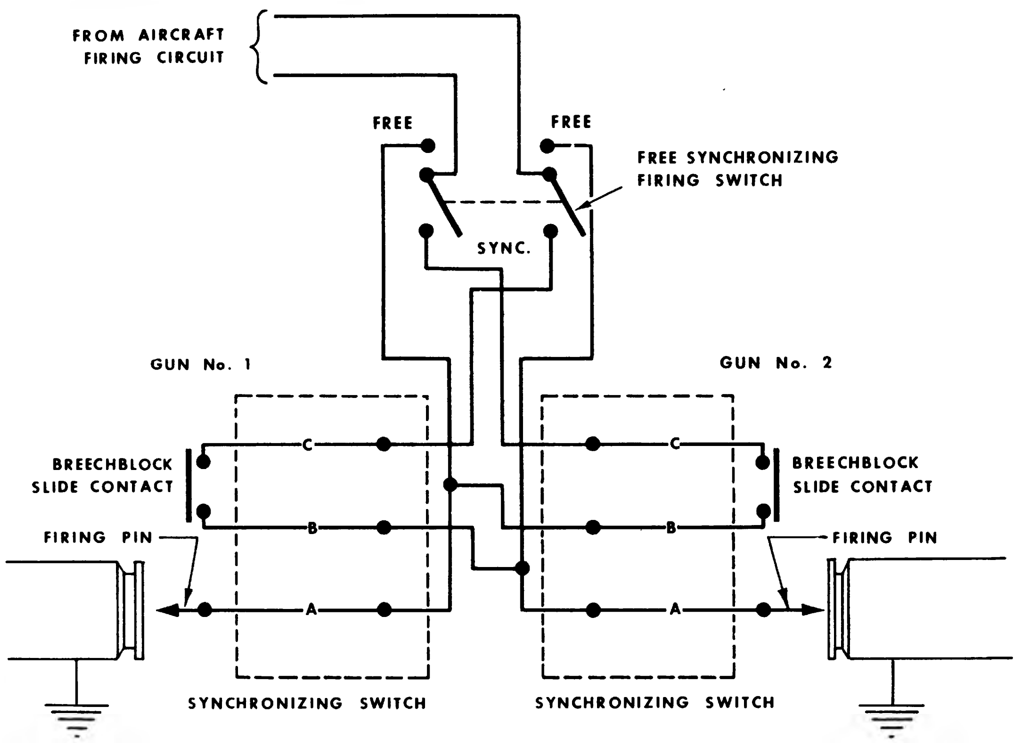


Figure 9-9.—Schematic diagram of firing circuit for synchronized guns.

position. This permits the current to flow directly through squib A to the firing pin of the usable gun. In this condition, the firing takes place immediately when the firing pin contacts the cartridge primer.

OTHER COMPONENTS AND ACCESSORIES

SYNCHRONIZING SWITCH MK 1 MOD 1

The synchronizing switch shown in figure 9-7 contains three contacts which operate with the breechblock to complete the firing circuit. The case is composed of two halves bolted together. The electrical components consist of the A, B, and C squibs (two forward and one aft as shown); two connectors; and interconnecting wires. The filler plates shown in figure 9-7 may be used when mounting the switch to the gun, depending upon whether the receiver of the gun is recessed or a flat surface. The two forward squibs of the switch represent a gap or break in the circuit which must be closed before the gun can fire. The rear squib is the contact for the firing pin which makes contact when the breechblock is in battery. In operation the break between the two forward squibs is closed by the breechblock before it reaches battery position.

FEED MECHANISM MK 7 MOD 2

The 20-mm Feed Mechanism Mk 7 Mod 2 is a pneumatically operated device for feeding 20-mm belted ammunition into Mk 12 Mod 0 type gun mechanisms. The feed mechanism is driven by an air motor on the mechanism, which is supplied with compressed air from the aircraft's pneumatic system.

The ammunition links used are the 20-mm Ammunition Link Mk 2 Mod 2 together with an end link Mk 2 Mod 1. (The Mk 2 Mod 0 link will be used until the supply is exhausted.)

The 20-mm Feed Mechanism Mk 7 Mod 2 is a pneumatic, reciprocating, piston type mechanism mounted on top of the gun receiver body. Design features of the mechanism are low profile, lightweight, and the ability to sustain high rate of gunfire with no adverse load on the gun mechanism and no adverse effect on the rate of gunfire. The mechanism can be quickly installed and removed, and permits installation of guns at the closest stagger which will allow free passage of ammunition. Identical components are required for right- and left-hand installation. This feature allows interchanging of components for feeding from either side of the mechanism.

Components

Subassemblies are the smallest grouping of parts that can be assembled together without disconnected parts to form a selfcontained unit.

Groups are related parts that serve a particular function.

Components are all parts of the mechanism, and are classified according to their function.

Major components (designated as to importance of function) are:

1. Cover and drive assembly.
   a. Cover subassembly.
   b Drive group.
2. Feed throat assembly.
   a. Round control group.
   b. Holding pawl group.
   c. Ejector group.
   d. Throat.
3. Tie bar assembly.

Component Arrangement

The feed mechanism is secured to the top of the receiver body by six locking lugs and two tie bar assemblies. The upper section of the feed mechanism is the cover and drive assembly. The drive group is bolted to the top of the cover with three flathead and three roundhead machine screws. Each screw is secured with a self-locking nut.

The throat assembly comprises the lower section of the feed mechanism. It is mounted on top of the gun receiver. Its lower section fits into the receiver body directly above the bolt passageway. The feed throat, which is made up of the throat, end plates, and tie bar bracket supports the holding pawl group, round control group, and the ejector group.

The tie bar assembly secures the feed mechanism to the support located forward of the feed mechanism. Each tie bar assembly has a knurled spring loaded snap lock that fastens it to the lug on the forward end of the throat. The forward ends of the tie bars are attached to the forward supports by a bolt and nut arrangement.

The drive group functions to actuate the drive slide. Drive pawls on the drive slide engage the ammunition links and drive the ammunition belt into the mechanism. The belt holding pawls retain the ammunition belt in the mechanism as the drive pawls move to engage the link. The link guide and T-rail guide, which are parts riveted on the underside of the cover, direct the ammunition belt into the round control group. The stripper removes the link from the ammunition as the link is moved across the stripper by the drive pawls. A bridge on the link supports the link on the stripper. The round is cammed into the feed throat by the stripper and forward guide cam surfaces. The holddown pawl, located in the stripper, bears on top of the round when the round is in the feed throat.

For further details on the 20-mm Feed Mechanism Mk 7 Mod 2 refer to the Maintenance Instructions Manual, NavWeps OP 1912 (latest revision).

FEED MECHANISM MK 9 MODS 4 AND 5

The feed mechanism is a recoil-operated spring driven device designed for feeding belted ammunition into the 20-mm Aircraft Gun Mk 12 Mod 3. There are two Mods of feed assemblies—the Mk 9 Mod 4, which feeds ammunition into the gun from the right-hand side; and the Mk 9 Mod 5, which feeds ammunition into the gun from the left-hand side. The 20-mm Feed Mechanism Mk 9 Mod 4 installed on the 20-mm Aircraft Gun Mk 12 Mod 3 is shown in figure 9-3.

The feed mechanism, which is initially spring powered, must be manually wound as the ammunition belt is threaded into the mechanism. This discussion is predicated on the feed mechanism having been threaded and ready for operation.

The feed mechanism (fig. 9-10) is composed of three major assemblies; namely, feedway assembly, driving assembly, and winding assembly. The operation of each assembly is discussed individually.

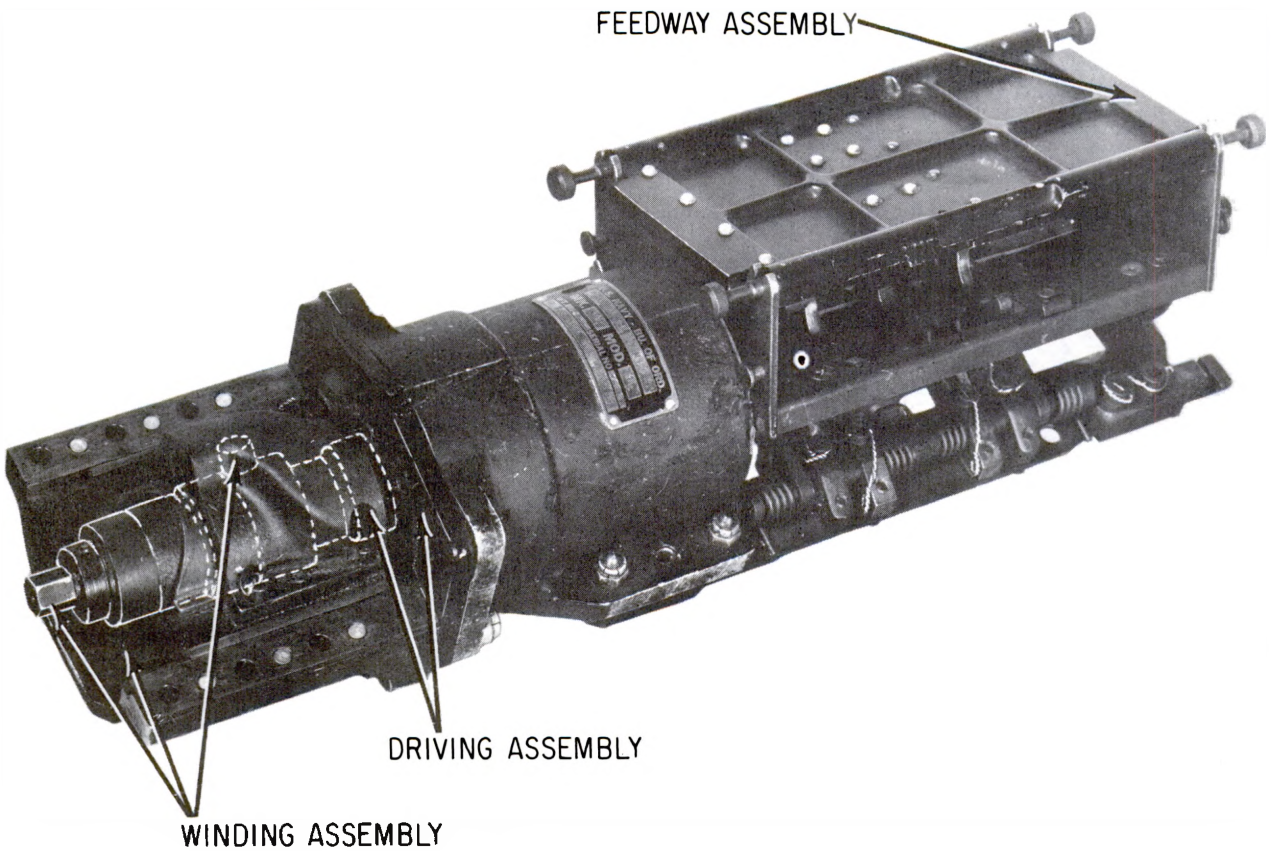


Figure 9-10.—20mm Feed Mechanism Mk 9 Mod 4.

Feedway Assembly

The feedway accepts the belted ammunition, strips the round from the link, and rotates it down into position to be picked up by the gun bolt. As the belted ammunition enters the feedway, the round is engaged by the forward and aft starwheels. On the starwheel shaft, in addition to the starwheels, are two stripping cams. These cams are positioned with respect to the starwheels so that when the starwheel shaft is rotated, both the starwheels and the cams position the linked round on the stripper finger and T-rail. As the starwheel shaft continues to rotate, the stripping cams combine with the T-rail and stripper finger so that after approximately 15° rotation of the starwheel shaft, round No. 1 is stripped free of the link. As rotation of the starwheel shaft continues, No. 2 and No. 3 rounds are stripped from their links. The first round has now partially displaced the control pawl as the round comes to a position on top of the gun bolt. When the gun bolt moves to its aft position, rotation of the starwheels, in conjunction with the camming action of the round control pawl, moves the round against the round guides. This controls the path of the round to the position for gun bolt pickup.

When the round is in the pickup position, the round control pawl is free to return to the vertical position. When using applicable end links, this feed mechanism will strip and position for chambering the last round in the ammunition belt.

Driving Assembly

The drive assembly portion of the feed mechanism (fig. 9-10) is basically a spring motor. It consists of a spring housing, power spring, spring arbor, and winding shaft. One end of the spring is secured to the spring housing and the other end to the spring arbor, which is secured to the starwheel drive shaft. A detent lock arrangement permits rotation of the starwheel shaft. The power spring is wound by the rotation of the spring housing while the detents hold the arbor and prevent rotation. The winding shaft is splined to the spring housing.

Winding Assembly

The winding assembly is composed essentially of cams and clutches which serve to impart the necessary rotation to the winding shaft to wind the spring in the driving assembly. The recoil and counterrecoil of the gun receiver are converted to rotary motion by the winding assembly.

The winding assembly (fig. 9-10) is arranged so that a cam assembly, in which the clutch assembly is seated, can move fore and aft with the recoil and counterrecoil of the gun. A pin on the bottom of the cam assembly, which fits in a hole in the top of the gun receiver, makes this possible. The rollers are attached rigidly to the clutches and bear against the cam surfaces in the cam assembly. The clutches are coil spring assemblies which grip the winding shaft when rotated in one direction and release the shaft when rotated in the other direction. Thus, if each clutch works opposite to the other, the recoil and counterrecoil of the gun move the cams in a direction that causes first one clutch and then the other to impart rotation to the winding shaft.

AMMUNITION BELTING SYSTEM MK 2 MOD 0

Ammunition Belting System Mk 2 Mod 0 is a motor-driven assembly for mechanically linking (using Mk 2 links) 20-mm aircraft ammunition in preselected ratios to form a continuous belt.

This system automatically performs three functions:

1. It feeds the links and connects them together in a continuous string.
2. It selects and feeds different types of ammunition in preset ratios.
3. It either links or delinks at speeds up to 250 rounds per minute. Normally motor driven, the system may also be manually operated. Converting from linking to delinking is a simple and quick operation.

For detailed information pertaining to description, operation, and maintenance, refer to the publication Ammunition Belting System Mk 2 Mod 0, NavWeps OP 2181 (latest revision).

NOTE: Ammunition used in the Mk 12 (and Mk 11) aircraft gun is covered in chapter 8 of this text.

SMALL ARMS

Strictly defined, the term "small arm" means any firearm of caliber .60 or smaller. However, the term is generally considered to mean a weapon intended to be fired from the hand or shoulder, such as rifles and pistols.

The various types of weapons classed as small arms are as follows:

Pistols and revolvers.
Rifles.
Carbines.
Submachine guns.
Automatic rifles.
Shotguns.

AUTOMATIC PISTOL, CALIBER .45, MODEL 1911A1

This pistol, often called the "Colt .45" or "Colt Automatic," is the standard service pistol and is issued to officers as a defensive sidearm, and on occasion to certain petty officers. It is often carried by sentries and other watchstanders.

During the uprising of the Moro tribes in the Philippines during the early part of the 20th century, it was found that the fanatic tribesmen often were not stopped when hit by projectiles from the .38 caliber sidearms then in use by American troops. This lack of stopping power was one of the factors which led to the adoption of the .45 caliber automatic pistol as the official United States sidearm in 1911.

The pistol was designed and patented by John M. Browning who was probably the world's greatest inventor of automatic weapons. The original Model 1911 differs from the current model 1911A1 only in minor detail, and the two operate exactly alike. The Model 1911A1 is a recoil-operated, magazine-fed, self-loading hand weapon, with a magazine capacity of seven rounds.

The essential features of the Automatic Pistol, Caliber .45, Model 1911A1 are as follows:

Caliber of bore . . . . 0.45 inch.
Number of grooves . . . . 6.

Uniform twist in rifling, left-hand.	1 turn in 16 inches.
Length of barrel	5.03 inches.
Overall length of pistol	8.6 inches.
Weight of pistol	2 pounds 7 ounces.
Muzzle velocity	830 fps.
Maximum range	1,600 yards at 30° elevation.
Maximum effective range	75 yards.

The two principal groups of the pistol are the slide and the receiver. There is no separate bolt, a portion of the slide serves as a breechblock. In the firing position, the barrel is locked to the slide by means of the transverse ribs which can be seen on the upper side of the breech end of the barrel in figure 9-11.

Operation

A loaded magazine is placed in the receiver and the slide is drawn fully back and released, thus bringing the first cartridge into the chamber. (If the slide is open, push down the slide stop to let the slide go forward.) The hammer which is now cocked is subjected to the pressure of the mainspring, but caught and held by the sear. When the trigger is pressed, the trigger yoke (not shown in fig. 9-11) pushes the disconnector back against the sear, pivoting the upper tip of the sear forward out of the full-cock notch on the hammer. The hammer strut is forced upward by the mainspring, rotating the hammer forward to strike the firing pin. The firing pin is the "floating" or inertia type—when the hammer is forward in the firing position, the firing pin is still too short to touch the primer of the chambered round. For positive ignition, full hammer travel is required to drive the firing pin into the primer. The firing pin spring then forces the firing pin into the out-of-battery position.

As the round is fired, the projectile is driven forward and recoil starts in the opposite direction. The barrel and slide, being locked together by the locking ribs, recoil together for a distance of about 1/8 inch. The barrel is secured to the receiver by the barrel link and slide stop pin. As the barrel moves rearward, the link rotates about the slide stop pin, with a resultant lowering of the breech end of the barrel. When the barrel locking ribs clear the grooves in the slide, a lug on the bottom of the barrel strikes the receiver, stopping the barrel while the slide is free to continue rearward, and the extractor pulls the empty case from the chamber. As it is being pulled to the rear after clearing the chamber, the case strikes the fixed ejector on

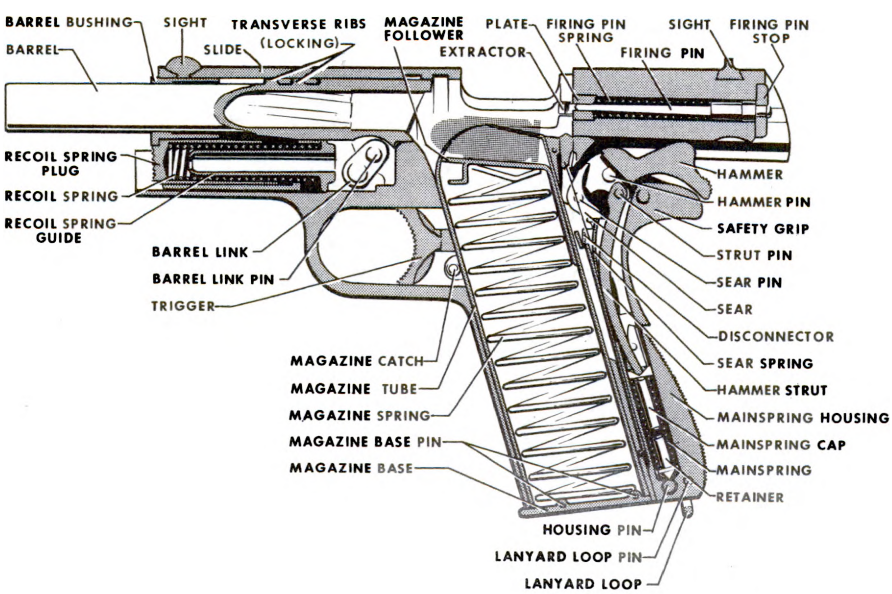


Figure 9-11.—Sectional view of Pistol, Caliber .45, Model 1911A1.

the upper left side of the receiver and is flipped up and out to the right.

As the slide clears the magazine, the magazine follower, pressed upward by the magazine spring, forces the next round up into the path of the slide. (If the magazine is empty, the magazine follower forces the slide stop upward which locks the slide back when it reaches full recoil. The slide stop is not shown in figure 9-11.) The recoiling slide pivots the hammer backward, forcing the hammer strut downward and compressing the mainspring. The bottom of the sear is constantly pressed forward by the long leaf of the 3-leaf sear spring so that the upper tip of the sear is pivoted backward to engage the full-cock notch of the hammer. This locks the hammer back in the cocked position against the pressure of the mainspring.

The recoil spring, which has been compressed as the slide recoils, now forces the slide forward (counterrecoil). The slide engages the next round; and as it is guided by the lips of the magazine and the loading ramp on the breech end of the barrel, shoves it forward and into the chamber. As the slide continues forward, it strikes the rear of the barrel extension, forcing it forward. The barrel link pivots upward around the slide stop pin, raising the rear of the barrel to engage the locking ribs with the grooves in the slide and locking the barrel and slide together. The joint forward movement of the slide and barrel is halted by the lug on the barrel striking the slide stop pin. The pistol is now loaded and cocked, and pressing the trigger will fire the chambered round and repeat the cycle of operation.

It should be noted that the weight of the slide and barrel is so much greater than the weight of the bullet that the latter has been given its maximum velocity and has been driven from the muzzle before the slide and barrel have recoiled to the point where unlocking occurs.

Safety Devices

The Automatic Pistol, Caliber .45, Model 1911A1 has five safety devices. These devices are discussed in detail in the following paragraphs.

The SAFETY LOCK is located on the left side of the receiver, just below and forward of the hammer. In the ON position a projection on the safety lock positively blocks any movement of the sear as well as locking the slide. The safety lock must be in the down or OFF position to fire. The safety lock is not shown in figure 9-11.

The GRIP SAFETY, located on the back of the grip or handle, has a projection which blocks any rearward movement of the trigger yoke. The grip safety is held in the ON position by the right leaf of the 3-leaf sear spring unless the pistol is properly held in the hand, when the grip safety is pivoted inward by the pressure of the hand. This moves the projecting lug upward to clear the trigger yoke.

The DISCONNECTOR, shown in figure 9-11, provides a connection between the end of the trigger yoke and the sear, and it is normally held in this position by the center leaf of the sear spring. The underside of the slide has a cutout portion to accommodate the upper tip of the disconnector when the slide is in battery. When the slide moves from its firing position, the tip of the disconnector is cammed down, disconnecting the sear from the trigger yoke (hence the name "disconnector"). Even though disconnected from the trigger, such as during recoil, the sear is free to pivot on its pin and catch the hammer in the full-cock position. It can be seen that once the trigger is pressed and the chambered round fired, the trigger must be released before firing again in order to take pressure off the disconnector and allow the disconnector to move up under spring pressure to provide a link between trigger and sear. Thus, the disconnector prevents automatic fire as well as accidental discharge before the slide is in full battery position and locked.

The INERTIA FIRING PIN is also considered as a safety device. The action of the "floating" firing pin has already been described under types of operation.

The HALF-COCK NOTCH, shown in figure 9-11, functions as a safety device. The tip of the sear which engages the hammer is constantly pressed by its spring against the hammer. As the hammer is being cocked by hand, the sear first snaps into the half-cock notch, then continues on to the full-cock notch. Should the hammer slip during manual cocking while the tip of the sear is between the half-cock and full-cock notches, the hammer will fall only as far as the half-cock notch where it will be engaged by the sear. (Should it slip before reaching the half-cock notch, hammer travel will be insufficient to cause the inertia firing pin to fire the round.) It can be seen in figure 9-11 that the shape of the half-cock notch prevents the sear from coming off the notch except when the hammer is pulled farther back.

When the last round is fired, the magazine follower forces the slide stop upward to engage a notch in the slide and locks the slide open in the full recoil position. The operator then knows the pistol is empty. To reload, the magazine catch just behind the trigger on the left side of the receiver is pressed. The empty magazine falls out due to a combination of gravity and spring pressure from the magazine spring and a fresh magazine is inserted in the grip. By depressing the slide stop with the thumb, the slide is released, loading a round in the chamber and leaving the pistol ready to commence firing. Magazines should be handled carefully, as damaged or bent magazines cause the great majority of all pistol malfunctions.

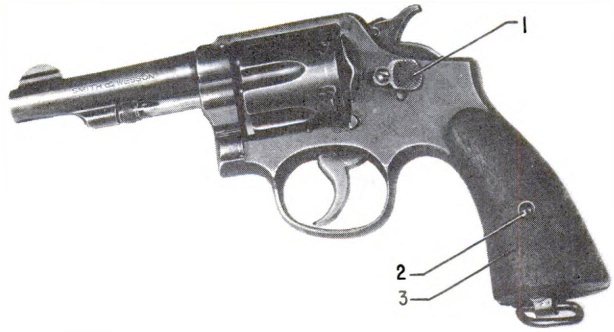
The caliber .45 pistol is probably the safest to handle and certainly one of the best designed military pistols in the world. It can take severe use and treatment and still function safely and properly; and in the hands of a trained man it is quite accurate. On the other hand, carelessness and ignorance of the weapon have resulted in many accidental injuries and deaths which could have been avoided.

REVOLVER, SMITH AND WESSON CALIBER .38 SPECIAL

The caliber .38 revolver (fig. 9-12) was issued during World War II as a substitute for the service sidearm, the Automatic Pistol, Caliber .45, Model 1911A1, and many are still in use. Because of its lighter weight, the .38 revolver is frequently issued to flight personnel instead of the .45 caliber pistol. The revolver is a double-action, 6-shot, cylinder-loading, manually operated hand weapon.

Although the revolver is designated as a .38 caliber weapon, it is like most so-called .38's and actually has a bore diameter of 0.357 inches. Other essential features are the following:

Number of grooves (right-hand twist). . . . . . 5.
Overall length of revolver . . . . . 9 1/4 inches.
Weight of revolver . . . . 29 ounces.
Muzzle velocity . . . . 870 fps.
Maximum range . . . . 1,600 yards.
Maximum effective range . . . . 50 yards.



1. Thumbpiece (cylinder release).
2. Stock screw.
3. Stock.

Figure 9-12.—Revolver, Smith and Wesson Caliber .38 Special.

Nomenclature

Before discussing the operation of the caliber .38 revolver, we will first consider the nomenclature of its major components. The revolver consists of two main groups—the cylinder group and the frame group.

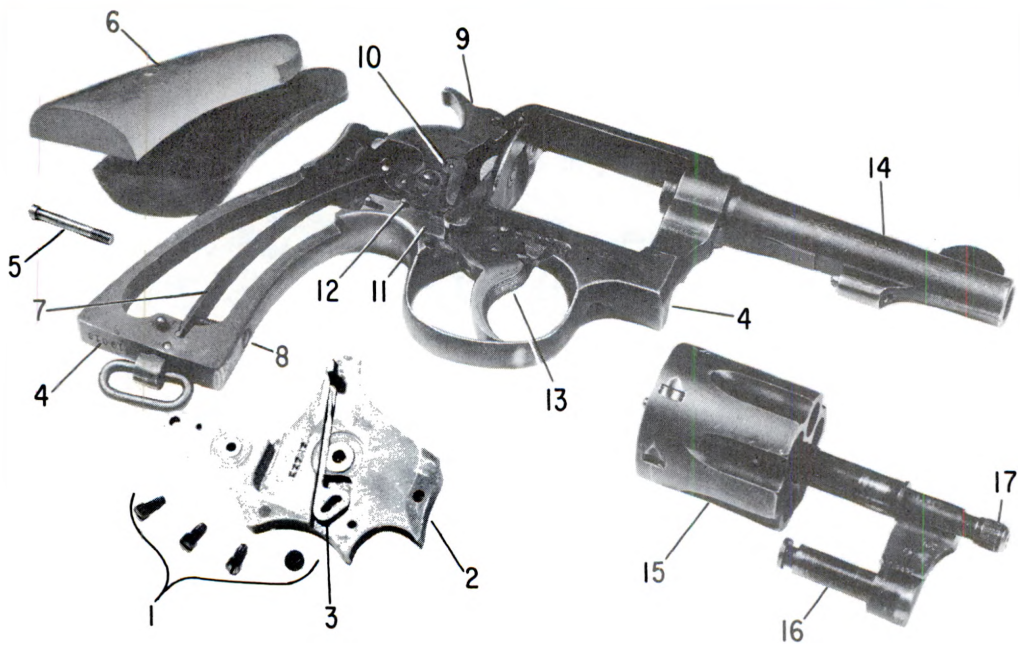
The components of the revolver and their nomenclature are shown in figure 9-13.

Operation

For the purpose of this discussion, operation of the revolver is limited to loading, firing, and unloading. To load the revolver, the cylinder must be swung out by pushing forward on the thumb latch and applying a little pressure on the right side of the cylinder. However, the thumb latch will not release the cylinder if the hammer is in the cocked position. (NOTE: The cylinder should never be flipped out sharply because of the likelihood of bending the crane, thus throwing the cylinder out of timing.)

Insert a round in each of the six chambers in the cylinder and swing the cylinder back into position; the weapon is then loaded and ready to be fired.

In firing single action, the hammer is drawn back to the full-cocked position with the thumb. NOTE: During the manual cocking action, the cylinder is rotated by hand and locked in the firing position by the cylinder lock. The hammer is held in the cocked position by the sear until released by the trigger. The weapon is fired by aiming the weapon at a



1. Sideplate screws.
2. Sideplate.
3. Hammer block.
4. Frame.
5. Stock screw.
6. Stocks.
7. Mainspring.
8. Mainspring strain screw.
9. Hammer.
10. Sear.
11. Rebound slide.
12. Hammer block pin.
13. Trigger.
14. Barrel.
15. Cylinder.
16. Crane or yoke.
17. Ejector plunger.

Figure 9-13.—Revolver, Smith and Wesson Caliber .38; right-side view with cylinder and ejector group, sideplate, and stocks removed.

target and applying a steadily increasing pressure on the trigger until the hammer is released.

Cartridges or empty rounds are ejected by swinging the cylinder out to the left and pushing the extractor plunger toward the rear of the cylinder. If undue pressure is required to eject the cases, it is an indication of dirty, rusty, or worn chambers.

Careful observation of the operation of the revolver will show the effect of two safety devices—the hammer block and the rebound slide. The hammer block prevents the hammer from going far enough forward to strike the primer when both the hammer and trigger are in the forward or uncocked position. Thus, if the revolver were dropped or otherwise struck on the hammer, the round would not be fired. The rebound slide actuates the hammer block to prevent the hammer from traveling far enough to strike the primer of the round to be fired should the hammer slip from the thumb while being manually cocked.

U. S. CARBINE, CALIBER .30, M1A1, M2, AND M3

The first of this series of carbines (short, light rifles) was the M1 (fig. 9-14) which was developed by Winchester Arms early in World War II. It was issued extensively by the Army and Marine Corps, advance base units, construction battalions, and various units of the Navy. The various models of carbines have an effective range of 300 yards and are much more useful than a revolver in the hands of a man who has received normal marksmanship training.

One disadvantage of the carbine is that its projectile does not have the "stopping power" of the .45 caliber pistol projectile. However, this disadvantage is more than offset (except in very close combat) by the ability of the average man to hit a target with the carbine at greater range than is possible with a pistol. The later models of carbines (M2 and M3)

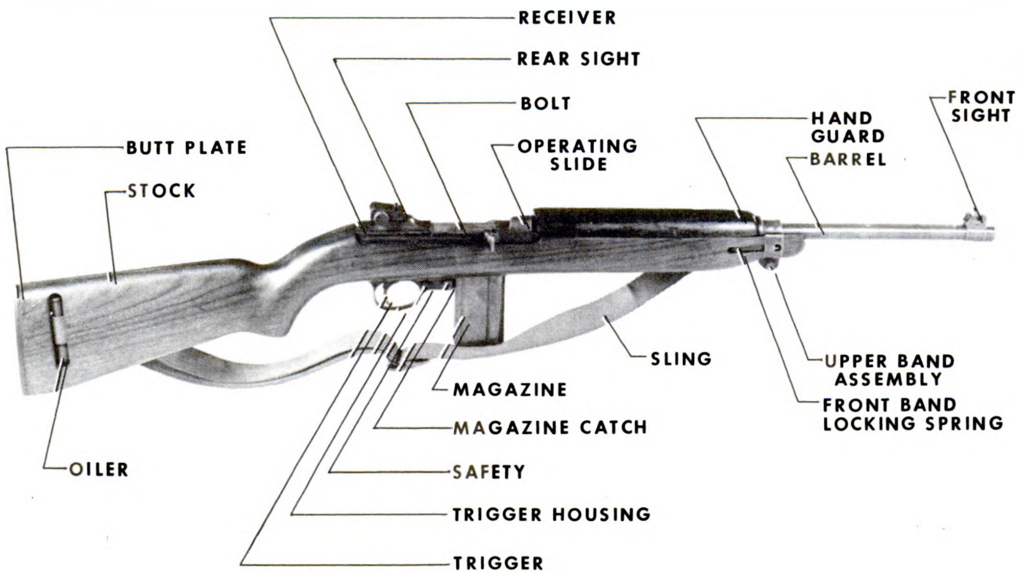


Figure 9-14.—U.S. Carbine, Caliber .30, M1.

can be fired fully automatic, and this adds greatly to the firepower of a unit.

The carbine is a short recoil, gas-operated, self-loading, air-cooled shoulder weapon, fed by a 15-round or 30-round magazine. Carbines M1 and M1A1 deliver only semiautomatic fire, while carbines M2 and M3 deliver either semiautomatic or full-automatic fire controlled by the operator through the use of a selector.

The only difference between the M1 and M1A1 carbines is the stock. The M1 has a one-piece wooden stock, while the M1A1 has a folding metal stock extension and a wooden handgrip. All solid stock models are normally equipped with a web sling.

The M2 carbine is the same as the M1 except for differences in design of a few components and the addition of others which permit the M2 to deliver either semiautomatic or full-automatic fire. The M3 is the same as the M2 except that the rear sight is not included and the top of the receiver is designed to accommodate special sighting equipment (sniperscope).

The M1 is the model most frequently encountered in the Navy. Therefore, only the M1 is discussed in this text. However, the M2 and M3 are identical to the M1 in most respects. The following data applies to both the M1 and the M2:

Weight (with empty 15-round magazine).	5.5 pounds.
Weight (with loaded 15-round magazine).	6.1 pounds.
Weight (with loaded 30-round magazine).	6.6 pounds.
Overall length	35.6 inches.
Muzzle velocity	1,970 fps.
Maximum range	2,200 yards at 30 degrees elevation.
Effective range	300 yards.
Length of barrel	18 inches.
Rifling, right-hand, one turn in.	20 inches.
Grooves in barrel	4.
Rate of fire, full automatic (M2 only).	750-775 rounds per minute.

Early models of the M1 carbine are equipped with an L-type rear sight, consisting of two arms at right angles, each pierced with an aperture. Either arm may be raised into position; the shorter arm is computed for 150 yards range and the longer for 300 yards. No windage adjustment is provided. These earlier models also had no provision for fixing a bayonet to the carbine.

Later models of the M1 have an adjustable sight graduated from 100 to 300 yards in divisions of 50 yards, and may be adjusted to either side to allow for wind. The upper band, which holds the stock to the barrel, incorporates a bayonet stud so that a bayonet may be secured to the carbine if desired. Both types of M1 carbines are utilized by the Navy.

U. S. RIFLE, CALIBER .30, M1

The U. S. Rifle, Caliber .30, M1 (fig. 9-15) is used by the Navy for ship's landing forces, drill, and marksmanship training. It is also the service rifle for officer training, recruit drills, and other naval training activities. This weapon replaced the bolt-operated Springfield Rifle, Caliber .30, as the standard United States service rifle. It is frequently referred to as the "Garand" after its inventor, John C. Garand.

The Garand is a clip-fed, gas-operated, air-cooled semiautomatic shoulder weapon. Clip fed means that the rifle is loaded by inserting a metal clip containing a maximum of eight rounds into the open receiver. After the first shot is fired, the power to chamber succeeding rounds and to cock the firing mechanism comes from the expanding gases of the previously fired round. When the last round is fired, the empty clip is ejected and the bolt remains open, indicating that the weapon is empty. The weapon has a fixed front sight and a rear sight which is adjustable in elevation and windage.

7.62-MM RIFLE M14

A new small arm presently in use in the Navy is the 7.62-MM Rifle M14. This rifle is expected in time to replace the M1 rifle, the M1 carbine, and all submachine guns. The rifle (fig. 9-16) is similar in appearance to the M1 rifle.

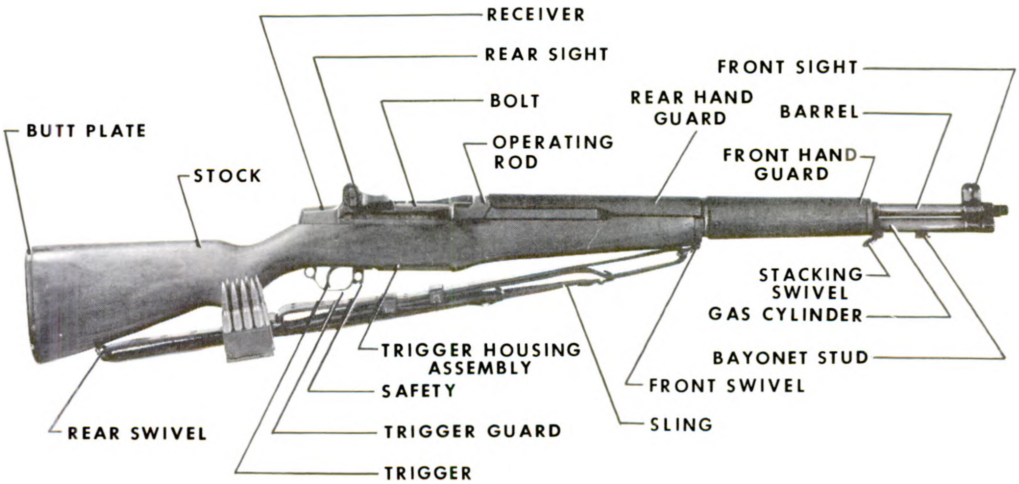


Figure 9-15.—U.S. Rifle, Caliber .30, M1.

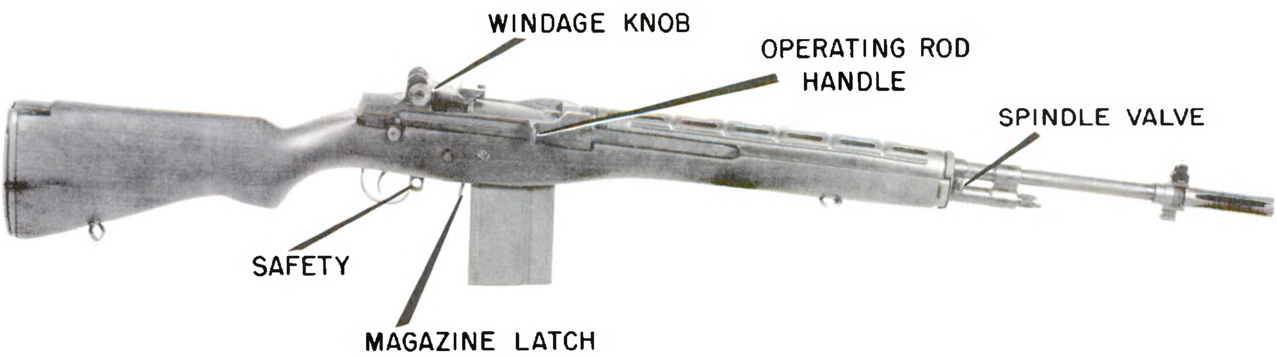


Figure 9-16.—7.62-mm Rifle M14.

The rifle is designated as the 7.62-mm Rifle M14 and may be supplied with a bipod to make the weapon more versatile. The 7.62-mm Rifle M14 is a lightweight, air-cooled, gas-operated, magazine-fed, shoulder weapon, designed for semiautomatic or full-automatic fire at the cyclic rate of 750 rounds per minute. The rifle is chambered for the 7.62-mm NATO cartridge and is designed to accommodate a 20-round magazine cartridge, the M2 rifle bipod, the M76 grenade launcher, and the M6 bayonet.

The overall length of the rifle (with flash suppressor) is 41.31 inches. The weapon has a muzzle velocity of 2,800 feet per second (fps) and a maximum range of 3,200 meters. Empty, the rifle weighs approximately 9 pounds. Fully loaded and ready to fire, the weapon weighs approximately 11 pounds.

Rifle Controls

The selector is located on the right side of the receiver just below the rear sight. Its function is to regulate the firing of the rifle as a semiautomatic or automatic weapon. When the selector is positioned with the face marked A toward the rear and the projection upward, the rifle is set for automatic fire. When the face marked A is away from the marksman, the weapon is set for semiautomatic operation.

The trigger and sear assembly is located inside of the guard assembly and is part of the firing mechanism. Its function is to control the type of operation (semiautomatic or automatic).

The safety is located on the firing mechanism near the guard assembly. Its function, when pressed to its rear position, is to lock the trigger, sear, and hammer, thus preventing firing of the rifle. The safety must be pressed to the forward position before the weapon can be fired.

The gas spindle valve is located at the front end of the stock and is connected to the gas cylinder. Its function is to control the gases used in firing the rifle and/or rifle grenade. When the slot of the spindle valve is in the vertical ON position, the spindle valve is open, releasing gases necessary for functioning of the rifle. When the slot is in the horizontal or OFF position, the spindle valve is closed. This permits full pressure of the gas to be utilized in propelling the rifle grenade and prevents bypass of the gas into the gas cylinder.

The windage knob is located at the right rear of the receiver. Its function is to adjust the lateral movement of the rear sight. To move the sight to the right, turn the knob clockwise. To move the sight to the left, turn the knob counterclockwise.

The pinion assembly is located at the left side of the receiver and is calibrated in meters. Its function is to adjust the elevation of the aperture (turn the pinion clockwise to raise—counterclockwise to lower).

The operating rod handle, located on the right-hand side of the receiver, is used to manually operate the rifle by moving the operating handle to the rear position and releasing. This permits the force of the magazine spring to position the top round in the path of the bolt after the operating rod has moved the bolt to its rearward position. As the operating rod moves the bolt forward, the bottom face of the bolt engages the base of the cartridge, ramming it forward, and feeding, chambering, and locking it in the barrel.

Loading

To load the rifle, insert the front end of a loaded magazine cartridge into the magazine well until the front catch snaps into engagement. Then pull the magazine cartridge rearward and upward until the magazine latch locks the magazine cartridge in position. There are several methods employed in loading the magazine itself. The Aviation Weapons Officer should consult the latest edition of the Operator and Organizational Maintenance Manual, TM 9-1005-223-12, for additional information.

SUBMACHINE GUN CALIBER .45, M3A1

The submachine gun is a short-range automatic weapon which is fired from the shoulder at ranges seldom greater than 100 yards. The weapon is particularly adapted to close combat and was used extensively during the jungle fighting in the Pacific during World War II.

The M3A1 is an air-cooled, blowback-operated, magazine-fed shoulder weapon which, though crude in appearance, is compact, rugged, low in cost, and simple to manufacture.

The M3A1 is constructed entirely of metal with a telescoping stock made of a single piece of steel rod, the ends of which are drilled and tapped to receive a bore brush so that the stock may be used as a cleaning rod.

The weapon has no provision for semiautomatic fire but the very low cyclic rate permits a gunner to fire single shots after little practice. The rate of fire is 450 rounds per minute, which approaches an ideal rate for a submachine gun.

An unusual feature of this gun is the hinged cover, over the ejection port, which must be open to fire, since it is also the safety. When the cover is down, the bolt is locked in either the open or closed position. In the closed position, the safety enters a hole in the bolt and prevents movement to the rear. In the open position, the safety bears against the rear of the cocking slot, preventing forward motion. The cover also protects the bolt and keeps dirt out of the action.

The following data applies to the M3A1:

Overall length (stock extended)	29.8 in.
Weight (approximate without magazine).	8.15 lb.
Weight (with loaded 30-round magazine).	10.25 lb.
Length of barrel	8 in.
Diameter of bore	.45 in.
Rifling: Number of grooves	4.
Right-hand twist, one turn in	16 in.
Rate of fire	450 rounds per minute.
Muzzle velocity	900 fps.
Chamber pressure (approximate)	12,000 to 16,000 psi.
Maximum range	1,700 yd.
Maximum effective range	200 yd.

The M3A1 cannot be cocked unless the cover is open, since cocking is accomplished by inserting a finger in the cocking slot and drawing the bolt to the rear until it is caught by the sear. An earlier model, the M3, does not have this feature but instead is cocked by means of a retracting handle on the right side of the gun just forward of the trigger. The M3A1 is an open-bolt weapon; however, the bolt remains closed when the last round in the magazine has been fired.

SHOTGUNS

In the armed services, any shotgun with a 20-inch cylinder barrel is classed as a riot gun. The gun is a 12-gage weapon either of the pump or semiautomatic type. Specifications call for riot guns to be equipped with bayonet stud, handguard, and sling swivels, but many have been procured without these accessories. Both types are found in the Navy. Riot guns are used to guard prisoners, arm watchstanders, and for other security functions that require a short-range weapon.

The standard load for riot guns is the #00 buckshot shell (the term shell is standard nomenclature for the shotgun cartridge). Each round contains 9 pellets, and each pellet is 0.34 inch in diameter. Since the magazine capacity of most military shotguns is 5 rounds, it can be seen that the riot gun makes an extremely effective close range weapon.

CURRENT SMALL ARMS

Table 9-1 is a brief summary of the current small arms used by the Navy.

EXPENDITURE REPORT

As in the case of all other conventional ammunition expenditure reports, small arms expenditures are submitted quarterly or as deemed necessary by higher authority. The standardized form Ammunition Asset/Expenditure Report NavWeps Form 8015/3 is used. BuWeps Instruction 8015.4A outlines exact procedures in submitting expenditure reports.

LOSS REPORT

Whenever small arms have been lost or stolen, the following authorities should be notified immediately:

1. Local police (civil, military, or naval).
2. District Intelligence Officer.
3. Federal Bureau of Investigation, National Stolen Property Files, via the Director of Naval Intelligence, Department of the Navy, Washington 25, D. C.

NOTE: In the case of loss overboard, above notification is not required. However, a survey procedure must be initiated.

SMALL ARMS RANGES

AUTHORITY FOR RANGE INSTALLATION

The small arms range is a familiar physical element of the naval shore station. Its presence is more or less taken for granted by those assigned to the station and even visitors to the

Table 9-1. –Naval small arms.

Identification	Caliber	Magazine Capacity	Firing action	Weight (pounds)	Overall length (inches)	Remarks
Hand Guns						
Colt	.45	7 rounds	Semiauto	2.5	8.6	
Smith & Wesson	.38	6 rounds	Manual	1.1	9.2	Revolver type gun.
Colt	.22	10 rounds	Semiauto	2.3	"H. D." 9 "B" 8.25	Practice and training gun.
Rifles						
Garand M1	.30	8 rounds	Semiauto	10.3	43.6	Can be used as sniper's rifle when fitted with telescope sight.
Carbine M1	.30	15 rounds	Semiauto	6.1	35.6	M1A1 identical to this, except for metal folding stock.
Carbine M2	.30	30 rounds	Semiauto or auto	6.1	35.6	
Browning M1918A2	.30	20 rounds	Auto	15.5	47	Has fast or slow automatic fire.
Mossberg M44US	.22	7 rounds	Manual	8.25	43	Training gun.
7.62-mm Rifle M14	7.62-mm	20 rounds	Semiauto or auto	9	41.31	To replace the M1 rifle, the M1 carbine, and all submachine guns.
Submachine Gun						
Thompson M3	.45	30 rounds	Auto	6	22.8	
Shotguns						
Remington Skeet M11	12 ga	5 shot	Auto loading	8	26 (barrel)	Several different makes are in use.
Winchester Riot M97	12 ga	5 shot	Manual	8	20 or 26 (barrel)	

station. Quite often there are several ranges within the confines of the station. There may be one for rifle, another for pistol, another for automatic weapons, and still another for skeet. Certain of these types may be combined into a single range. There are other types of ranges which serve highly specialized purposes, such as those for training troops to maneuver under actual fire. Although these ranges may be taken for granted by many, a great deal of planning, designing, expenditure of effort and money, and many other factors are involved in procuring authorization to construct and to operate these ranges.

The primary purpose of constructing small arms ranges is to afford adequate provisions for qualifying and requalifying military personnel in the safe handling and effective firing of all types of small arms. Small arms are indispensable items of warfare. Most men do not possess a native ability to handle and fire these weapons properly. As a consequence, they have to be taught both of these feats. To safely handle, to accurately fire, and to tactically employ small arms in a correct manner are the primary aims of all training concerned with small arms usage.

Small arms ranges of the Navy are constructed with appropriations from the Congress. Because of this fact, the Chief of Naval Operations has directed that these ranges must not only be made available to all branches of the military but, in addition, to all able-bodied males capable of bearing arms under reasonable regulations prescribed by the controlling authorities. Hence, it is the policy to promote interest in small arms marksmanship in civilian rifle clubs and to aid in the training of civilians in the common defense of the United States. Further, commanding officers are strongly encouraged by this policy to extend the privileges of the ranges under their supervision to local police clubs, local pistol and rifle clubs of civilian membership, and other clubs chartered by the National Rifle Club of America. The only restrictions to such employment of the military ranges are that these clubs will incur no expense to the government during the course of their usage of the ranges, and in no manner will they interfere with the regular training of the military personnel.

Military personnel are required to requalify in small arms at specified periods in order to maintain their proficiency. This applies to officer and enlisted personnel alike. The training must be thorough. Any training in this area short of thorough is dangerous and wasteful. Certain military personnel require more advanced study and practice in the use of small arms than others. This fact exists because certain personnel, by the nature of their duties, will have more occasion to employ these weapons than others in the service. Such members will have duty in landing parties, security watchstanding, aviation and construction batalion crews, and may even be members of the Naval Emergency Ground Defense Force. About 20 percent of the naval personnel billeted ashore should be completely trained in the use of small arms as this is roughly the percentage necessary for watchstanding and similar duties.

History has clearly revealed that nations which aggressively support all types of civilian ranges have adequate ranges for the military, sponsor many marksmanship contests, and have always been outstanding in the prosecution of wars. Small arms still continue to be heavily weighted factor in winning a war despite the tremendous increase in new and more devastating weapons. A nation with a good percentage of its population trained in effective usage of small arms is at a decided advantage over those without this training in the event of war and as a general deterrent to war.

The National Rifle Association of America has been supported in part by the Congress most of the years since 1902. It enjoys such prestige and vast membership throughout the United States. Its chartered clubs compete in tournaments in which thousands of shooters compete for national honors.

In 1956 the Navy put into effect a program designed to promote more interest in marksmanship throughout the service. This new program increases the number of Navy-wide firing competitions each year. Winners of local contests are sent to compete in other tournaments with competition increasing as each new contest is fired. The winners of the Navy contests are sent to the national tournaments. Appropriate awards and honors are made for each successful individual or team competition. To prosecute this program, all Navy range facilities have been closely checked for correct physical layout and general adaptability for competitive firing. Certain leading petty officers were selected to act as special instructors with other collateral duties. These petty officers were selected because of their interest in shooting—

many of them champions in their own rights.

TYPES OF RANGES

After a small arms range facility has been constructed and is ready for use, it is manned by personnel assigned by the commanding officer of the station. A range officer is assigned to and made responsible for the overall operation of the range, for its internal security, and for the safety of all hands concerned. Ordnance strikers and rates from third class to and including chief petty officers are assigned in sufficient numbers to carry out the necessary work and to administer the details of the range. Certain members of the crew are assigned primary duties which involve instructing the trainees in the safety precautions necessary and conducting indoctrinational lectures from approved syllabuses. These lectures cover such areas as safety precautions to be employed in the use of each type of small arm, types of courses to be fired, scoring, functioning principles of the weapon concerned, range etiquette, duty in the butts, proper stance and positions for firing, trigger squeeze, employment of slings, spotting scopes, pasting targets, and many other items pertinent to proper utilization of small arms.

Pistol Ranges

Navy pistol ranges are standardized only to the extent that they incorporate 15- and 25-yard or 25- and 50-yard positions from which the different courses may be fired. In addition, some ranges contain a 50-foot location from which the .22-caliber pistols are fired.

Rifle Ranges

The M1 Garand rifle is currently the standard rifle of the Navy. It is fired normally for marksman, sharpshooter, and expert on ranges of 200, 300, and 600 yards. The .30 caliber carbine is also fired on the same range as the standard rifle, but at positions of only 100 and 200 yards distance from the target.

With the issuance of Change No. 1 to the Landing Party Manual, (1960 Revision), a special rifle course (Course D) is included for the range qualifying of the M14 Rifle. This special course is fired from the 200-yard position only.

Small Arms Courses

Standard courses for rifles, pistols and revolvers, submachine guns, ground machine-guns, and automatic rifles are listed in tables 9-2 through 9-6. These courses are established by the Landing Party Manual and must be used for record firing. However, the officer in charge may vary or adjust these courses to fit available range conditions (e.g., if 300 yards is the maximum range available, fire 500- or 600-yard stages at 300 yards with appropriately reduced targets).

RESPONSIBILITIES

Responsibilities connected with administration and operation of a small arms range are not all assignable to any one person although the officer in charge of the range has the final responsibility, to the commanding officer, for the range. Responsibility for safety and the proper conduct of firing exercises lies with all hands concerned. If a "coach" notices a danger-out situation on the firing line, it is his responsibility to take immediate steps to correct it. If the group instructor notes an omission in the training syllabus, it is his responsibility to bring it to the attention of the officer in charge of instruction or the officer in charge of the range. Among his other responsibilities, the range officer is responsible to bring to the attention of his commanding officer any discrepancies noted in the overall physical plant, shortcomings in the training, and other personnel and material problems. These are all merely examples to illustrate the fact that acceptance of and attention to responsibilities are mandatory to all hands concerned with any undertaking.

The range officer delegates authority down the line. Those involved automatically accept certain responsibilities in connection with the authority delegated to them. On the proper discharge of these responsibilities depends the successful conduct of the undertaking.

Aviation Weapons Officers are normally delegated the responsibility of small arms proficiency in their respective units or squadrons. With operations permitting, the Aviation Weapons Officer (with trained AO assistants) should supervise range parties, insuring proper procedures in the following:

1. Inexperienced men are properly indoctrinated in small arms handling prior to going to the range.

Table 9-2. –Rifle courses.

Course A–Rifle National Match Course

Range (yards)	Time limit	Shots	Tar-get	Position	Sling
200	10 min	10	A	Military standing	Parade.
200	50 sec	10	A	Standing to sitting or kneeling.	Loop.
300	60 sec	10	A	Standing to prone	Loop.
600 (or 500)	20 min	20	B	Prone	Loop.

Total shots record firing–50. Maximum score–250.

Qualifying scores: Expert–215, Sharpshooter–200, Marksman–165.

Table 9-2. –Rifle courses–Continued.

Course B–Rifle Expert Course

Range (yards)	Time limit	Shots	Tar-get	Position	Sling
200	5 min	5	A	Standing	Parade or hasty.
200	5 min	5	A	Sitting	Loop.
200	5 min	5	A	Kneeling	Loop.
200	50 sec	10	D	Standing to sitting	Loop.
200	50 sec	10	D	Standing to kneeling	Loop.
300	60 sec	10	D	Standing to prone	Loop.
600 (or 500)	15 min	15	B	Prone	Loop.

Total shots record firing–60. Maximum score–300.

Qualifying scores: Expert–270, Sharpshooter–250, Marksman–220.

Table 9-2. –Rifle courses–Continued.

Course C–Carbine Expert Course

Range (yards)	Time limit	Shots	Target	Position (sling not used)
100	50 sec	10 (2 mags, 5 each)	A	Fire 5 rds stand–reload fire 5 rds sitting.
100	50 sec	10 (2 mags, 5 each)	A	Fire 5 rds stand–reload fire 5 rds kneeling.
200	50 sec	10 (2 mags, 5 each)	B	Fire 5 rds stand–reload fire 5 rds sitting.
200	50 sec	10 (2 mags, 5 each)	B	Fire 5 rds stand–reload fire 5 rds kneeling.
200	60 sec	10 (2 mags, 5 each)	B	Standing to prone.

Total shots record firing–50. Maximum score–250.

Qualifying scores: Expert–225, Sharpshooter–200, Marksman–175.

2. Range safety precautions are judiciously observed.
3. Squadron and local regulations are followed.
4. Small Arms—Sheet 2, is filled out on each individual firing; also, that proper notations are recorded in officer jackets and enlisted records.
5. A master firing log is kept for ammunition accounting, permanent reference, or administrative inspections.

COMPETITIONS AND MEDALS

There are numerous competitions held throughout the services. Navy personnel and Marine personnel are eligible to compete in matches other than their own under specified circumstances. Medals are awarded for successful qualification in several types of small arms firing.

All commanders are encouraged to conduct rifle and pistol competitions to the fullest extent that time, facilities, and ammunition allowances will permit. The major objectives of competitive firing are to extend the scope of regular small arms training, stimulate interest in small arms firing, and to select and develop both individuals and teams to represent the Navy in national and international competitions. Each separate command or unit ashore or afloat should, to the limits possible, organize and train teams for pistol, rifle, and revolver firing matches.

The small arms utilized by teams and individuals in official Navy firing will be standard Navy ordnance equipment. It is desirable that small arms used by individuals and teams in match firing be especially serviced (match conditioned) to insure optimum performance.

NOTE: Specially serviced small arms have been "smoothed up" in operation. There have been no major changes to these pieces,

Table 9-2. –Rifle courses–Continued.

Course D–Special Rifle Course Fired at 200 yards

Time	Shots	Target	Position	Sling
None	10	A	Prone	Loop.
None	5	A	Sitting	Loop.
None	5	A	Kneeling	Loop.
None	10	A	Standing	Hasty or parade.
50 sec	10	D	Prone	Loop.
50 sec	10	D	Sitting or kneeling from standing.	Loop.

Total shots record firing–50. Maximum score–250.

Qualifying scores: Expert–225, Sharpshooter–215, Marksman–190.

nor have the trigger pulls been reduced below specified minimums.

The Bureau of Naval Weapons is responsible for making available match conditioned weapons for Fleet, U.S. Navy, and National Match shooters. Also, small arms may be match conditioned by authorized individuals or activities, such authorization to be granted by the Chief, Bureau of Naval Weapons or the Chief of Naval Personnel. The small arms used in Fleet and U.S. Navy competitions must conform to current National Trophy Match Regulations.

Ammunition allowances and the courses to be fired in competitions are set and fixed on an annual basis. In areas in which insufficient personnel are available to form teams, individuals may still participate in training and match shooting. Each commander is authorized to train personnel from which to select team members for one team. Commanders are further authorized to arrange competitions between his team and local competition, such as other armed services, reserve components, law enforcement agencies, and civilian rifle and pistol clubs in the vicinity. Type commanders, district or river command commandants, or senior officer present of ships operating in close proximity may conduct small arms competitions, matching teams in each weapons class from the units afloat and/or activities ashore. The commander in chief of each fleet is authorized to conduct an annual fleet competition, consisting of team and individual matches with the pistol and rifle. The Chief of Naval Personnel is authorized to conduct an annual United States Navy competition which matches individuals and teams representing the various fleets and shore activities. These competitions are for rifle and pistol firing. Appropriate trophies and other awards are given winners of each of these competitions. The fleet commanders award fleet trophies, and the Chief of Naval Personnel awards the United States Navy trophies.

Place badges are awarded by the fleet commanders to individuals for pistol and rifle excellence. These badges are provided and

Table 9-3. –Pistol and revolver courses.

Course E–Pistol and Revolver National Match Course

Range (yards)	Time limit	Shots	Target	Type of fire
50	10 min	10	Standard American 50 yds slow fire	Slow.
25	20 sec	*10	Standard American 25 yds RF & TF	Timed.
25	10 sec	*10	Standard American 25 yds RF & TF	Rapid.

*Time allowed is for one 5 shot clip. 2 clips to be fired.

Total shots record firing–30. Maximum score–300.

Qualifying scores: Expert–240, Sharpshooter–225, Marksman–210.

Table 9-3. –Pistol and revolver courses–Continued.

Course F–Pistol and Revolver Expert Course

Range (yards)	Time limit	Shots	Target	Type of fire
25	None	10	Standard American 25 yds RF & TF	Slow
25	20 sec	*10	Standard American 25 yds RF & TF	Timed.
25	15 sec	*10	Standard American 25 yds RF & TF	Rapid.
15	15 sec	*10	Standard American 25 yds RF & TF	Rapid.

*Time allowed is for one 5 shot clip. 2 clips to be fired.

Total shots record firing–40. Maximum score–400.

Qualifying scores: Expert–300, Sharpshooter–280, Marksman–220.

Table 9-4. –Submachine gun course.

Course G–Submachine Gun Course

Range (yards)	Time limit	Shots	Target	Position	Type of fire
200	10 min	10	B	Prone	Slow.
100	25 sec	10	3 A (1)	Standing to sitting	Semiautomatic.
25	10 sec	15	3 A (2)	Standing, gun at hip until commence firing.	Automatic.

(1) Three targets, rifle A, 10 feet apart. No hit outside of the 4 ring is scored. Fire should be distributed; deduct 10 points for any target not hit inside the 4 ring. In applying penalty, no score shall be less than zero at any one range.

(2) Three targets, rifle A, 5 feet apart. Same scoring and penalties as above.

Total shots record practice—35. Maximum score—175. Qualifying score—100.

Table 9-5. –Ground machinegun course.

Course H–Ground Machine Gun Course

Range (yards)	Time limit	Shots	Target	Type of fire
200	None	10	B	Bursts of 3 to 5.
200	35 sec	20	B	Do.
200	20 sec	20	B	Do.
500	None	10	B	Do.
500	40 sec	20	B	Do.
500	20 sec	20	B	Do.

Total shots record firing–100. Maximum score–500.

Qualifying score–260.

Table 9-6. –Automatic rifle course.

Course I–Automatic Rifle Course

Range (yards)	Time limit	Shots	Tar-get	Position	Type of fire
200	10 min	10	B	Prone with standing rest.	Single shots.
200	20 sec	10	B	Prone	Semiautomatic.
200	25 sec	*3 strings of 10	B	Sitting	Do.
500	10 min	10	B	Prone	Single shots.
500	80 sec	40	B	Prone	Semiautomatic.

*25 sec per string of ten.

Total shots record firing–100. Maximum score–500.

Qualifying score–300.

engraved by the Chief of Naval Personnel who also sets the standards for the matches and the badges.

In order to qualify for the designation of Distinguished Marksman and the award of a Navy Distinguished Marksman Badge, the individual must have received three major rifle marksmanship awards previously. Specified conditions and limitations exist which delineate the manner in which these three awards must have been earned when considering them as fulfilling the requirements for the badge. Qualification for the award of a Navy Distinguished Pistol Shot Badge closely follows those for the distinguished marksman award.

An Expert Rifle Medal is awarded to each officer and enlisted man who qualifies as expert rifleman by firing the appropriate rifle course and attains the proficiency set forth by regulation. Commanding officers submit the requests for these medals as they are earned. Small Arms–Sheet 2 (fig. 9-17) is completed in each instance and forwarded to the Chief of Naval Personnel who issues the medal.

An Expert Pistol Shot Medal is awarded to each officer and enlisted man who qualifies as expert pistol shot by firing the appropriate .45 caliber automatic or .38 revolver course and attains the proficiency required. The medals are awarded and issued the same as those for the expert rifleman award.

Qualification as an expert rifleman or expert pistol shot terminates at the end of four years. If the person who has earned one of these awards fails to requalify during the four-year period, he must cease to wear the ribbon significant of this award unless and until he does requalify. The medal for these awards may be retained for the periods of nonqualification, but not worn. Only one such medal is issued to an individual. If it is lost or damaged so that it is unfit for wear through no fault of the owner, it is replaced without cost.

If a man fails to qualify for expert, he may still qualify as a sharpshooter or a marksman. While no medals are issued for these qualifications, an entry is made on page 13 of the service

SMALL ARMS—SHEET 2
OPNAV-3573-2 (Rev 1-54)

Report of Scores
(See instructions on reverse of this sheet)

NAS
Ship or station

Division or activity ORDNANCE BRANCH

Place JACKSONVILLE, FLA.

Date of firing 15 OCT., 1964

Weapon fired 45 CAL. PISTOL

Course fired COURSE "E"

Target No.	Full name	File or service No.	Rank or rate	Branch of service	Scores						Qualification
							50 YD	25 YD	25 YD	Total	
1	PRICE, E. R.	2812628	AOC	USN			70	90	84	244	EXPERT
2	WITCHEY, J. C.	3416161	AO1	USN			67	80	53	220	MARKSMAN
3	REVEL, C. E.	2918115	AO2	USN			75	84	72	231	SHARPSHOOTER
4	BAILEY, R. S.	4362822	AO3	USN			68	66	77	211	MARKSMAN
5	HILL, H. H.	3908126	AOAN	USN			58	72	75	205	NONE

I certify that the above record practice was conducted in accordance with regulations.

C. H. Holbrook
Name

LT JG, *U. S. Navy.*
Rank *Chief Pit Officer.*

R. F. Marriott
Name

LT., *U. S. Navy.*
Rank *Officer in Charge of Firing Line.*

Figure 9-17.—Small Arms—Sheet 2.

record to the effect that the person has so qualified.

All information concerning an officer's small arms qualifications is forwarded to the Chief of Naval Personnel for inclusion in his file jacket.

SAFETY PRECAUTIONS

No attempt is made in this text to give in detail the many safety precautions associated with the correct handling, operation, field stripping, reassembling, and firing of each type of small arm or aircraft gun used in the Navy. Pertinent instructions and safety precautions are published for each type of weapon and may be procured in quantity if desired. There are, however, certain basic precautions concerning aircraft guns, small arms utilization, and range procedures which consistently apply and cannot be overstressed.

Some of the many general precautions that should become a matter of habit for aviation ordnance personnel are as follows:

1. Live ammunition should be loaded into guns for firing purposes only. Except when specifically authorized by the Bureau of Naval Weapons, the use of live ammunition is prohibited when testing equipment and training personnel.
2. Treat every weapon with the respect due a completely loaded weapon.
3. Never point a weapon at anyone you do not intend to shoot.
4. Never leave a loaded weapon or one with rounds in the magazine where it may be picked up by others.
5. Immediately upon picking up a weapon, point it in a safe direction, and make sure, by personal inspection, that it is not loaded.
6. Do not consider a weapon unloaded and safe after having removed the magazine only. Always examine the breech for a round in the chamber after removing the magazine.
7. Ascertain that the bore and action of a weapon are not obstructed in any manner prior to loading and firing.
8. Never become hurried when involved in handling and firing weapons. Strive to be relaxed but alert at all times.

CHAPTER 10

NAVAL AIRBORNE ROCKETS AND ROCKET FUZES

The rocket is an ancient weapon but the use of rockets as standard aircraft armament is new to us. Some study is in order concerning the nature of rockets and the effect of rocketry on combat flying.

In Asia, more than 700 years ago, the Chinese astounded the invading Mongols with rocket-arrows. Later, the Chinese used rockets against the Arabs; the Hindus against the British; and in 1812, the British against the United States.

Today's rockets have little resemblance to the originals. After successful use of rockets in the early part of the nineteenth century, western nations undertook extensive research in the field of rocketry. This interest waned after 1860, however, because of greatly advanced artillery weapons.

During the first World War and the following interim, rocket research again accelerated. World War II saw extensive use of rockets. These rockets were both air- and ground-launched. The United Nations also used rockets extensively in the action in Korea.

The great potential of the rocket is most evident as an air-launched weapon. Rocket-armed aircraft can deliver a salvo of destruction equivalent to that of the main battery of a cruiser.

The rocket can be delivered to any target within combat range of the carrying aircraft and can be fired from a great variety of angles and altitudes. This was especially effective in the Korean campaign where rockets were fired from low-flying aircraft into caves, earth-covered revetments, and railroad tunnels behind enemy lines, destroying large quantities of equipment and supplies which were thought to be safe from aerial bombardment.

Since the airborne rocket is usually launched at close range—usually measured in yards—its accuracy as a propelled projectile is much higher than that of a free-falling bomb dropped from high altitude. The velocity of the rocket is much higher than that of a bomb, and moving land and sea targets have practically no time in which to take evasive action.

Aircraft rockets are at present stabilized by means of fins, either fixed or folding.

The coverage of aircraft rockets in this text is by no means complete, but rather deals in generalities. The reader is referred to Aircraft Rocket, NavWeps OP 2210, (latest revision) for specific details.

PRINCIPLES OF ROCKET PROPULSION

Rockets are propelled by the rearward expulsion of expanding gases from the nozzle of the motor. It is a common misconception that rockets are pushed forward by the action of the hot gases on the surrounding air. However, rockets can function even in a vacuum.

To understand how a rocket operates, consider a closed tube into which a gas under pressure has been introduced. The pressure of the gas against all the interior surfaces is equal and the system is in equilibrium, figure 10-1 (A). If the right end of the tube is removed, figure 10-1 (B), the pressure against the left end is unopposed and the tube tends to move to the left.

In the rocket motor, sufficient confinement of gases evolved in the burning of the propellant is necessary to permit a buildup of pressure to provide the sustaining driving force. This can be accomplished by restricting the size of the opening, as in figure 10-1 (C). In this case, the useful thrust is the difference between that force acting on the remainder of the left end and that acting on the right end. However, with this type of design, considerable turbulence is caused in the flow of gas through the opening, with a consequent loss of available energy. This turbulence can be decreased greatly by adopting a design similar to figure 10-1 (D). In this instance, the horizontal component of the force acting on the right wall is

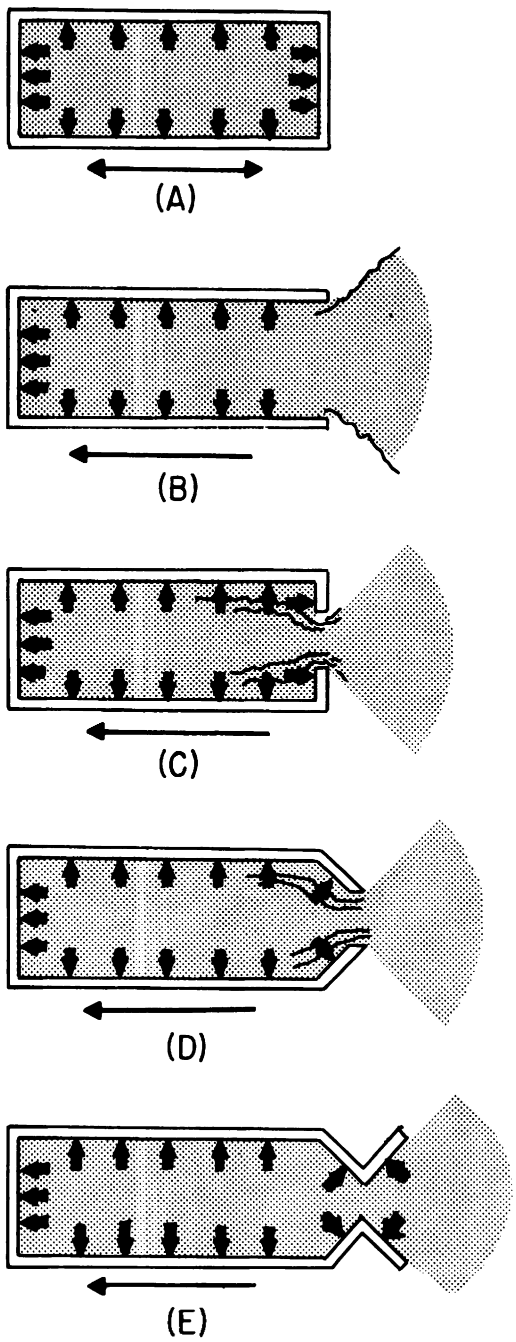


Figure 10-1.—Principles of rocket propulsion.

equal in magnitude to the force acting on the right wall in figure 10-1 (C).

If a divergent expansion section is added, figure 10-1 (E), advantage can be taken of the force of the expanding gases acting on the wall of the expansion section. This force adds to the useful thrust.

The motor of a rocket is called a reaction motor because it operates on Newton's Third law of Motion: To every action (force) there is an equal and opposite reaction (force).

The forces necessary are produced by burning a mass of propellant at high pressure inside the motor tube. The propellant when burned is transformed to gas under high pressure, which then flows at high velocity through the nozzle.

According to Newton's Third Law, the velocity attained by a rocket may be expressed mathematically roughly as

$$V = \frac{mv}{M}$$

where

V = Velocity of rocket
M = Mass of rocket
v = Effective gas velocity
m = Mass of propellant

When consideration is given to the fact that the rocket is losing mass as it accelerates, the rough expression above is changed to

$$V = v \log \; 1 + \frac{m}{M}$$

The last expression may be simplified without introducing over 1 percent error by

$$V = \frac{mv}{M + \frac{m}{2}} \text{ provided the ratio } \frac{m}{M} \text{ is below } 0.3$$

v is significantly increased by the use of properly designed nozzles.

ROCKET CHARACTERISTICS

The principal factors taken into account in designing a rocket are hitting accuracy, payload weight in relation to overall weight, velocity, time-to-target, type of target, and safety. Many of these factors contend against each other. The guiding factor is the tactical purpose of the rocket.

The lack of recoil is a major advantage of rockets and is the determining factor in almost all applications. The force of the propelling gases acts only upon the motor walls. Except for the impinging jet-exhaust, no stress is exerted upon the launcher and firing aircraft. Therefore, the launcher may be a relatively simple, light structure.

The rocket carries its propelling forces within it, and a prolonged time of acceleration is possible. This factor obviates the need for high initial acceleration to attain required velocity. The acceleration given a shell may be approximately 100 times greater than that given a rocket of comparable caliber. Therefore, rocket components may be of relatively light construction.

The mean dispersion of a salvo of air-launched rockets is about 5 to 10 mils. This shotgun effect provides high hit probability. Rocket accuracy is comparable to that of a gun on a fixed mount and superior to that of a bomb. This degree of accuracy is all that rockets need. Each rocket carries enough high explosives to destroy the target for which it has been designed.

Modern combat requires the greatest destruction deliverable in the shortest possible time. In this situation, the superiority of rockets over other weapons is decisive.

Conflicting design considerations make compromises necessary in order to meet tactical requirements. The developing activity subjects prototypes to extensive field firings. Before a rocket design is released to production, these tests must establish a reliability quotient of at least 95 percent.

To maintain this performance level, rigid control of the components is essential. During manufacture, a comprehensive series of tests confirms the specifications established. These tests include careful inspection of metal parts and physical testing of components—particularly those affected by propellent burning characteristics. Finally, sample lots of completed rockets are proof-fired to check overall performance.

TRAJECTORY

The trajectory of a rocket differs from that of other projectiles. These differences stem mainly from the fact that a rocket carries its source of power with it. The motor not only increases the size of the missile in relation to its payload but also provides reduced initial velocity, prolonged period of thrust, and increased range potential.

A pilot's personal flying habits are critical to the successful firing of rockets. He must master the aircraft as a launching platform since the rocket trajectory is an extension of his aircraft trajectory, and, as such, is sensitive to every variation during the tracking run.

In order to aim successfully at the target, it must be possible to predict the rocket trajectory. The exterior ballistic characteristics of rockets are known, and the trajectory of a rocket launched by an aircraft in unaccelerated flight is relatively simple to predict. The directing forces acting upon the rocket converge in a vertical plane, directing the rocket forward and downward. A skid, however, introduces horizontal influences which destroy this vertical unity, and the trajectory becomes relatively unpredictable.

The rocket follows the flightpath of the aircraft at the instant of release. However, slight variations of the aircraft will not seriously affect rocket trajectory.

LAUNCHING

Due to the time delay during which a ground-launched rocket gains sufficient momentum to insure stability, the accuracy of the rocket is affected by the launcher length. The initial velocity of an aircraft-fired rocket is nearly the velocity of the aircraft; therefore, aircraft rocket launchers may be very short in length with no adverse effect upon accuracy.

The effective launching of a rocket in the direction of the flight line may be upset by local air turbulence which acts to increase dispersion. However, the impact of the windstream along the flightpath tends to correct this yaw. The possible effect of local airflow is a factor considered in the aircraft design.

Two factors affect the placement of launchers upon the aircraft:

1. The effect of turbulent air currents about the launcher upon the initial rocket trajectory.
2. The effect of the jet blast of the rocket upon the launcher and aircraft structures and engines.

AIRCRAFT ROCKET DEVELOPMENT

Although the history of rockets covers a span of eight centuries, their use in aircraft armament began in World War II. Rockets answered the need for a large missile which could be fired without recoil from an aircraft.

One of the earlier rockets was designed to utilize a 3.5-inch solid warhead and a 3.25-inch motor. It was launched from rails mounted under the wings of a torpedo bomber. The purpose of the solid warhead was to rupture the hull of a submarine.

Another early rocket employed a 5-inch warhead with a larger payload of high explosives and an air-arming fuze. It utilized the same 3.25-inch motor. The assembly, however, was unsatisfactory in accuracy and range. A new design, employing the same 5-inch warhead plus a 5-inch motor, was developed and was known as HVAR (high-velocity aircraft rocket). It was used successfully in combat in August of 1944.

The need for a simple, economical rocket for practice firing resulted in the 2.25-inch SCAR (subcaliber aircraft rocket).

There have been two postwar rockets developed which are currently used by the Navy. The first is the 2.75-inch folding-fin aircraft rocket (FFAR) which is called the "Mighty Mouse." This rocket is used for either air-to-air and air-to-ground operations.

The second development is the folding-fin Zuni rocket. It is a general purpose rocket having a 5-inch caliber and is also used for either air-to-air or air-to-ground operations. The Mighty Mouse and the Zuni rockets are discussed in more detail later in this chapter.

Rocket development today is carried out principally at the Naval Ordnance Test Station at China Lake, California, although other naval activities contribute to rocket design and testing.

ROCKET AND ROCKET FUZE TERMINOLOGY

Some of the more common rocket terms as used in this text are defined in the following paragraphs. It will behoove the Aviation Weapons Officer to become familiar with these terms.

1. Ammunition—all the components, and any and all explosives in any case or contrivance prepared to form a charge, complete round, or cartridge for cannon or small arms, or for any other weapon, torpedo warhead, mine, bomb, depth charge, demolition charge, fuze, detonator, projectile, rocket, or the like; all signaling and illuminating pyrotechnic materials; and all chemical warfare materials under the cognizance of the Bureau of Naval Weapons or used by the military services for offensive, defensive, saluting, and training purposes.

2. Ammunition components—integral units which are parts of a complete round of ammunition. Ammunition components may consist of inert parts, explosive parts, or both. Examples of ammunition components are fuzes, rocket warheads, rocket motors, rocket fins and fin assemblies, dummy nose fuzes, auxiliary boosters, igniters, and propellent grains.

3. Ammunition details—the accessories which are used in packing, handling, protecting, and surveillance of ammunition; for example: containers, thread protectors, spacers, and fuze covers.

4. Booster—an assembly containing an intermediate explosive, which is sensitive enough to be detonated by a small amount of initiating explosive and is powerful enough to cause detonation of a less sensitive explosive.

5. Delay element—an assembly containing a relatively slow-burning explosive initiated by a primer, which delays the functioning of the succeeding units of the explosive train. Black powder is commonly used in delay elements.

6. Detonator—an assembly in the explosive train of fuzes which contains a charge of high brisance. When fired by the primer or delay element, the detonator explodes with sufficient force to initiate a booster. Tetryl and the metal azides are common detonator charges.

7. Explosive train—a functional arrangement of different types of explosives in a fuze which initiates the main charge of the rocket warhead. Depending on the fuze, it may consist of a primer, delay element, detonator, and booster. Each separate component is less sensitive than the preceding charge, starting with the primer and working to the booster.

8. Fins or fin assembly—a flight stabilization device, usually a number of tail planes, which tend to keep the rocket on its aimed trajectory.

9. Fuze—the initiating device which detonates a high-explosive main charge; or expels, disperses, or fires some other type of load.

10. Hangfire—a misfire which later fires from delayed ignition.

11. Warhead—that part of the rocket containing the payload; either high explosive, chemical, or special filler, and the fuze. The payload may be solid metal, with no fuze.

12. High velocity—a phrase used to describe 5.0-inch rockets used with 5.0-inch warheads and motors, to distinguish them from 5.0-inch rocket assemblies employing motors of smaller diameter.

13. Igniter—the initiating device which ignites the propellent grain. It usually is an

assembly consisting of an electric squib, match composition, black powder, and magnesium powder.

14. Main charge—the high-explosive filler of the rocket warhead.

15. Misfire—a situation in which a rocket does not fire when the firing circuit is energized.

16. Motor—the propulsive component of a rocket. It contains the propellant, the igniter, and the nozzle(s).

17. Primer—the first element in the explosive train of a fuze. It is a sensitive explosive which usually is initiated by a firing pin and, in turn, initiates the next element, which is less sensitive, in the explosive train.

18. Propellent grain—the solid fuel used in a rocket motor which, upon burning, generates a volume of hot gases that stream from the nozzle and propel the rocket. Also called propellant or propellent powder grain.

19. Retrofired—fired in a direction opposite to the aircraft's direction of flight, usually to make the rocket drop in a straight line to the target.

20. Rocket—a missile propelled by the sustained reaction of a discharging jet of gas against the container of the gas.

21. Round—an assembly of all the components necessary for functioning of the rocket for the purpose intended. This includes warhead, motor, and fuze(s).

2. Subcaliber—a term referring to a practical round of less than the caliber of the service round. Although smaller than service rounds, subcaliber rockets have the same characteristics of trajectory.

23. Thrust—the force exerted by the rocket motor.

24. Setback—This term is applied when fuze parts react to acceleration of the rocket. It causes movable parts to move aft when the fuze as a whole moves forward. Slow accelerations, compared to gun ammunition, are characteristic of rockets. The acceleration depends greatly upon the initial temperature of the propellant; it is quite small at low temperatures. By making the parts operated by setback relatively massive and the retaining mechanisms relatively weak, small setback forces can be utilized effectively.

25. Acceleration—This term applies to fuzes which utilize a gear timing device in conjunction with the setback principle described. A simple setback-armed fuze is armed by initial acceleration; acceleration-armed fuzes are armed by prolonged acceleration, the length of which is determined by the integral timing mechanism of the fuze.

26. Air or water travel—the force exerted by the air or water stream passing the rocket may be used to arm nose fuzes by turning propeller vanes.

27. Gas pressure from burning propellant—during the burning of the rocket motor propellant, pressure of the gases is exerted on the base of the rocket warhead and base fuze. This pressure is fairly constant during burning and is of the magnitude of several thousand psi. Entrance of the gas can be controlled to delay the arming of the fuze.

28. Creep—a continuous inertial force caused by deceleration which, in turn, is caused by surface drag on the rocket after the motor has burned out. Internal fuze parts tend to move toward the nose of the round. These forces may be controlled by anticreep springs, which prevent fuze initiation until the fuze strikes a target with sufficient impact to overcome the resistance of these springs.

29. Friction—frictional forces which are a consequence of setback and creep are not high in rockets. Friction is not utilized to any extent at present in rocket fuze operation.

30. Impact inertia—inertia existing at the moment of impact is used in some rocket fuzes to bring about a phase of arming. Fuzes using this force are identified as "deceleration-discriminating."

COMPONENTS OF A ROCKET

MOTOR

The motor of a rocket consists of those components which propel the rocket in flight and stabilize it. This structure must possess the mechanical strength to support the propellant and internal pressures.

Not all rocket motors are identical, but they do have certain components in common. These components are the nozzle assembly, motor tube, propellant, electrical leads, and igniter.

Nozzles

The primary function of either a single- or multiple-nozzle assembly is to increase the thrust of a rocket motor. The expanding gas impinging on the conical exit surface of the nozzle creates a component force in the direction of rocket motion, which adds to internal gas pressure force to increase the rocket velocity. The outward directed components cancel each other when integrated around the nozzle.

For optimum rocket performance, the nozzle line of thrust, the geometric axis of the rocket, and its center of gravity should coincide. Deviations in any of these factors increase dispersion and lessen accuracy.

Motor Tubes

The motor tube supports the other components of the rocket. Internal threads at either end of the tube provide the means for attaching the head and motor assembly. Launcher lugs, if needed, and fin assembly are also secured to the tube. The tube supports the propellent grain internally.

The length and diameter of the motor tube are closely dictated by the caliber and purpose of the rocket. The wall thickness and type of metal, usually steel or aluminum, are largely determined by the type of propellant; that is, the amount of pressure and extremity of operating temperatures, the tube will be required to withstand. With an internal-burning propellent grain, the tube may attain temperatures of 400° F; with an external-burning grain this temperature may reach 1,000° F. The pressure, allowing a necessary margin for safety, is in the range of 1,500 lb/in.^{2}, depending upon propellent characteristics.

Propellants

A rocket may be propelled by either a solid or liquid fuel. However, the two are not interchangeable and involve basically different motors.

SOLID.—Most solid propellants are a double-base grain, usually a nitroglycerin-nitrocellulose mixture, extruded in either of two general shapes. An external-burning grain is normally in cruciform shape, while an internal-burning grain is cylindrical in form. Each is wrapped completely or in part with an inhibitor to control burning.

Solid fuels are sensitive to the ambient temperature at the time of burning. A warm grain burns faster than a cold one, thus complicating the prediction of the rocket trajectory. Compensation for varying propellent temperature is provided in one of two ways: (1) Constant-temperature rocket launchers; or (2) propellent-temperature monitors which automatically feed propellent temperature to the computer of the fire control system. However, temperature sensitivity has been greatly reduced in recent propellants and new rockets will use these improved fuels. On each rocket is a label specifying the firing temperature range. Recently these limits have been extended.

LIQUID.—Extensive experimental research by Dr. Robert Goddard and his associates in New Mexico between World Wars I and II established basic principles employed in the development of current liquid-propellent rockets. The validity of many design features developed by this group was attested by successful use in the V-2 program in Germany. This program established the practicality of liquid-propelled rockets of large caliber to maintain controlled flight over hundreds of miles. No successful small-caliber, liquid-propelled rocket was developed during World War II, although design studies were made by the Germans on the TAIFUN and in the United States on the LOKI.

A typical liquid-propellent rocket is illustrated in figure 10-2. The propellant consists of fuel and oxidizer which are stored in separate tanks (3) and (4) outside the combustion chamber. Upon ignition, the chemical gas generator (1) activates the tank burst diaphragms (2) forcing the propellants under constant pressure aft to the injector (5) at which point the propellent particles are force-sprayed into the combustion chamber (6) where the chemical energy of the reacting propellants is converted into the mechanical energy of the exhaust jet.

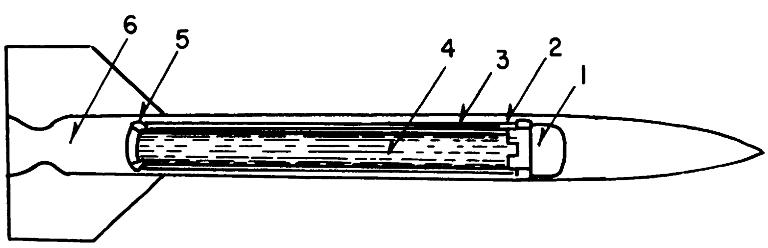


Figure 10-2.—Typical liquid propellent rocket.

To justify this complicated plumbing, the liquid-fuel rocket must offer distinct advantages, and it does. Compared to solid propellants, the liquid fuels have logistic advantages of higher availability and greater ease of manufacture. A high mass rate of discharge, independence from temperature variations, and reduced time-to-target are other assets.

In the past, the question of relative merit of solid or liquid-propellent rockets has been considered one of caliber: large rockets using liquid fuels; smaller ones, solid. However, recent advances in research have made possible a small liquid propellent motor suitable for launching from an aircraft. A propulsion system called "Hybrid," which combines both liquid and solid propellant in one motor has been developed.

Liquid propellants are classified as monopropellants or as bipropellants.

Monopropellants are those which contain within themselves both the fuel and oxidizer and are capable of combustion as they exit. Bipropellants are those in which the fuel and oxidizer are kept physically separated until they are injected into the combustion chamber. An example of a monopropellant would be the mixture of hydrogen peroxide and ethyl alcohol; an example of a bipropellant would be liquid oxygen and kerosene.

While solid propellants are stored within the combustion chamber, liquid propellants are stored in tanks and injected into the combustion chamber. In general, liquid propellants provide a longer burning time than solid propellants. They have a further advantage in that combustion can be easily stopped and started at will by controlling the propellent flow.

When oxygen or an oxygen-rich chemical is used as an oxidizer, the best liquid fuels appear to be those rich in both carbon and hydrogen.

In addition to the fuel and oxidizer, a liquid propellant may also contain a catalyst to increase the speed of the reaction. A catalyst is a substance used to promote a chemical reaction between two or more other substances.

Inert additives which do not take part in the chemical reaction are sometimes combined with liquid fuels. An example is water which is often added when alcohol is used as a fuel. Although it does not take part in the chemical reaction, the water does provide additional particles which contribute to a higher thrust by increasing the rate of mass flow through the system.

IGNITION

In contrast to the changing designs of most rocket components, the ignition system remains almost constant and basically simple. The igniter contains an explosive, a squib, and the necessary electrical attachments. An electric impulse heats an electrical filament in the squib, which ignites the powder. This ignition provides just sufficient energy to ignite the propellant without including undue stress on it.

The nominal time lag from trigger to launching is only a few milliseconds.

ROCKET HEADS

The shape of a rocket head is usually the result of a compromise of the conflict among aerodynamic considerations, payload requirements, fuze design, and the physical dimensions of the round.

The rocket head is the explosive or destructive part of the rocket. It is constructed as a separate unit and assumes a variety of forms, depending on the application. Aircraft rocket heads are classified according to their function. They are generally classified as general purpose, high-explosive, shape charge, armor-piercing, flare, and practice heads.

FINS

An immediate visible difference in the design of a rocket is its means of attaining stability. The stabilizing moments may be applied by means of fins or spin.

Fins provide rocket stability by the action of biting into the relative windstream. This action increases the aerodynamic forces at the rear of the rocket in relation to those at the nose, and causes the center of pressure to shift to the rear. When a rocket yaws, the longitudinal axis of the rocket deviates from its flightpath, and the pressure of wind upon the fins exerts a restoring moment which tends to keep the nose directed at the point of aim.

Four or more fins symmetrically fixed at the rear of the rocket comprise the fixed-fin assembly. Fixed fins have the advantages of rigidity and ease of manufacture. When the size of the rocket is critical, fixed fins are a disadvantage. They extend the diameter of the round, thus limiting the number which may be carried on a given launcher.

Folding fins are usually hinged in such a manner as to maintain the nominal round diameter when in the launcher. Use of folding fins increases the number of rounds carried in a given volume and the number which may be fired from a given frontal area.

The stability of a spin-stabilized rocket is achieved, as it is for the artillery shell, by the rotation of the round about its longitudinal axis. This spinning is effected by a ring of nozzles canted at such an angle (10° to 15°) that the exhaust gases cause the rocket to rotate at the same time it is driven forward.

This stability which may be increased by increasing the rate of spin, is limited by the centrifugal forces the motor tube and propellant can tolerate while under internal operating pressures.

A spin-stabilized aircraft rocket launched into a high-velocity crosswind immediately tends to tumble. At this critical point, the low initial spin rate is not sufficient to insure stability. A solution to this problem would be to impart spin to the round by mechanical means while in the launcher. This solution, however, introduces launcher-design problems of weight and complexity.

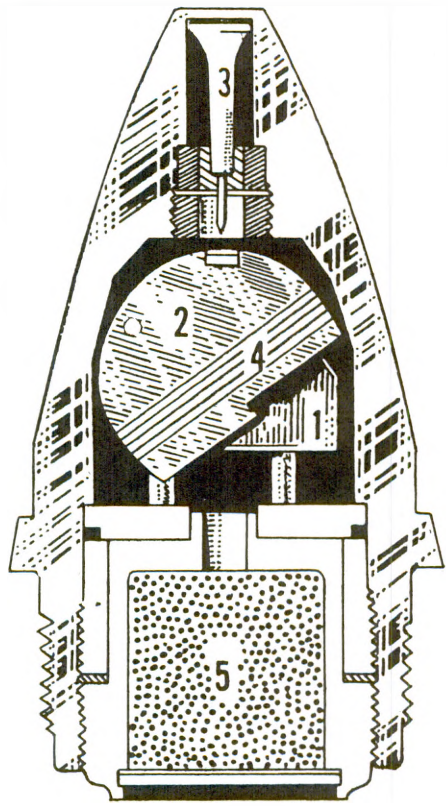


Figure 10-3.—Rocket nose fuze.

FUZES

The fuze is designed to meet two paradoxical problems: to provide maximum safety during handling and launching, and to guarantee positive detonation at the target. Two interrelating systems perform these functions. The arming mechanism renders the fuze safe and, in the proper circumstances, prepares the way for the detonator to act. The detonating system initiates the blast.

Arming is activated by one or more of these factors: acceleration forces, windstream, pressure of propellent gases, centrifugal forces.

The detonator may act upon immediate impact, after penetration (short-delay type), after a specific time delay, or upon target proximity.

Two basic design types are the nose fuze and base fuze, which may be used singly or in combination. The nose fuze is normally instantaneous while the base fuze is a delay (short) type.

Nose Fuze

A nose fuze of modern design is the Mk 176 fuze (fig. 10-3) a setback or acceleration-arming type, which combines very short time-lag detonation with a high degree of safety. Acceleration forces cause the setback weight (1) to recede, freeing the unbalanced rotor (2) which then tends to move into balance, thus alining pin (3), firing train (4), and booster (5). Upon impact a continuous path for detonation is provided.

A sustained acceleration force of several g's is required for an appreciable time in order to allow the fuze to arm. This rocket fuze has been tested by subjecting it to high instantaneous accelerations. After momentary setback forces disappear, the components of the arming mechanism return to their inert positions.

Base Fuze

Base fuzes are used to advantage when a prolonged delay is desired in order that the rocket head may penetrate the target prior to detonation.

Most base fuzes are similar to the one illustrated in figure 10-4. Arming is initiated by the propellent gases during rocket burning time. These gases gradually accumulate a pressure capable of collapsing the diaphragm (1). This action depresses the arming plunger (2) and allows the lock-ball (3) to drop from its safe position. This completes the first step of arming.

During burning time, acceleration prevents the shutter (4) from revolving into place. The second step is initiated at impact. The pin (5) remains in motion after rocket deceleration, driving forward, causing detonation. Retarded detonation is inherent in the construction. Time delay may be extended by including a delay element in the explosive train.

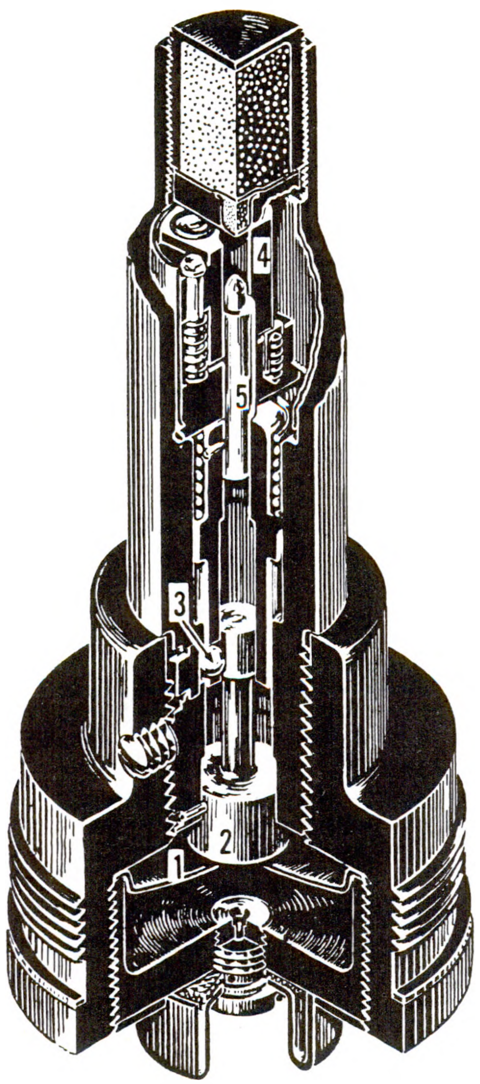


Figure 10-4.—Rocket base fuse.

PRETAKEOFF CHECKS

For optimum rocket performance, an accurate preflight check is good insurance. It should consist of the following:

1. Make a visual inspection of the rocket for possible damage or bent fins.
2. Make a visual inspection for proper mounting of the rocket in the launcher.
3. Check the security of arming wires and firing pigtails.
4. Check the electrical firing circuits.
5. Check the operation of the rocket circuit and sighting circuits.

Precise alinement of rocket fins is mandatory to establishing a predictable trajectory. Service rockets are the products of tested engineering designs and rigidly controlled manufacturing tolerances; but, their final performance characteristics depend upon the care with which they are handled during transportation, storage, assembly, and loading.

ROCKET FLIGHT

A free-falling body is subject to the forces of gravity and wind. A rocket is affected not only by the forces of gravity and wind but also is subjected to the forces of thrust during the burning time of the propellant.

The momentary instability of a rocket at launching is not critical because of its rapid acceleration and the high restoring moment of its fins. During the burning period, a rocket continues to accelerate. After burning, the velocity decreases due to drag. Gravity accounts for the curve of rocket trajectory.

The burning time of a rocket refers to that period during which the rocket is effectively propelled by the gas energy generated by the burning propellant. The length of burning time depends upon the rocket design and the propellent temperature and may vary from 1 to 2 1/2 seconds. The distance a rocket travels during burning time may be in the order of 1,500 feet.

PROPELLENT TEMPERATURE

Rocket performance is influenced by propellent temperature which is the result of the various temperatures to which the rocket has been exposed during the previous several hours, including storage, loading, and flight. Increased propellent temperature decreases burning time and increases burning rate; the effects on rocket performance are increased acceleration and reduced flight time. Considerable research effort is devoted to designing temperature insensitive propellants.

DISPERSION

The dispersion of a salvo of rockets, air-fired, ranges from 5 to 10 mils. This means that 68 percent of the rounds will be within a circle of 5 to 10 mils in diameter about the center of impact (mean point of all rockets fired). This pattern is established during the period of thrust. Increase in mil dispersion during free flight is negligible. Although the mil dispersion remains almost constant, radial dispersion measured in feet increases with range.

EFFECTS OF ACCELERATION

An aircraft flying at a given altitude and at a speed which produces a lifting force equal to the pull of gravity remains in a level flight and is said to have an acceleration of one g. An aircraft in a pullup or banked turn encounters forces of acceleration greater than one g.

If a rocket is fired at a time when the aircraft is executing a maneuver, the rocket trajectory is affected by the conditions accompanying that maneuver.

The rocket trajectory is not directly affected by the acceleration, but in order to generate the lift needed to produce the acceleration, the angle of attack must be increased. This causes the effective launcher line to deviate more from the launcher axis in a downward direction. A rocket fire control system compensates for this effect. Gravity causes the rocket trajectory to curve downward in a plane perpendicular to the earth's surface.

EFFECTS OF SKID

When skidding, the aircraft is pointing in one direction and flying in another direction. As in accelerated flight, the rocket turns towards a compromise course when the aircraft is slipping or skidding.

In order to fire accurately in the pursuit path, the pilot must track smoothly and avoid skidding.

TIME-TO-TARGET

Reduced time-to-target reduces the lead necessary to establish a hitting course and is the vital concern of the fire control system and terminal accuracy. For example, a fighter flying 500 knots in a tailchase pursuit fires a 2.75-in. FFAR with a propellent temperature of 70° F against a fighter target flying 500 knots 1,000 yards ahead. The rocket will reach the target in slightly over 2 seconds.

Three factors control the time-to-target: firing range, rocket velocity (including the aircraft's velocity), and target velocity. The target velocity cannot be controlled, and so far as pilots are concerned, the longer the range the better. It is obvious that the time-to-target can be diminished best by increasing average rocket velocity. Almost all service rockets fired from aircraft attain supersonic velocities, and ways are being found to increase rocket velocities while maintaining desirable dispersion patterns.

AIR-TO-AIR ATTACKS

The problem of choosing the best approach angle has been rendered more difficult by the high velocities of jet aircraft, and yet, in a sense, simplified by limiting the choices which can be executed effectively. The optimum approach angle in an air-to-air attack is dependent upon the relative positions of the two aircraft, upon the closing rate, and the defensive maneuvering of the target. These factors may limit the pilot's choice so the method of attack must be based on the target type and situation. In most cases against modern high-performance aircraft, tail approaches will predominate. Records show most aircraft have been destroyed by firing from the tail cone approach.

LEAD PURSUIT COURSE

Flying a lead pursuit course, the pilot leads the target by the angle necessary to enable him to score hits continuously throughout the run. The advantage of being able to fire a killing salvo at will throughout the attack is obvious. Lead pursuit course attack necessitates accelerated flight. The ballistics of rockets differ from gun projectiles because of the former's long burning time, windage effects, and mass. Consequently, when firing rockets in a pursuit course the lead is increased. Modern fire control computes the required lead for particular armament and aircraft model.

COLLISION COURSE

To avoid the high g's involved in some pursuit courses, another course of attack may prove more effective. In a collision course the attacking aircraft flies a straight path to a point in space from which rockets may be fired to intersect the target. The idea is that the pilot of the attacking aircraft will establish the collision course while he pulls out. Modern aircraft use fire control equipment to fire automatically rocket salvos when the collision course coincides with the hitting trajectory.

It is in a situation such as this that rockets prove most effective. A shotgun salvo of rockets should insure a kill.

AIR-TO-GROUND ATTACKS

The requirements for a successful air-to-ground attack are similar to those for an air-to-air attack. The effect of target speed and maneuverability is reduced, but the problem of opposing fire is increased.

The more accurate the tracking and ranging, the greater is the hit probability. Compared with guns, longer effective slant ranges are possible with rockets.

The accuracy of an air-to-ground attack depends upon the already discussed factors of smooth tracking and the effects of angles of attack and skid, wind and target motion, and propellent temperature. The following effects also require consideration.

1. Dive angle—the smaller the dive angle, the larger the gravity drop.
2. Launching speed—the greater the speed, the less the gravity drop.
3. Slant range—over 20 percent error in true slant range estimation is critical.
4. Pulling up or nosing over—with a computing sight, instantaneous shooting during a pullup will tend to overshot the target—nosing over to undershoot it.

The increase of trajectory distance with pullup is a factor used to advantage in the toss technique for either bombs or rockets.

ROCKET HEADS

Several types of heads have been developed to meet different tactical requirements. Some of these are discussed in the following paragraphs.

Armor-Piercing (AP)—This type is designed to penetrate armorplate or fortifications before exploding. Usually made of heat-treated steel, an armor-piercing warhead has thick walls and, consequently, a smaller explosive charge than other warheads.

The explosive used is one which will withstand the shock of impact without detonating. Explosive D is the charge normally employed. Since the nose section of an armor-piercing warhead must be of maximum strength, the fuze is located in the base.

General Purpose (GP)—This type is a compromise between the armor-piercing and the high-explosive designs. The general purpose warhead has a nose section and walls not as strong as those of an armor-piercing warhead, yet stronger than those of a high-explosive warhead. The explosive charge is more than that in the armor-piercing warhead, but less than that in the high-explosive warhead.

The general-purpose warhead is for use against a variety of targets. Its maximum penetration may be obtained by using a solid nose plug and a delayed-action base fuze. Its maximum blast effect may be obtained by using an instantaneous-action nose fuze.

High Explosive (HE)—This warhead is designed to damage a target by the blast of its explosive charge or by the fragments from its shell. The warhead has a relatively high percentage of explosive by weight. Because of the thinness of its walls, it will penetrate only light armor.

It is fuzed in the nose, since it is ordinarily intended for instantaneous action. However, it may be assembled with a delayed-action base fuze to allow some penetration of the target.

An auxiliary booster may be installed in an HE warhead to insure thorough detonation of the relatively large explosive filler. An auxiliary booster supplements the detonating capacity of the booster in the fuze. Granulated TNT normally is the explosive used in the auxiliary booster. Auxiliary boosters are shipped installed in the warhead.

High-Explosive Antitank (HEAT)—This type was developed for use against tanks, but is equally effective against other armored or fortified targets. This warhead employs the shaped-charge principle of explosives to produce a jet of high-velocity, high-temperature particles which will force its way through an extraordinary thickness of armor.

The explosive jet will penetrate heavy armor metal or concrete, but will not produce an explosive blast behind the armor. The jet will materially increase the temperature behind the armor and, in the case of a small enclosure such as the inside of a tank, its searing heat normally will kill the occupants.

Recent development of improving the fragmentation of this round, for antitank as well as for antipersonnel use, will result in its redesignation to ATAP (antitank antipersonnel).

The explosive charge in this type of warhead is detonated at its after end to produce the jet from the cone at the forward end. Detonation by the booster in the after end usually is accomplished through transmittal of the explosive impulse by a length of detonating cord. It connects the booster charge to the initiating charge which is adjacent to the nose fuze. The combination of an instantaneous-acting nose fuze and rapid-burning detonating cord permits detonation of the explosive load in time for the shaped-charge to produce its explosive jet before being disintegrated by impact on the target.

Practice (PRAC)—Practice heads are of two types, subcaliber heads and inert-loaded service heads. Most subcaliber heads are a hollow metal slug, although the hollow spaces may be filled with an inert material to bring the weight within required limits. One type of subcaliber head is solid metal. The inert-loaded service head is a service head in which the weight and placement of an inert filler give the head the same ballistic characteristics as those of the explosive-loaded service head, called warhead.

Smoke (SMOKE)—This warhead is designed to produce a volume of heavy smoke for target identification or screening purposes. It employs a tube of explosive, usually tetryl, which bursts the relatively thin walls of the warhead, dispersing the smoke. This burster tube is activated by a nose fuze. The abbreviation (SMOKE) for this warhead is followed by the abbreviation for the smoke-producing agent which the warheads contain; for example, WP for white phosphorus or PWP for plasticized white phosphorus.

VT—This warhead was developed to receive a VT fuze. VT fuzes generally are larger than mechanical fuzes, requiring a larger space in the warhead. Essentially, a VT warhead is a high-explosive warhead with a larger fuze cavity.

TRAINING ROCKET ASSEMBLIES

The Navy at the present time employs two standard rockets for training purposes. They are discussed in the following paragraphs.

2.25-INCH SUBCALIBER AIRCRAFT ROCKET (SCAR)

The 2.25-inch subcaliber aircraft rocket is a fin-stabilized rocket used for practice firing at ground targets. (See fig. 10-5.) These rockets are composed of two major components, the head and the motor.

The head is of machined steel, die-cast zinc, or cast iron. It is threaded at the rear for assembly to the motor and is hollowed out to give the head the correct weight to produce proper ballistic characteristics when the rocket is fired.

The motor consists of a metal tube threaded at the front for attaching the rocket head. The tube contains a cylindrical grain of ballistite for a propellant. The propellant is ignited by an electrically fired igniter charge of black powder. The rocket is propelled by the propellent gases escaping through venturi type nozzles at the rear of the motor tube.

Currently there are two SCAR assemblies in service use. They are the Mk 4 Mod 0 and the Mk 6 Mod 0. Both assemblies are similar and are used to simulate trajectories of the 5.0-inch HVAR rocket.

5.0-INCH ROCKET TARGET MK 26 MOD 0

This rocket is a high-velocity target rocket used for training pilots in missile firing. It has an overall length of 74 inches, a diameter of 5 inches, and a weight of 215 pounds.

The target rocket is assembled using the standard 5.0-Inch Rocket Motor Mk 10 Mod 6, Target Kit Mk 23 Mod 0, and Tracking Flares Mk 21 Mod 0. (See fig. 10-6.) The kit consists of an inert head weighing 125 pounds, a center hanger, and a modified HVAR fin assembly. The Tracking Flares Mk 21 Mod 0, which are attached to the fins, are shipped separately.

SERVICE ROCKET ASSEMBLIES

2.75-INCH FOLDING-FIN AIRCRAFT ROCKET

The 2.75-inch folding-fin aircraft rocket (FFAR) (Mighty Mouse) was developed primarily for air-to-air use against large bombers. However, it has proven to be a valuable weapon against air-to-ground targets such as locomotives, buildings, and bunkers. With the Mk 5

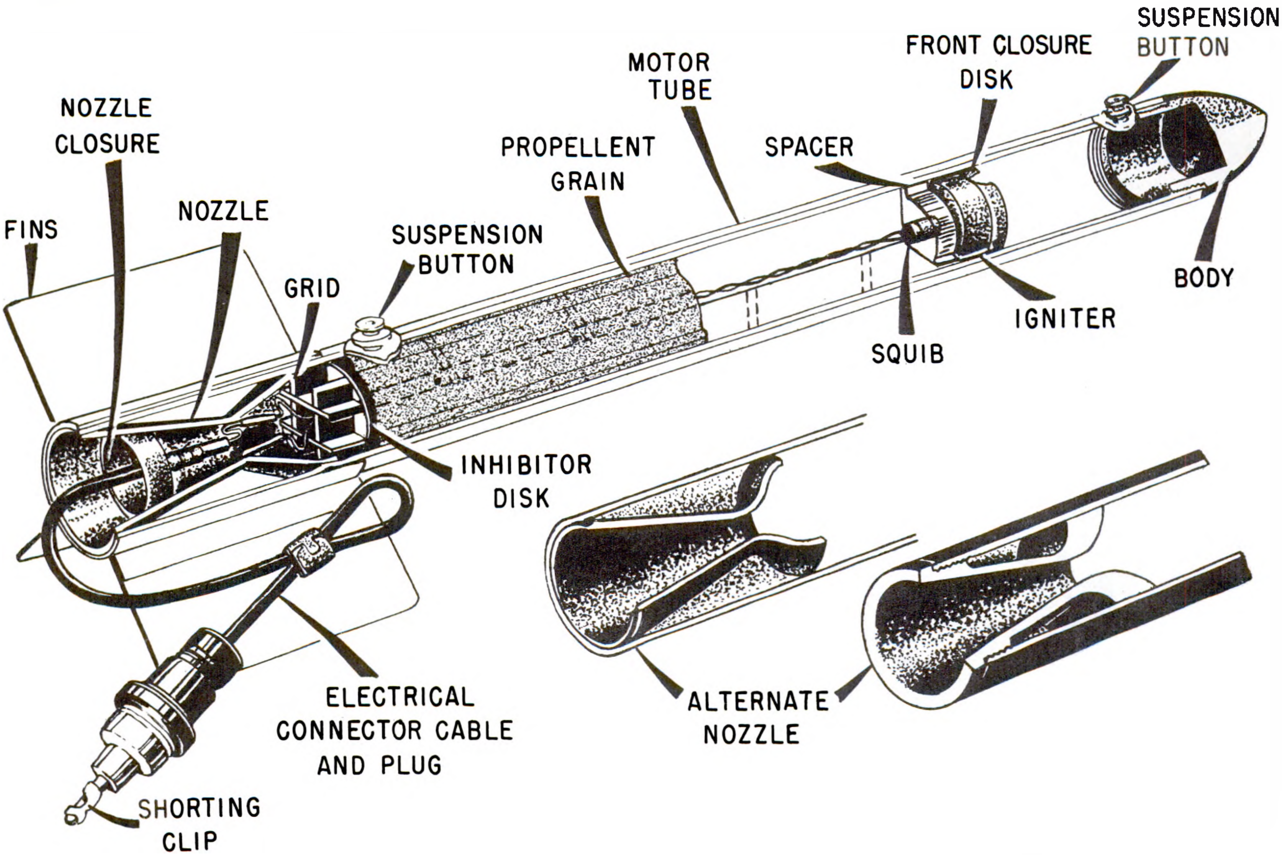


Figure 10-5.—The 2.25-inch subcaliber aircraft rocket.

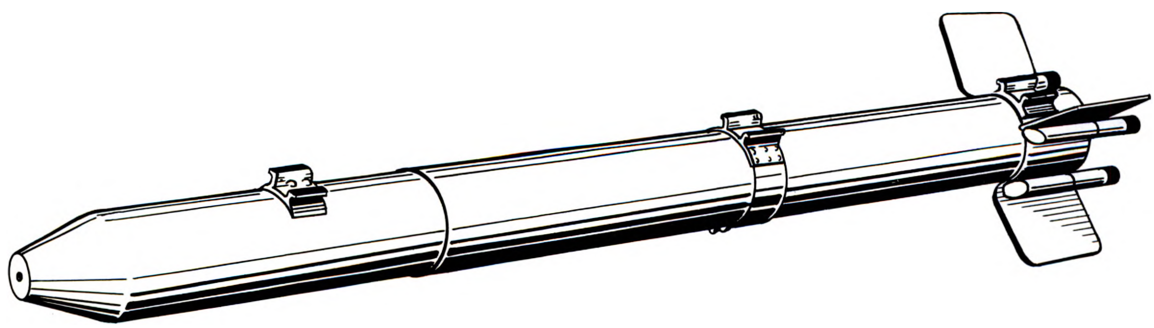


Figure 10-6.—The 5.0-Inch Rocket Target Mk 26 Mod 0.

head, this weapon also has a considerable capability against tanks and armored vehicles.

The Mighty Mouse was designed to be fired in large numbers. Thus, it is carried in rocket launchers with a capacity of 7 or 19 rockets. The rocket is 2.75 inches in diameter, has a length of 48 inches, and weighs 18 pounds.

The rocket consists of a fuze, head, and motor assembly. These components are normally shipped and stowed separately (except

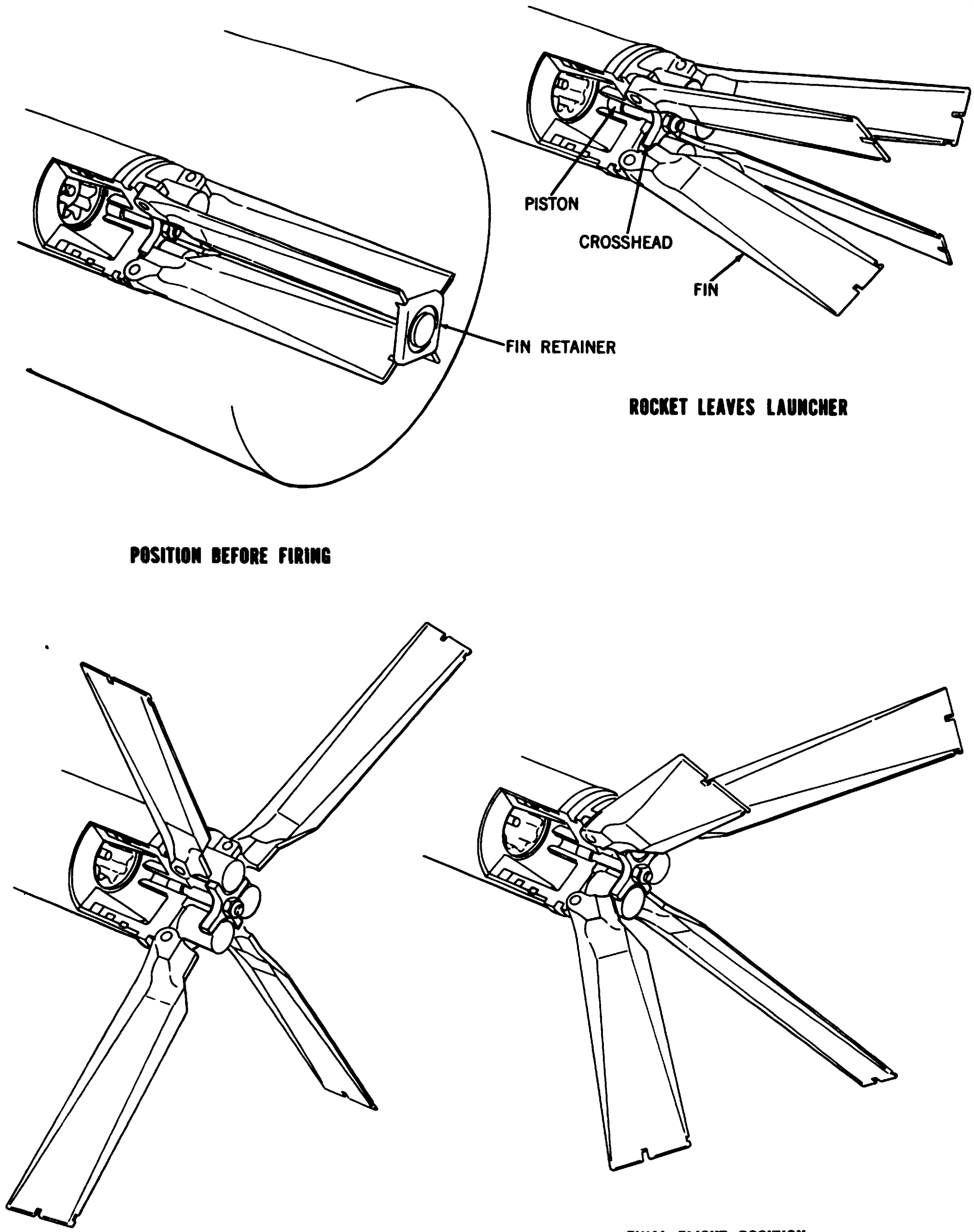


Figure 10-7.—Folding-fin rocket.

where the Aero 7D, rocket launcher package, is used).

Fin Assembly

When the motor is fired, figure 10-7, the fin retainer is blown off, freeing the fins. Gas pressure from the motor forces the piston and crosshead aft, pushing the crosshead against the heels of the fins. The launcher tube restrains the fins for a short period of time, with the fins exerting a force of about 2 pounds per blade against the tube.

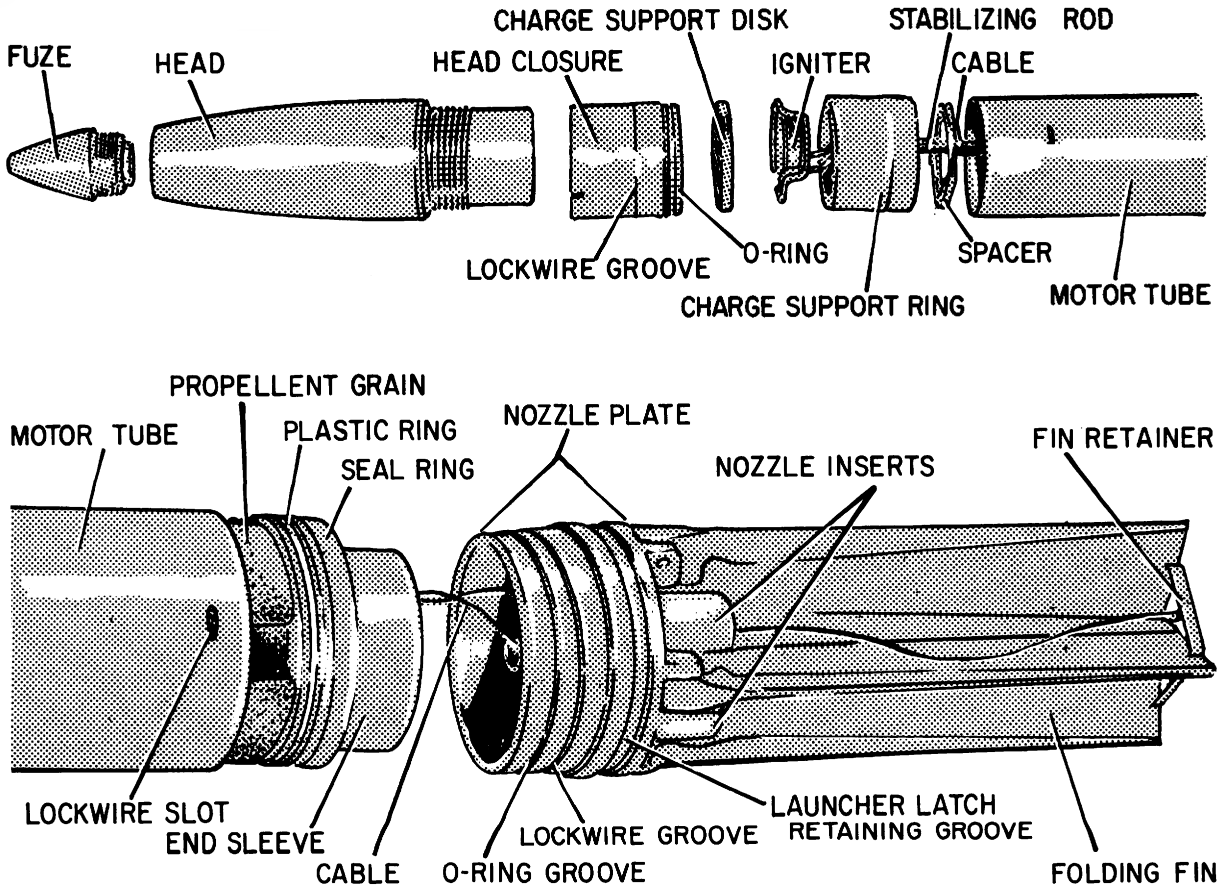


Figure 10-8.—The 2.75-inch folding-fin aircraft rocket.

As soon as the round clears the launcher, the crosshead forces each fin open to an angle of slightly less than 90° with the axis of the motor tube. Then, air resistance and setback forces return the fins to an angle of 45°, in which position the heels of the fins rest against the fully extended crosshead. The crosshead and fins stay in this position throughout the remainder of the flight.

Head

The head (fig. 10-8) is an ogival steel case threaded internally at the forward end for attachment of the fuze and externally at the after end for attachment of the motor. The head is loaded with a high-explosive charge. A threaded, cup-shaped cavity liner is screwed into the nose end of the loaded head and seats on the forward face of the explosive filler.

This liner prevents exposure of the filler when either the shipping plug or the fuze is removed.

CAUTION: Never remove fuze cavity liner.

Currently available heads are the Mk 1 Mods 1, 3, 4, and 5 and Mk 5 Mod 0. The Mk 1 heads are loaded with HBX-1 while the Mk 5 heads are filled with composition B.

NOTE: All Mods of the Mk 1 head are identical except for the methods used in their production.

In addition to high-explosive heads, inert loaded and drill heads are also produced. Each may be identified by its color. Explosive-loaded heads are painted olive drab; inert loaded heads are painted light blue; and heads for dummy rounds are painted black.

NOTE: Inert-loaded heads are issued with a dummy nose fuze.

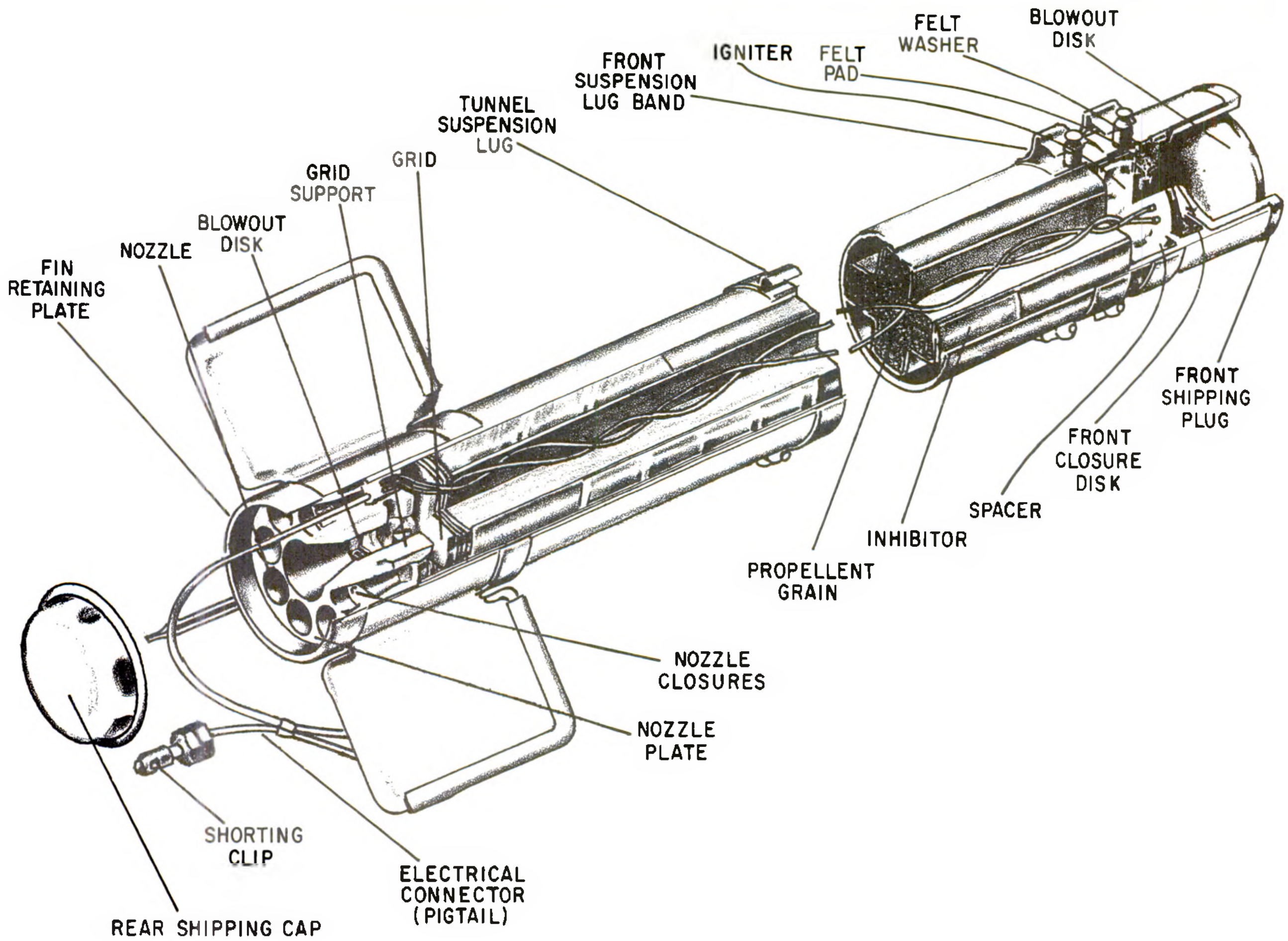


Figure 10-9.—The 5.0-inch HVAR rocket motor.

Fuze

The rocket uses either Fuze Mk 178 (point-detonating) or Fuze Mk 176 (point-detonating) depending on the type of mission on which the rocket is to be employed. Fuze Mk 178 is very similar to the Fuze Mk 176. The main difference is the absence of a delay element in Fuze Mk 178.

The cone-shaped steel fuze body (fig. 10-8) is 2.75 inches long. It encloses the firing mechanism, arming mechanism, primer, delay element, detonator, and booster. It is threaded at the lower end for attachment to the head.

Motor Assembly

Currently, four motors are used with the Mighty Mouse. They are the Mk 1 Mods 3 or 4, Mk 2 all Mods, Mk 3 all Mods, and Mk 4 all Mods. The motors have fins that fold within the 2.75-inch diameter of the rocket, which permits the rocket to be fired from tubular launchers.

5.0-INCH HIGH-VELOCITY AIRCRAFT ROCKET (HVAR)

The 5.0-inch high-velocity aircraft rocket consists of three parts, the head, motor, and tail fins. There is only one 5.0-inch HVAR motor currently used by the Navy, but it may be used with any one of several rocket heads. Approximate weight of these assemblies range from 130 to 150 pounds, and they vary in length from 69 to 85 inches.

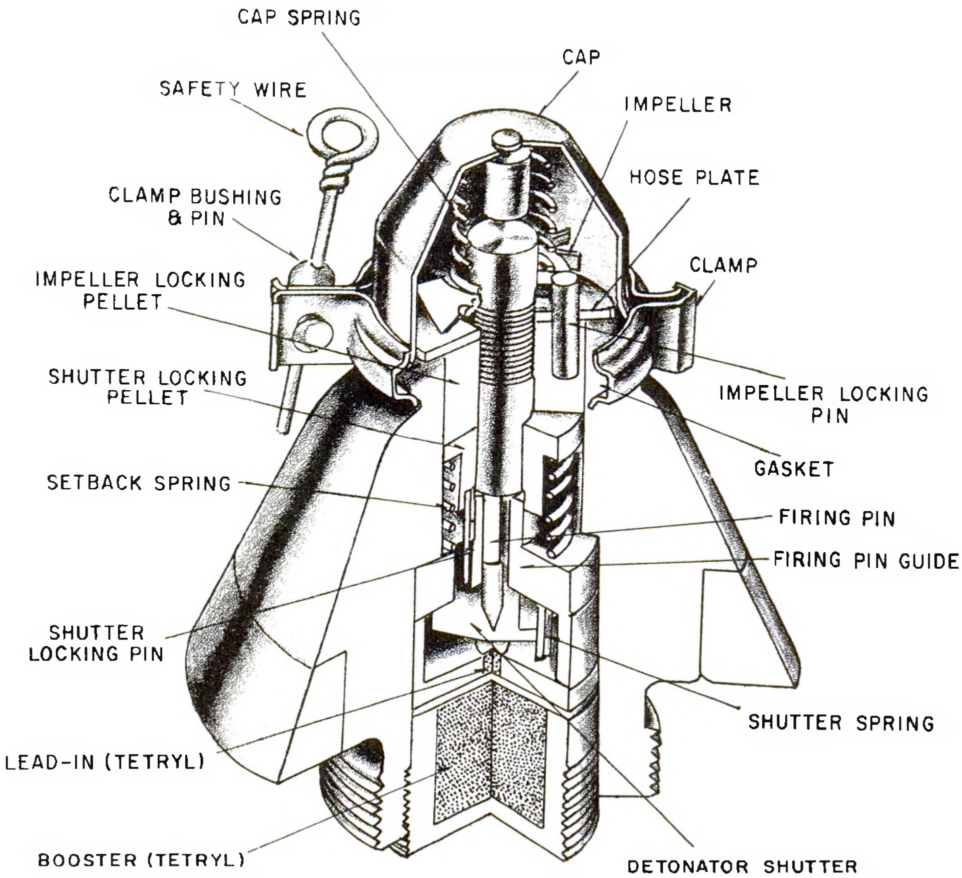


Figure 10-10.—Cutaway view of the Nose Fuze Mk 149 Mod 0.

Motor

The 5.0-inch HVAR motor (fig. 10-9) currently used is the Mk 10 Mod 6. It consists of a seamless steel tube with internal threads on both ends. At the rear is a nozzle plate having eight nozzles arranged in a circle, and a larger central blowout nozzle closed by a copper disk. The blowout nozzle acts as a safety valve. The copper disk is designed to blow out if the internal pressure exceeds 2,400 psi, which is the normal maximum pressure when the propellent grain temperature is 100° F. In this manner, the usable temperature range of the rocket is increased.

Suspension lugs mounted on bands for attachment to the rocket motor are provided to suspend the rocket from the rails or T-slots of the rocket launchers. The motor is arranged so that the bands may be mounted at various positions for the different launchers.

Heads

The various heads used in 5.0-inch HVAR's are listed below:

The 5-Inch Rocket Head Mk 2 Mod 2 is loaded with explosive D and weighs approximately 48 pounds. It is fuzed with a permanently installed base fuze only. The base fuze screws into an adapter in the base of the head. The adapter and base fuze are gas-checked to prevent leakage of motor gases into the loaded head upon firing.

NOTE: No attempt should be made to remove the base fuze. An improperly base fuze head can be the cause of loss of life and/or material.

The 5.0-Inch Rocket Head Mk 6 Mod 1, a general purpose head, is loaded with TNT and weighs about 48 pounds. It is fuzed with Nose Fuze Mk 149 Mod 0 and Base Fuze Mk 164

Mod 0. However, during shipping and stowage, the nose fuze is replaced by a nose shipping plug.

The 5.0-Inch Rocket Head Mk 6 Mod 4 is similar to and issued with the same base fuze as the Mk 6 Mod 1, but is arranged for installation of VT (Proximity) Rocket Fuze Mk 172 Mod 0 in the nose rather than Nose Fuze Mk 149 Mod 0.

The 5.0-Inch Rocket Head Mk 25 Mod 1 (shaped charge) comprises a cylindrical steel tube fitted with a copper cone at the forward end, a high-explosive filler (composition B), a steel windscreen on the forward end of the cylindrical tube with an adapter to attach a nose fuze, (Nose Fuze Mk 149) and a booster set into the explosive charge at the after-end of the head cylinder. It is not equipped with a base fuze. The fuze is replaced by a nose shipping plug during shipping and stowage.

Nose Fuzes

NOSE FUZE MK 149 MOD 0.—The Mk 149 Mod 0 (fig. 10-10) is a typical air-arming, impact-firing nose fuze designed for use with the HVAR rocket. The fuze body fits directly into the fuze seat liner in the nose of the rocket head.

In the unarmed position, the firing pin is screwed down alongside the detonator shutter, holding it in a safe position. The impeller is attached to the firing pin and is prevented from turning by the impeller locking pin, which is attached to the impeller locking pellet. The cap on the nose of the fuse is held tightly in place on the gasket by a clamp assembly held together by a safety wire, or by an arming wire when the round is loaded on a launcher and ready to fire. This cap prevents exposure of the fuze to the weather and is removed only when the rocket is fired with nose fuze armed. A cap spring located under the cap bears on the top of the impeller, preventing it from turning as long as the cap is secured by the safety or arming wire. When an assembled round is loaded on the launcher, the arming wire is first inserted in a hole provided next to the safety wire in the clamp pin and bushing assembly, after which the safety wire is removed. This order must not be reversed or the cap will fly off, exposing the impeller.

When the round is fired, the arming wire pulls free, releasing the clamp assembly and allowing the cap spring to throw off the cap, thus exposing the impeller. At the same time, acceleration inertia forces the impeller locking pellet and pin backward, releasing the impeller. The same force moves the detonator shutter locking pellet and pin back, and as long as acceleration continues, the shutter is held locked by the locking pin. The impeller turns outward in a clockwise direction, and after about eight turns the firing pin is clear of the detonator shutter. When acceleration ceases, the shutter locking pin is withdrawn by the action of the setback spring on the shutter locking pellet. The detonator shutter is swung into the armed position by the action of the shutter spring, provided the firing pin has by this time advanced sufficiently to clear the detonator shutter. The shutter is locked in the armed position by a detent engaging in a hole in the firing pin guide. The firing pin jams and stops turning when the end of the threads reaches the nose plate. Upon impact, the firing pin shears the threads in the nose plate and is driven into the detonator, thus setting off the explosive train.

Nose Fuze Mk 149 Mod 0 fires at impact angles as low as 5° to 10° for water, and for land targets which allow slight penetration. On hard targets it fires at impact angles of not less than 20° to 25°.

Since the shutter is held in the safe position by the shutter locking pin during acceleration, arming will not occur until about 0.1 second after acceleration ceases. Therefore, the arming distance of the fuze will vary from 200 to 800 feet, depending upon initial propellent temperature at which the round is fired.

Nose Fuze Mk 149 Mod 0 is safe as long as the cap and clamp on the nose are held in place by the safety wire or arming wire. If the cap and clamp assembly comes off accidentally, the fuze is still safe as long as the arming impeller is locked by the locking pin.

The Nose Fuze Mk 149 Mod 1 is very similar to the Mk 149 Mod 0, except the firing pin of the Mod 1 is drilled longitudinally to make it collapse in its well in the shutter if the fuze is dropped accidentally while in the unarmed condition. This collapsing prevents it from accidentally initiating the booster lead-in. The firing pin of the Mod 0 is not drilled.

VT NOSE FUZE MK 172 MOD 2.—The Mk 172 Mod 2 (fig. 10-11) is a proximity fuze armed, like other nose fuzes, by a combination of air travel and inertia. Its operation is similar to that of VT bomb fuzes and it will cause an airburst of the rocket head at distances between

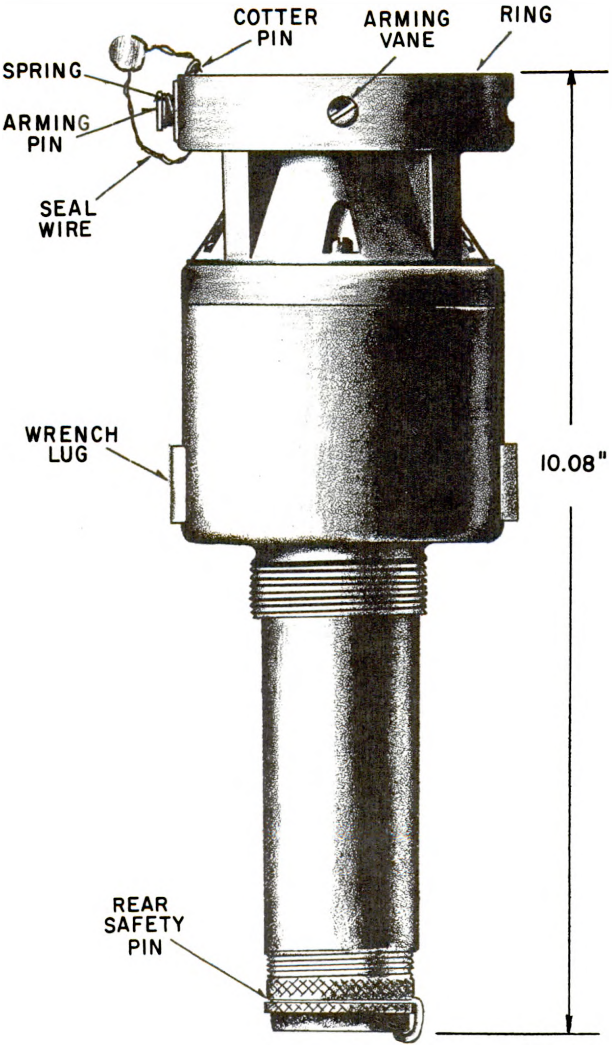


Figure 10-11.—Nose (VT) Fuze Mk 172 Mod 2, external view.

10 and 40 feet from the target. It is particularly effective against personnel without top cover, such as men in foxholes and slit trenches and exposed gun crews aboard ship.

The Mk 172 Mod 2 fuze may be easily recognized by its exposed 10-bladed arming vane which is surrounded by an antenna ring.

VT Fuze Mk 172 Mod 2 is designed for air-to-ground firing where airbursts are necessary to spray fragments on personnel or light equipment. This fuze may be used in air-to-air firing, but the rocket must come within 20 feet of its target before the fuze will function.

NOTE: This fuze must not be used if the seal wire is broken with which the fuze is shipped.

Base Fuzes

Fuze Mk 164 Mod 0 is used in the 5-Inch HVAR High-Explosive (HE) Heads Mk 6 Mod 1 and Mk 6 Mod 4 and incorporates a delay functioning time of 0.015 second. Fuze Mk 166 Mod 0 is used in the 5-Inch HVAR (HE) Head Mk 2 Mod 2.

These base fuzes (fig. 10-4) are armed by a combination of gas pressure, inertia, and deceleration. Between 275 pounds and 325 pounds of gas pressure within the motor tube is required for complete arming. They fire due to inertia of the internal parts upon impact.

FOLDING-FIN ZUNI ROCKET

The Zuni (fig. 10-12) is a 5.0-inch high-velocity, folding-fin, solid-propellent rocket for use by both fighter and attack aircraft against bombers, fighters, and ground targets. Physical characteristics of the Zuni are as follows:

Nominal diameter . . . . 5.0 in.
Maximum length . . . . 110.0 in.
Loaded weight . . . . 107.0 lb
Fuzed warhead weight approximate . . 48.0 lb

Two interchangeable warheads provide effectiveness in a variety of tactical situations. An inert-loaded head is also available for practice exercises. The Zuni is fired from a tubular launcher.

The 5.0-inch folding-fin aircraft rocket (Zuni) uses a different method of fin extension. Where the 2.75-inch rocket fins are extended by piston-crosshead action, Zuni fins are blast operated. The heels of Zuni fins are installed to lie over the nozzle cone. The first gases from the motor kick the fins open to latch on ratchet pawls. A small plastic fin retainer disk holds the fins closed before motor firing.

Motor

The Mk 16 Mod 1 Zuni rocket motor (fig. 10-12) is 77 inches long with a maximum outer diameter of 5 1/8 inches. These motors are shipped completely assembled in the Aero 10D rocket launcher (fig. 10-13), or in individual shipping containers. A thread protector is screwed into the head end of the motor

Figure 10-12.—The 5.0-inch Zuni folding-fin rocket.

when it is shipped individually. This thread protector should not be removed until just before the rocket head is attached. The contact band at the forward end of the motor is covered by a shielding band that must be left in place until just before the contact band on the motor enters the launcher during loading. The shielding band seats in the motor-detent groove and covers the ignition contact band, thereby shorting out the ignition circuit and providing protection against radiofrequency energy. Care should be taken when loading motors in launchers to avoid touching the contact bands to eliminate the possibility of transferring radiofrequency energy.

The nozzle assembly screws into the aft end of the aluminum-alloy motor tube. In addition to the application of a luting compound

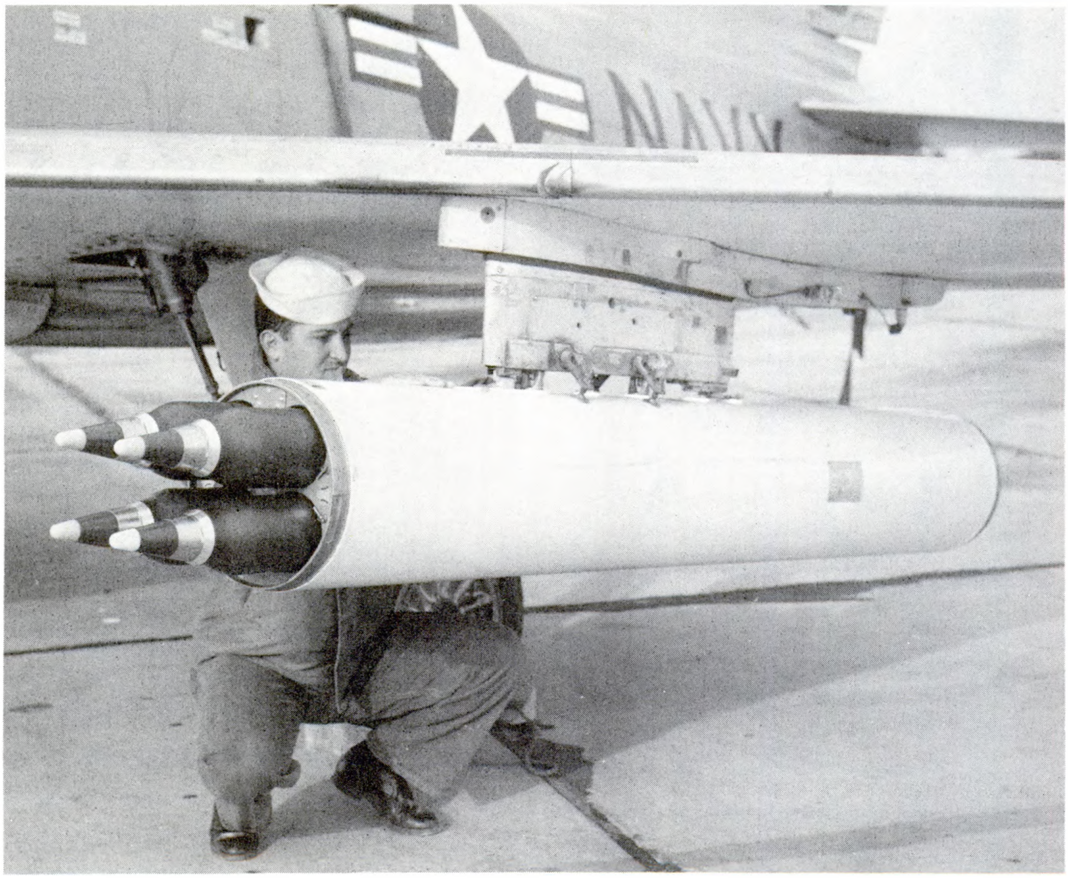


Figure 10-13.—Aero 10D aircraft rocket launcher package.

to the nozzle-attachment threads, the nozzle carries an O-ring seal as further insurance against gas leakage.

The nozzle assembly consists of the steel nozzle, four aluminum fins, and the steel fin locking pawls. The aluminum-alloy fins are 13 inches long and 2.3 inches wide and are uniformly tapered in thickness from the pivot to the tip. A light plastic retainer holds the fins folded within the 5 1/8-inch diameter of the round. On ignition, this fin retainer is blown off and gas pressure on the heels of the fins pushes them open. The fins open to flight position about 4 feet after emerging from the launcher. The spring-loaded pawls then hold the fins in flight position against aerodynamic drag. A special treatment provides a heat-barrier coating over the entire fin surface to prevent erosion by the hot exhaust gas. To protect the propellent charge from moisture, the nozzle opening is closed by a metal seal. No gas pressure enters the chamber of the motor directly behind the head.

To smooth the burning and suppress flash of the propellant, a ballistic rod is installed through the center of the star-shaped grain perforation in the forward section. The nozzle end of the propellent grain seats against a rubber seal ring on the nozzle. A helical steel spring at the head end of the propellent grain pushes it back against the rubber seal ring, thereby preventing the flow of hot gas through the space between the propellent grain and the motor tube.

There is an external contact band at the head end of the motor for the motor-ignition circuit.

The tin-case igniter, located at the head end of the motor, is charged with black powder and coated magnesium powder. Two Mk 1 squibs connected in parallel initiate the igniter. A lead wire connects the center post of the terminal with the igniter contact band on the outside of the motor. The ignition is grounded to the motor body by the terminal and clamp nut to complete the ignition circuit.

Heads

Two heads are currently available for the Zuni rocket. They are the 5.0-Inch Rocket Head Mk 24 Mod 0 (GP), and the 5.0-Inch Rocket Head Mk 32 Mod 0 (ATAP). Other heads are currently under development.

The Mk 32 Mod 0 rocket head (fig. 10-14 (A)), when fuzed with a point-detonating (PD) fuze, effects shape-charge action. Thus, it is highly effective against heavy targets such as tanks or bunkers. The Mk 32 head has a cavity liner to prevent exposing the explosive when fuzes are changed. For fragmentation action against aircraft or personnel, a proximity fuze may be attached to the head.

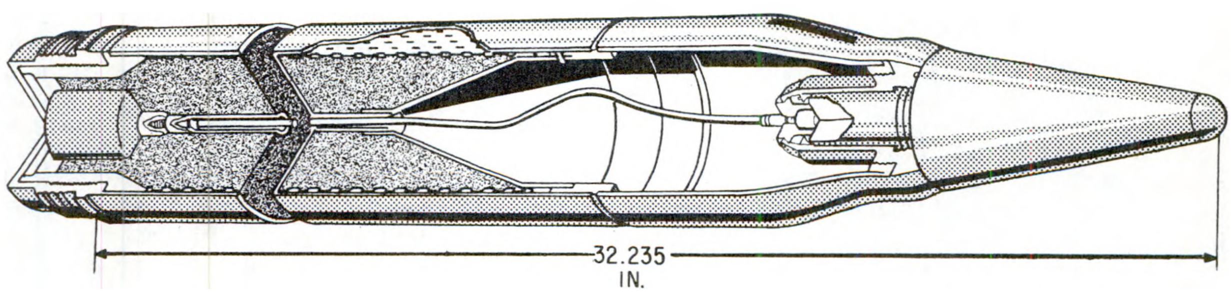
The Mk 24 Mod 0 general purpose head (fig. 10-14 (B)) may be fuzed for contact, proximity, or delayed detonation. The Mk 191 Mod 0 (BD) fuze is permanently assembled in the base of the Mk 24 head and may be removed only at a Navy Ammunition Depot by qualified personnel. When used with a steel nose plug, the Mk 24 is a delay-action warhead. The steel nose plug enables it to penetrate heavy targets, such as concrete bunkers and ships, and to detonate inside the target. The T2061 proximity fuze or Mk 188 point-detonating fuze also may be used in this head with effectiveness. A metal fuze liner is used to prevent exposure of the high explosive when a nose fuze is being attached or detached.

Fuzes

The Mk 188 Mod 0 fuze (fig. 10-15 (A)) is a point-detonating nose fuze that may be used in the 5.0-Inch Rocket Head Mk 32 Mod 0 and Mk 24 Mod 0. It is a mechanical setback or acceleration-arming type fuze similar to the Mk 176 fuze previously discussed in this chapter. It is carrier-safe and will not arm within the length of the carrier if dropped or accidentally fired.

The proximity fuze T2061 (fig. 10-15 (B)) is also designed for use with Zuni Warheads Mk 24 and Mk 32. It is especially effective against aircraft. In air-to-air firing, the T2061 fuze functions within 40 feet of the target aircraft and when used with the Mk 32 head will destroy an enemy aircraft.

(A)



(B)

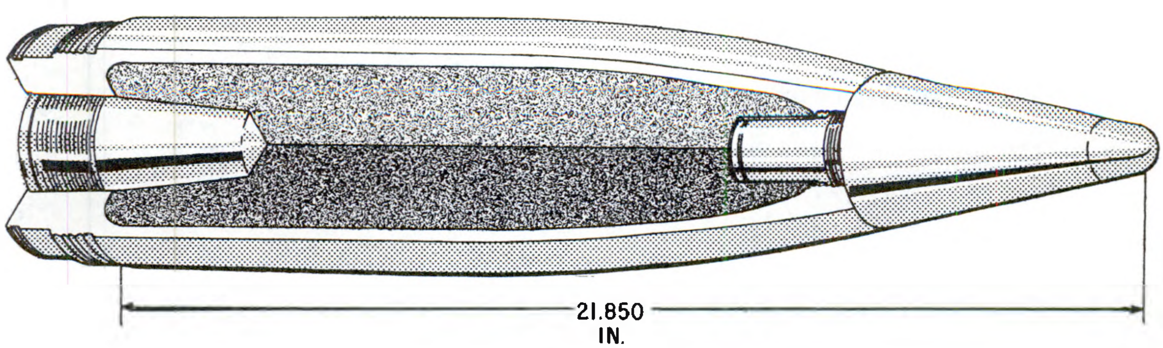


Figure 10-14.—5.0-inch Zuni rocket head.

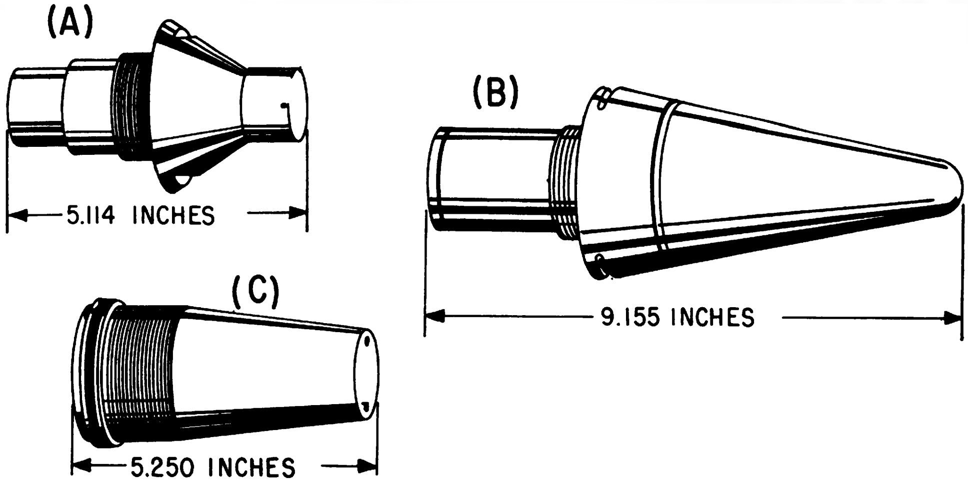


Figure 10-15.—Zuni rocket fuzes.

Since the T2061 fuze is used with shipper-launcher-packages, it has no external arming devices. Its electronic components are completely enclosed in a blunt-nosed, ogival, fuze head.

In air-to-ground application, the warhead is detonated above ordinary terrain at appropriate approach angles, thus achieving maximum effectiveness. When the rocket is fired as one of a salvo, the fuze will not function on another rocket in flight. The fuze is also carrier-safe.

The Mk 191 Mod 0 base-detonating fuze (fig. 10-15 (C)) is an electromechanical, acceleration-arming, impact fuze. It is installed in the base of the 5.0-Inch Rocket Head Mk 24 Mod 0 at the time the head is loaded with high explosive. It, too, is carrier-safe.

CAUTION: This fuze must not be loosened, removed, or worked on by fleet personnel. If the gas seal around the fuze is not in place or the fuze is loose or missing, the head must not be used; it must be returned to the Naval Ammunition Depot. A loose, missing, or unsealed base fuze can result in great material damage and loss of life.

AIRCRAFT ROCKET LAUNCHER PACKAGES

AERO 6A-2

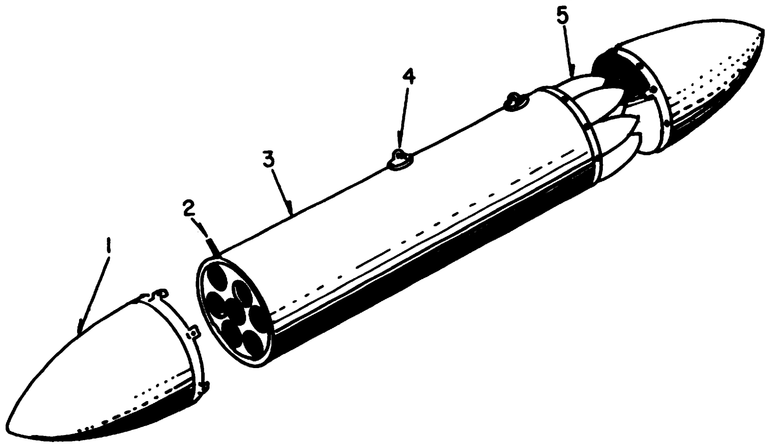
The Aero 6A-2 aircraft rocket launcher package (fig. 10-16) is an expendable dual purpose store which houses seven rocket motors from the time of manufacture to firing at the target. The package is used for overseas shipment and storage of seven 2.75-inch folding-fin aircraft rocket motors and as a service launcher for these rockets when equipped with rocket heads.

The shipping configuration consists of two packages:

1. The launcher center section fitted with two reusable shock absorbing end pans, rocket motors, and motor retaining plugs.
2. An expendable fiberboard shipping drum and eight low-drag, frangible fairings. (One package of fairings is supplied with every four motor containers.)

The launching configuration consists of one center section containing seven assembled rockets and equipped with two frangible fairings. The Aero 6A-2 launcher suspends from the bomb hooks of Aero 15C-1 pylon or Aero 14 type pylons by hangers. Electrical power to the launcher from the aircraft's 28 volt d-c system is through an ignition cable equipped with a jack plug which fits standard HVAR receptacles.

The launcher center section is made of seven paper tubes surrounded by a heavy fiberboard casing and capped with metal end bulkheads. The paper components are encapsulated with a tough plastic material which protects the paper against moisture and the effects of rocket blasts. The metal bulkheads are swaged in place and sealed to the casing. Three internal longitudinal tie rods, with fittings on the end bulkheads, provide attaching means for the shipping end pans.



1. Frangible fairings.
2. Ignition cable.
3. Center section.
4. Suspension hangers.
5. Assembled rockets.

Figure 10-16.—Aero 6A-2 rocket launcher package.

A leaf spring detent latch retains the rocket in each launching tube until thrust loads of 10 to 15 g's are applied. However, simple manual unloading from tail end of the launcher is accomplished by depressing detents. Short wooden fillet sticks hold the detents in place and locally reinforce the paper tubes.

Electrical power for the rocket ignition system is supplied to the launcher by the armament circuits of the aircraft. The firing impulse is distributed to the seven rockets by a small molded plastic intervalometer attached to the aft bulkhead. The intervalometer has no moving parts and requires no maintenance. The wiring of the intervalometer converts the aircraft firing pulse into a ripple-salvo of firing pulses at the rate of 100 pulses per second. Blast from the last rocket to fire severs the ignition cable at the cable breaker. This facilitates jettisoning of the spent launcher.

The launcher fairings are made of treated wood fiber and will shatter readily from the rocket impact. A metal band at the base of each fairing fits over the bulkhead and is turned to the right to lock the fairing to bulkhead.

NOTE: Current BuWeps Instructions should be consulted for applicable restrictions and other pertinent information prior to using the Aero 6A, 6A-1, or 6A-2 rocket pod.

AERO 7D

The Aero 7D is an expendable launcher-shipper package unit for shipping, stowing, and firing 19 completely assembled 2.75-inch folding-fin aircraft rockets. It is suitable for air-to-ground or air-to-air rocket launching. Unlike the Aero 6A-2 and 10D launchers, the Aero 7D is not divided into 2 separate configurations, 1 for shipping and 2 for firing. Because 2.75-inch folding-fin aircraft rockets are shipped, stored, and fired using the same Aero 7D container-launcher, the components are described for a single launcher configuration.

The Aero 7D rocket launcher package consists of a center section, reusable shock pans, and frangible fairings. The center section contains 19 assembled 2.75-inch folding-fin aircraft rockets, the launching tubes, suspension provisions, the launcher ignition system, end covers, rubber retainers, and locking rings. The frangible fairings are shipped and stowed in a separate container. Each fairing container accommodates 6 frangible fairings. Both the center section and fairing container are watertight.

The launcher center section is constructed of 19 thermosetting plastic impregnated paper tubes clustered and bonded together to form an integral part of the structure. This cluster is contained in an aluminum skin. The ends are closed and supported with metal bulkheads.

External suspension lugs are screwed into thread inserts to provide for attachment to aircraft bomb racks. In each tube, the rocket is held in place by a flexible metal spring detent; the rocket blast upon firing releases this spring.

A hard rubber pad is fitted to the front of the package to provide support for the rocket nose should any rocket become dislodged from its detent during shipment and stowage. A soft rubber pad is fitted to the rear of the package to support the rocket fin retainers of the rockets during shipment and stowage. These items are removed when the fairings are installed.

Shock pans are used to support the ends of the launcher center section when it is packaged for shipment or storage. These pans provide stability to the package for single or multiple stacking, and contain locking slots for compressing the cover seal ring by means of a locking ring assembly for sealing the center section and assuring a watertight container. The end pans are removed when the fairings are installed.

Electrical power for the rocket ignition system is supplied to the launcher by the 28-volt d-c armament circuit of the aircraft. Two receptacles are provided for making contact. One receptacle is located near the forward end of the center section, the other near the after end of the center section. Either receptacle may be used for making contact. The type of bomb rack used with the launcher determines which receptacle is used. On aircraft using bomb racks with striker arms, Aero 14 or 15 type combination bomb rack and rocket launcher pylon, a post assembly is inserted in the receptacle. Grounding of the circuit is provided through the suspension lugs which attach the launcher to the aircraft. As a safety precaution, shorting buttons are placed in each receptacle. The shorting buttons are not removed from the receptacles until connections are made and just before the aircraft is ready for flight. When fired, current passes through an intervalometer which ripple-fires the rockets in pairs at 10-millisecond intervals.

Each contact receptacle is protected by a dust cap and shorting button assembly. The shorting button is a leaf spring button which is pressed in place between the five pins of the receptacle. A retaining cord connects the button with the inside of the dust cap. The dust cap is screwed in place over the receptacle and prevents entrance of foreign material. Before making electrical contact to the aircraft, the dust caps are removed from both receptacles and allowed to dangle. The shorting button is removed from the position to be used when electrical connection is made. The remaining shorting button is pulled out just prior to takeoff.

The firing impulse is distributed to the individual rockets by a shunt-fuse intervalometer which is installed through the aft bulkhead into the wiring harness receptacle. The intervalometer has no moving parts and requires no maintenance. The wiring of the intervalometer converts the firing pulse into a ripple-firing with a 10-millisecond delay interval.

Frangible fairings are attached to the forward and aft ends of the center section after the center section has been attached to the aircraft. The launcher fairings are made of treated paper and shatter readily from rocket impact or blast. A metal band at the base of each fairing provides lugs which engage grooves in the center section end rings. As the fairing is rotated clockwise, a leaf spring clip locks the fairing in place. When attached, the fairing is flush with the outside surface of the center section and forms an aerodynamically smooth joint.

Multiple suspension provisions make the Aero 7D adaptable to most Navy and Air Force tandem 14-inch and 30-inch bomb racks, and single bomb hook United Kingdom bomb racks. Threaded suspension lugs not being utilized are removed to provide minimum weight and maximum clearance for each installation.

AERO 10D

The Aero 10D aircraft rocket launcher package (fig. 10-13) is a reusable dual-purpose store which houses four 5.0-inch folding-fin aircraft rocket, Zuni, motors from the time of manufacture until assembled with warheads and fired at the target. It is suitable for air-to-ground or air-to-air rocket launching.

The shipping configuration consists of two packages: the launcher center section, containing four 5.0-inch folding-fin aircraft rocket, Zuni, motors, with the shock pans, covers, and locking rings installed; and the fairing container, containing six streamlined, frangible fairings, enough to equip three launchers.

The shipping ends comprise a multipurpose arrangement consisting of the shock pan assembly, cover assembly, and locking ring assembly. The shock pan assembly is a heavy metal picture frame type structure which provides stability and rigidity. It is equipped with an alternate hold and pin arrangement on the sides, so arranged that when the launchers are stacked, the shock pans interlock. The cover is equipped with a rubber seal ring which, when compressed by the locking ring assembly, forms a watertight closure over the end of the launcher. The locking rings fit into grooves in the shock pan and serve to hold the cover in place and compress the seal ring. In addition, the locking ring is equipped with handles that can be hinged back perpendicular to the horizontal centerline of the launcher and latched to the shock pan by means of a spring-loaded pawl to facilitate manual handling.

The launcher center section contains the four launching tubes, the electrical ignition system, suspension lugs, and a sear type detent latch.

The flight configuration consists of a launcher center section, with the shock pan, cover, and lockring assemblies removed, containing four assembled Zuni rockets and a frangible fairing installed and securely locked in place on each end.

Electrical power for the rocket ignition system is supplied to the launcher by the 28-volt d-c armament circuit of the aircraft. Electrical connection between the aircraft and the launcher is made through either of two paralleled receptacle assemblies, located in the vicinity of the launcher center section lugs. As a safety requirement, both receptacles are fitted with shorting plugs and dust caps. A selector switch is located in the aft bulkhead of the launcher for preflight selection of either ripple- or single-firing of the rockets. A rotary relay type intervalometer located in the forward bulkhead distributes the firing pulse to the individual rockets and is designed for a 50-millisecond time-delay interval. Electrical connection to the rocket motor is completed in each tube through contact posts on the detent latch to a contact band on the rocket motor. The forward contact post is the negative connection and the aft contact post is the positive connection.

In addition to the selector switch located in the launcher, some aircraft are equipped with a selector switch in the cockpit. In aircraft so equipped, the pilot has the inflight option of either ripple- or single-firing, provided the selector switch in the launcher is in the proper position before takeoff. In aircraft not so equipped, the method of firing is restricted to the preflight setting of the launcher selector switch.

Multiple suspension provisions make the Aero 10D launcher adaptable to most Navy and Air Force tandem suspension 14-inch and 30-inch bomb racks plus the United Kingdom single-suspension bomb racks. The Aero 10D launcher is not suspended from a bomb rack that does not have independent ignition and jettisoning circuits. For further information in handling, loading, assembling, and storing of aircraft rocket launcher packages, the Aviation Weapons Officer should consult Aircraft Rockets, NavWeps OP 2210, or other official publications.

TESTING AIRCRAFT ROCKET FIRING CIRCUITS

Before the electrical connections can be made to the rockets, the rocket firing circuit must be checked to insure that the firing circuit is operating properly. The check must comply with instructions contained in the aircraft's Maintenance Instructions Manual, BuWeps Instructions, or local instructions.

Two basic tests must be performed. The first test consists of a continuity test which is performed prior to loading the rockets and in any location where auxiliary power is available. The second test, a no-voltage test, is performed in the arming area and requires that the pilot have the aircraft's engine and generators running. Figure 10-17 shows the standard equipment that is normally used in performing these two tests.

NOTE: The greatest single cause of firing failure is the lack of electrical continuity between the aircraft and the rocket.

The continuity test or no-voltage check for aircraft rocket firing circuits is similar for all aircraft carrying any type of rocket or rocket launcher package. However, the Operation and Service Instructions Manual for the rocket launcher package model to be used should be checked prior to performing any test involving amperage or voltage requirements.

The no-voltage test must be performed just prior to connecting the rocket circuit to the rocket or rocket pod. The no-voltage test is made using either the Rocket Launcher Firing Circuit Tester (fig. 10-17) or a voltmeter with

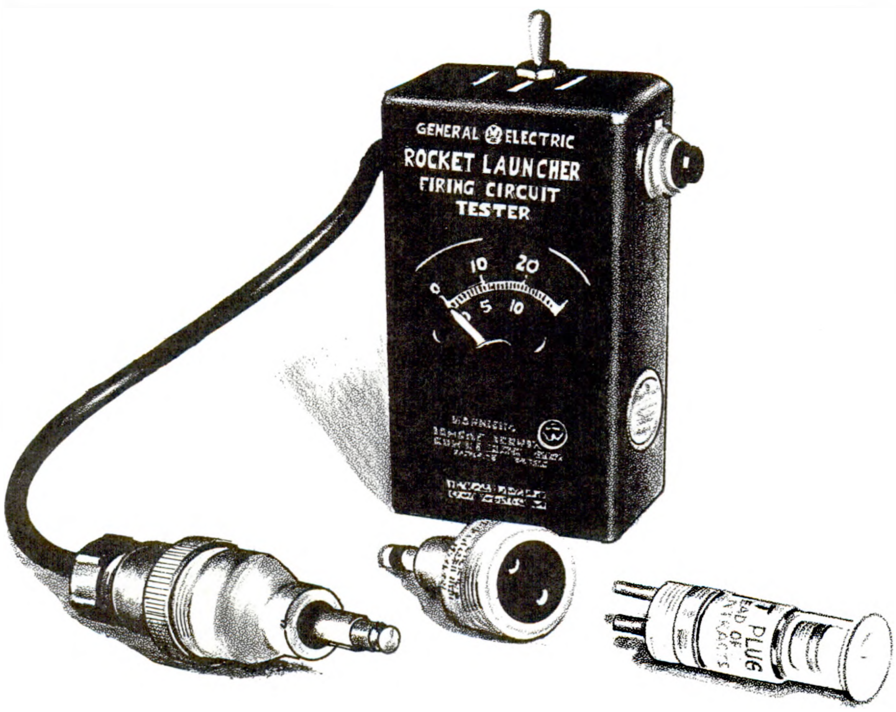


Figure 10-17.—Rocket Launcher Firing Circuit Tester.

a 0-30 and 0-1.5 volt scale modified to include a 5-watt, 1/2-ohm resistor across the 1.5-volt circuit of the meter. The standard circuit tester incorporates this resistor as part of the unit. It has the two scales on its face, a 3-position switch on the top marked TEST, 0-30, and 0-1.5, and a TEST button on the side.

The Aviation Weapons Officer is concerned mainly with the selection of qualified testing personnel and any improper readings obtained. An aircraft with stray or surge voltage found in the aircraft rocket firing circuit, must be immediately downed for rocket firing until a thorough check of the rocket firing circuit is performed.

ROCKET SAFETY PRECAUTIONS

The aircraft rocket is no more dangerous than any other explosive weapon, but it does have certain peculiar hazards. A completely assembled rocket, if accidentally fired, will take off under its own power in the direction in which it is pointed, with threat of damage to anything in its path. When fired, an assembled rocket expels a blast of burning gas capable of injuring or killing anyone it strikes, because of concussion or burns.

Four hazards exist in dealing with aircraft rockets:

1. Inadvertent electrical contacts which may set off the rocket.
2. Excessive temperatures or pressures which may cause the motor to explode in a ground fire or in the air when fired.
3. Continued exposure to abnormal stowage temperatures which may cause the propellant to deteriorate, with attendant hazards of possible explosion when the rocket is fired.
4. Rough handling or blows which may break the propellent grain, thus exposing too much surface to burning and leading to possible excessive pressures in the motor when fired.

Generally, a rocket motor without a head attached is unlikely to explode. It does present a potent fire hazard since ballistite or S.P.C.G. ignites easily and burns readily. High-explosive heads, either fuzed or unfuzed, present the same risk as do gun projectiles under the same conditions. Rockets, whether completely assembled or disassembled, must be handled with extreme care to avoid damage to parts.

Rocket motors should be stowed in the same manner as smokeless powder. Matches and open flames must never be allowed in the stowage area. Smoking should not be permitted in the loading area within 200 feet of any ammunition.

Do not fire rocket motors when the propellent temperature is outside the safe-firing temperature limits specified on the motor tube. If the motor has been exposed for more than 1 hour to temperatures outside these limits, maintain that motor within the safe-temperature limits for 6 hours before firing.

Rocket motors must not be stowed in the same compartments with or near radio apparatus or antenna leads, due to the possibility of induced currents igniting the motor.

High-explosive heads and fuzes (except base fuzes which are permanently installed in the head) must be stowed separately from each other, in the same manner as high-explosive projectiles.

Do not tamper with or attempt to repair any parts of the round. If the round is damaged or defective, remove the head from the motor and mark the defective part for return to the issuing agency.

Do not remove the shorting device from the contact bands or other electrical contacts until just before loading the round in the launcher.

Careful examination of the rocket motor will reveal an opening in the forward end to allow escape of gases and flames, should the motor be accidentally ignited prior to installation of the head. For this reason, always examine a line-loaded head to insure that its base fuze is in place to prevent the gas pressure and flames from reaching the high explosive in the head. Inert loaded heads use a steel base fuze hole plug in lieu of a base fuze.

A rocket component dropped from a height exceeding 5 feet, must not be loaded but rather put aside for return to an ammunition depot (if feasible) or disposed of according to current directives and local regulations.

Rocket fuzes shipped in sealed containers are to remain in the sealed cans during stowage. As a rule, noze fuzes are stowed in a ship's bomb fuze magazine, or under conditions specified by the Bureau of Naval Weapons. Cans should be placed upright in assigned magazines and secured firmly.

Fuzes are relatively sensitive and must be handled with care to avoid extreme shocks which might cause damage. Operations such as fuzing, unfuzing, assembly, or disassembly of all types of ammunition should be carried on at a distance from other explosives and from vital installations. Only the minimum number of persons and rounds required should be in the vicinity. The ideal situation would be to permit work on only one round at a time, on a deck or at some other location remote from all magazines, ready stowage, explosive supplies, or vital installations.

Examination of the exterior of some fuzes does not indicate whether they are armed. If for any reason it is thought a fuze might be armed, it should be treated as an armed and sensitive fuze. No attempt should be made to remove it from the rocket head. The complete fuzed round should be disposed of by gently lowering it tailfirst into deep water. If available, explosive-ordnance-disposal personnel should dispose of such rounds.

Disassembly of rocket fuzes is not permitted except as authorized by the Bureau of Naval Weapons.

CAUTION: Never attempt to remove a base fuze from the rocket head.

CHAPTER 11

AIRCRAFT BOMBS AND BOMB FUZES

BOMBS

Aircraft bombs are largely a development of the last three decades. Although bombs were dropped in World War I, the size, accuracy, and terminal ballistics at that time were such that their military value was limited almost entirely to psychological and nuisance effects. Between wars some development work was performed on bombs, but only in the late thirties did progress become rapid. Stimulated by World War II, the aircraft bomb quickly became a major weapon of destruction; and in the final tally for that war, bombs accounted for more killing, wounding, and property destruction than any other type of weapon.

Aircraft bombs are designed for release over enemy targets to reduce and neutralize their war potential by destructive explosion, fire, nuclear reaction, war gases, etc. They are used strategically to destroy installation, armament, and personnel; and tactically to provide direct support of our land, sea, and air forces engaged in offensive or defensive operation.

OPERATION

Bombs are carried either in the bomb bay of aircraft or externally under the wings or fuselage. Hooks on aircraft racks and shackles engage suspension lugs attached to the bomb body. For mechanically fuzed bombs, the loop of an arming wire is attached to an arming solenoid at the center or other convenient location of the rack or shackle. The free ends of the arming wire are passed through safety devices in the fuze and maintain the fuze in an unarmed condition. Safety (Fahnestock) clips are placed over the protruding ends of the arming wire to prevent it from slipping out of the fuze safety devices prior to bomb release.

If a bomb must be released over friendly territory, the arming wire is released with the bomb and stays in place as the bomb falls. This prevents the fuze from arming so that the bomb does not explode upon impact. When the bomb is released for effect, the arming wire is retained with the aircraft, and the fuze is free to become armed. Electrically fuzed bombs do not require arming wires.

Fuze action is controlled by energizing or deenergizing the electrical fuzing circuit, thereby dropping the bomb either safe or armed as desired. Current low-drag bombs (fig. 11-1) have provisions for mechanical and electrical fuzing which necessitates special bomb rack design.

COMPONENTS

A cutaway view of a high-explosive bomb completely assembled and ready for loading is illustrated in figure 11-2. The main components of a complete bomb are discussed in the following paragraphs.

Bomb Body

The bomb body is a case which contains the main explosive charge and one or more auxiliary boosters. The case of the bomb is made of steel of various thicknesses. It is curved to a streamlined shape at the nose and tapered slightly in the rear. Some bombs have drilled and tapped holes into which suspension lugs are screwed. The case has a threaded opening in the nose, designed to receive a fuze. A larger opening in the rear of the case is threaded to receive the base plug.

The base plug closes the filling hole of the bomb and forms the base of the bomb. An extension of the plug to the rear is threaded to provide for the attachment of the fin assembly. In bombs of current manufacture the

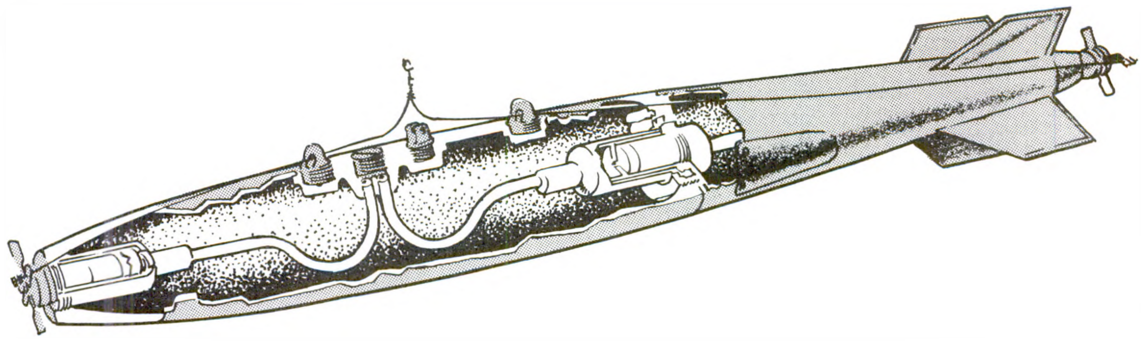


Figure 11-1.—Mechanical or electrical fuzing provisions.

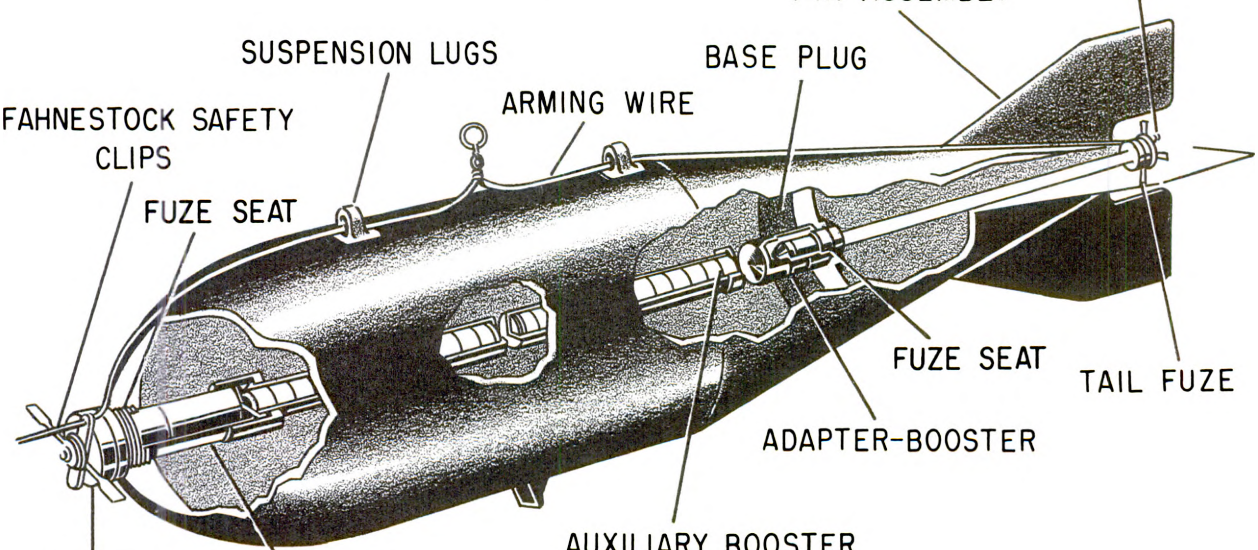


Figure 11-2.—Cutaway view showing bomb components.

base plug has studs or stakes extending into the explosive charge to prevent removal of the plug. A threaded opening in the base plug is provided to receive a tail fuze.

The fuze seat (fig. 11-2) is the name given to any threaded opening in a bomb case designed to receive a fuze. As illustrated, these openings can be in either the nose or the tail of the bomb, or both.

Seats for nose fuzes are usually machined in the bomb case. To provide for maximum flexibility, their dimensions (thread size and depth of seat) are standardized as much as practicable. Large bombs have a fuze seat which is 2 to 3 inches in thread diameter and 5 inches deep. Smaller bombs have a fuze seat which is 1.5 inches in thread diameter and 1.3 inches deep.

Tail fuze seats are located in the base plug of the bomb case. Two models of adapter-boosters provide tail fuze seats for high-explosive, chemical, incendiary, and fragmentation bombs. These are also discussed in detail in later paragraphs.

The fuze seat liner is a metal cup which is assembled to the fuze seat—either nose or tail. The purpose of the fuze seat liner is to provide for the insertion of a fuze without contacting the explosive charge.

The closing plugs are metal and fit into fuze seats or seat liners until fuzing. Their purpose is to close the cavity and protect the seat liner threads during shipping and storing. They are removed only for inspection or for fuzing the bomb. If a bomb is returned to storage after being prepared for use, the fuzes are removed and the fuze hole plugs are replaced.

The explosive charge is poured or pressed into the bomb cavity at the loading plant. The type of explosive used depends on the intended use of the bomb.

An auxiliary booster is included in the main explosive charge when the bomb is filled. It consists of a column of tetryl pellets and is usually cast within the charge adjacent to the fuze seat liner, adapter-booster, or both. The purpose of the auxiliary booster is to relay and amplify the detonation wave from the booster and thus insure the detonation of the main explosive charge.

The bomb is suspended from the releasing device by suspension lugs. The suspension lugs may be either welded to, bolted on, or screwed into the bomb body. Lugs for double-hook racks or shackles are either 14 or 30 inches apart, depending upon the size of the bomb. On older type bombs still in use, a lug for single-hook suspension is located on the side of the bomb body opposite the double lugs. In the low-drag series of bombs the location for the single lug is midway between the double lugs.

Some bombs are provided with hoisting lugs. These lugs are either welded to, or screwed into the bomb body. The hoisting lug is usually located midway between the double suspension lugs.

Fuze

A fuze is a mechanical or electrical device designed to start the detonation of a bomb at a desired time. Fuzes can be located in either the nose or tail of most bombs, or both. In some bombs they are placed in the bomb body. A breakdown of the various types of mechanical and electrical fuzes and their uses are discussed later in this chapter.

Adapter-Booster

An adapter-booster is a metal tube threaded on the outside for insertion in the fuze seat or seat liner of the bomb body, and threaded on the inside to provide for the insertion of the fuze. The tube contains the booster charge. The adapter-booster is designed to fit into the bomb case, and the fuze is designed to fit into the adapter-booster. (See fig. 11-2.)

One function of the adapter-booster is to make possible the use of small fuzes in large fuze seats. The external contour of the adapter-booster fits the bomb type fuze seat and the space between is filled with tetryl to serve as an auxiliary booster.

Two models of adapter-boosters provide tail fuze seats for high-explosive, chemical, incendiary, fire, and fragmentation bombs. One model is 1.5 inches in thread diameter and 2.86 inches deep. This model is used on all high-explosive bombs up to 250 pounds. The other model (adapter-booster M115A1) is 2 inches in thread diameter and 2.68 inches deep, but also includes a fuze seat. Both of these models are drilled for the insertion of a lockpin which locks the adapter-booster in the base plug while the fuze is in place.

Arming Wire Assembly

Fuzes are always shipped in a safe, or unarmed, condition. Usually, they are kept safe by a wire which passes through the arming device of the fuze. As long as this wire is in place, the arming device cannot operate and the fuze remains safe.

When the fuze is inserted in the bomb, this shipping wire is removed and the arming wire is inserted in its place. This wire keeps the fuze from arming until the bomb is actually released. The arming wire is pulled from the fuze when the bomb is released and the arming device is then free to arm the bomb. As pointed out previously a bomb can be dropped safe if the arming wire is not pulled from the fuze, but allowed to remain in the fuze, thus preventing the arming device from operating.

The wires usually consist of either one or two strands attached to a swivel loop. Safety Fahnestock clips are attached to the ends of the wires after installation of fuzes in the bomb. This prevents accidental withdrawal of the arming wires, with consequent premature arming of the fuzes, while the aircraft is in flight.

The standard arming wire assemblies (fig. 11-3) will fit any bomb up to and including 2,000 pounds. For larger bombs, an extension cable is supplied. After the bomb is installed on the shackle or rack, excessive wire is cut to approximately 2.5 inches beyond the fuze. For proper release, wire should be free from twists, kinks, and burrs. The use of arming wire brackets is required on fuzes used with depth bombs. They should be separately requested for use with depth bombs. A metal tubular protector is supplied for use with the arming wire bracket to prevent chafing of the arming wire by vibration of the fuze vane.

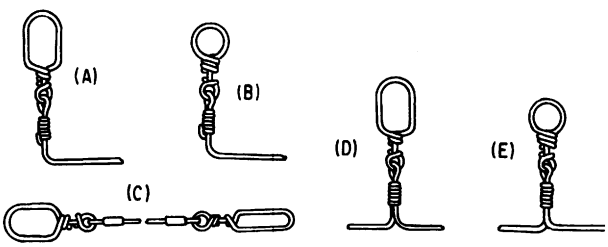


Figure 11-3.—Arming wire assemblies.

Arming wires are packed in metal containers or spiral-wound fiber containers containing 50 or 100 assemblies and overpacked in a wooden box. Generally, safety Fahnestock clips are packed with the wires. Fragmentation bomb clusters are an exception. Each cluster is supplied with its own arming wire assembly.

The most commonly used arming wire assemblies are given in table 11-1. (Also, see figure 11-3 in conjunction with table 11-1.)

Fin Assembly

The tail, or fin assembly, provides for stability of the bomb in flight. This comparatively light sheet metal device makes it possible to aim the bomb. Because of it, the bomb falls in a smooth, definite curve instead of tumbling wildly through the air.

Fin assemblies are of three types: box, ring (or shrouded), and conical. Box fins, which are limited to use with slower aircraft, consist of a fin sleeve, which fits over the tail of the bomb (held in place by the fin locknut), and sheet metal fin blades. The blades are riveted or spot welded to the fin sleeve and to each other, forming a square, boxlike assembly. Ring type fins are used on depth bombs and are attached to the bomb body by bolts. Conical fins, which have been developed to meet the requirement of increased bomb ceilings and increased speeds of fast flying aircraft, are cone shaped and provide increased stability and ballistic performance for bombs released from high altitudes or at high speeds. The conical fin is of sufficient strength and ruggedness to withstand any type of maneuver or flight condition encountered by jet attack aircraft.

IDENTIFICATION

Bombs are identified by standard nomenclature consisting of the following information stamped on the bomb body:

Type of bomb.
Weight of bomb.
Bomb case number.
Average gross weight.
Displacement.
AIC symbol (ammunition identification code).
Explosive charge.
Lot number.
Explosive US bomb (indicates United States property).
Month and year of loading.

Bombs are also painted in various color schemes for quick identification. The type of bomb and explosive is indicated by the number, size, and color of the bands located on the nose and tail sections of the bomb body. (See fig. 11-4.) Further information on color identification for each type of bomb may be found in Aircraft Bombs, Fuzes and Associated Components, NavWeps OP 2216 (Volume 1).

DISPOSAL

Obsolete and unserviceable ammunition is to be disposed of in accordance with the latest instructions provided by the Chief of the Bureau of Naval Weapons.

Table 11-1. —Arming Wires.

Arming Wires	Figure 11-3	Type	Material	Diameter (inch)	Length (inches)
Mk 1	A	Single	Bronze	0. 064	57
Mk 1 Extension	C	Single	Steel	0. 0625	16
Mk 2	D	Double	Bronze	0. 064	57
Mk 3	A	Single	Steel	0. 033	57
AN-M1A2	E	Double	Brass	0. 064	60
AN-M6A2	B	Single	Brass	0. 064	57
AN-M7A1	E	Double	Brass	0. 064	81. 5
AN-M8A1	E	Double	Brass	0. 064	117
M13	E	Double	Brass	0. 064	106
M16	E	Double	Brass	0. 064	146

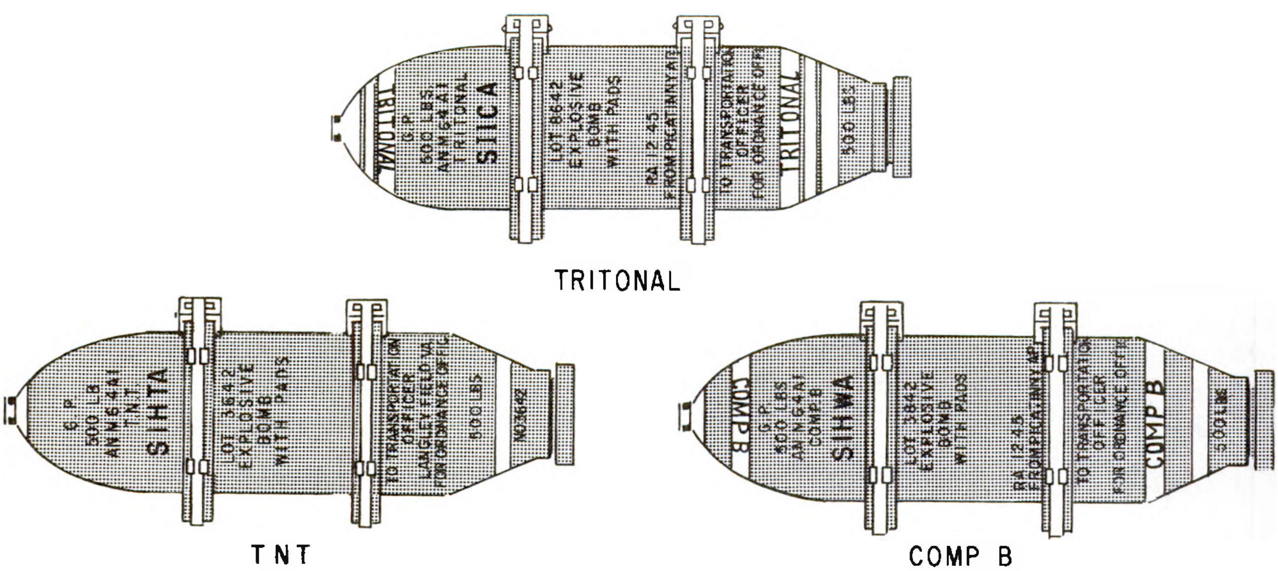


Figure 11-4.—General purpose bombs with typical markings.

In all instances where disposition by dumping is specified, NavOrd Instruction 8026.9 of 15 December 1956 must be complied with. The area designated by the district commandant or sea frontier commander must be used.

Commanding officers of ships at sea which have been instructed to dispose of ammunition and chemicals by dumping must insure that all chemicals, except pyrotechnics, are dumped in depth of 1,000 fathoms or more and that bulk explosives, explosive-loaded ammunition, and pyrotechnics are dumped in depths of 500 fathoms or more.

All ammunition and chemicals must be dumped at least 10 miles from shore.

All activities must insure that items to be dumped will readily sink. To avoid washing ashore, material must be removed from outside packing and shipping containers before dumping (unless especially prepackaged or especially prepared to insure negative buoyancy).

All provisions prescribed for specific types of items to be dumped must be observed carefully when disposing of that type of material.

As a safety precaution, it must be assumed that fuzes may function at some indeterminate time after the dumping of bombs, regardless of the method of disposal. Lower the bombs over the side to the water surface. Keep them off the hull to the fullest extent practicable. Release bombs into the water with the least amount of fall that circumstances permit.

CLASSIFICATION

Bombs are classified according to filler as follows:

1. High explosive.
2. Fire and incendiary.
3. Smoke.
4. Practice.
5. Chemical

High-explosive bombs, in turn, are classified according to use:

1. Semi-armor-piercing (SAP).
2. General purpose (GP).
3. Low-drag general purpose (low-drag GP).
4. Demolition.
5. Fragmentation (Frag).
6. Aircraft depth (AD).

In the case of high-explosive bombs, the part of the bomb that causes the damage is the explosive filler. If it is known what percentage of the weight of the bomb is taken up by the explosive charge, it can be fairly well determined what the bomb will do. This ratio of the weight of the explosive to the total weight of the bomb is known as the loading factor. If the total weight of a bomb is 1,000 pounds, for example, and 500 pounds of this weight is explosive, the bomb's loading factor is 50 percent.

General Purpose Bombs (GP)

General purpose bombs are used for the destructive effect caused by blast, fragments, and vacuum pressures created by above-surface explosions, and the mining effect, or earth shock, resulting from the detonation of buried bombs. GP bombs range in size from 100 pounds to 2,000 pounds and resemble each other closely. The cylindrical body tapers in an ogive to the nose, and in a straight cone to the base plug closing the tail end. It uses either a box tail fin or a conical tail fin.

The loading factor of a GP bomb is approximately 50 percent. The standard filler is either TNT or tritonal. The GP bomb has fair penetration and good fragmentation, and is used for attacks on unarmored vessels, submarines, aircraft, personnel, and most ground targets. The metal case is strong enough not to rupture on impact with normal soil when released from high altitudes, but it might fail on impact with heavy armor or high reinforced concrete structures.

The GP bomb casing has sides from one-fourth to one-half inch thick, with heavier nose and tail sections. Its maximum penetration is approximately three-fourth inch of armorplate, and it will penetrate several decks of an unarmored ship or several floors of an ordinary building.

GP bombs can accommodate both nose and tail fuzes which are usually used for most bombing operations. However, when chemical, long-delay tail fuzes are installed, the nose fuze is omitted. The larger bomb (500-, 1,000-, and 2,000-pound) have an adapter-booster capable of receiving the hydrostatic tail fuze AN-Mk 230 which has a 2-inch thread diameter. When other fuzes are used, a fuze adapter must be used on the inside of the adapter-booster to convert the seat to accommodate the fuzes with the 1.5-inch thread.

Data pertinent to GP bombs may be found in table 11-2. It is suggested that the table be studied, noting particularly the ratio of explosive weight to total weight.

Table 11-2. —GP bomb data.

	AN-M30A1	AN-M57A1	AN-M64A1	AN-M65A1	AN-M66A2
Assembled weight, pounds:					
TNT	119.5	263.4	545.7	1064.0	2118.5
Tritonal	124.5	272.4	564.7	1104.0	2196.5
Explosive weight, pounds:					
TNT	57.0	127.0	264.0	555.0	1097.8
Tritonal	62.0	136.0	283.0	595.0	1181.0
Assembled length, in.	40.3	47.8	59.2	69.5	92.61
Body diameter, in. . .	8.0	10.8	14.2	18.8	23.3
Double suspension, center to center, in.	14	14	14	14	30
Fin assembly:					
Box type	AN-M103A1	AN-M106A1	AN-M109A1	AN-M113A1	AN-M116A1
Conical type	M135	M126	M128	M129	M130
Nose fuze (use one) . .	AN-M103A1	AN-M103A1	AN-M103A1	AN-M103A1	AN-M103A1
	AN-M139A1	AN-M139A1	AN-M139A1	AN-M139A1	AN-M139A1
	AN-M140A1	AN-M140A1	AN-M140A1	AN-M140A1	AN-M140A1
	Mk 243 Mod 0	Mk 243 Mod 0	Mk 243 Mod 0	Mk 243 Mod 0	Mk 243 Mod 0
	Mk 244 Mod 1	Mk 244 Mod 1	Mk 244 Mod 1	Mk 244 Mod 1	Mk 244 Mod 1
	VT AN-M166	VT AN-M166	VT AN-M166	VT AN-M166	VT AN-M166
	VT AN-M168	VT AN-M168	VT AN-M168	VT AN-M168	VT AN-M168

Table 11-2. —GP bomb data—Continued.

	AN-M30A1	AN-M57A1	AN-M64A1	AN-M65A1	AN-M66A2
Tail fuze, with box type fin	AN-M100A2	AN-M100A2	AN-M101A2	AN-M102A2	AN-M102A2
	M115	M115	AN-Mk 230	AN-Mk 230	AN-Mk 230
	M123A1	M123A1	M116	M117	M117
	M132	M132	M124A1	M125A1	M125A1
			M133	M134	M134
Tail fuze, with conical type fin	M172	M172	M175	M176	M177
	M175	M175	M181	M184	M183
	M181	M181			M185

Low-Drag General Purpose Bombs

Low-drag GP bombs (fig. 11-1) have slender bodies with long, pointed noses. Conical type fine assemblies increase their aerodynamic performance and accuracy in bombing. The low-drag GP bombs have thicker sidewalls and nose sections than standard GP bombs.

These bombs, which were designed primarily for electric fuzing, contain a fuze cavity in both the nose and tail sections. An electric fuze may be utilized in either or both positions. When a proximity fuze is required, the M20 proximity fuze sensing element is used in conjunction with an electric fuze in the tail cavity. The bomb is detonated by the tail fuze upon receipt of a signal from the proximity sensing element.

Low-drag GP bombs are equipped with a steel nose plug. This plug is removed when the electric fuze is installed in the nose cavity. When a proximity sensing element is used, the nose plug must be omitted.

The fin assemblies have covered handholes for access to the fuze tail position. (See fig. 11-1.) The base fuze-hole shipping plug is removed when the electric fuze is installed.

The low-drag GP bombs, which are filled with tritonal, may be used on the same kind of targets as standard GP bombs.

Low-drag GP bombs are manufactured in four sizes. Detailed information on each is given in table 11-3.

Semi-Armor-Piercing Bombs (SAP)

In appearance the SAP bomb resembles the GP bomb; but has a thicker case and a correspondingly smaller amount of explosive. Approximately 30 percent of the total weight of the SAP bomb is explosive filler. Previously, TNT and amatol have been used as a filler for SAP bombs; however, most SAP bombs are presently being loaded with picratol.

This bomb can accommodate both nose and tail fuzes. Tactical requirements usually nullify the need for a nose fuze, in which case the nose fuze cavity is fitted with a solid steel plug. When a nose fuze is used, it is generally the AN-M103A1; but nose fuzing is recommended only in cases of emergency when no suitable GP bombs are available. The same type tail fuzes used in GP bombs are used in SAP bombs. To allow maximum penetration they are equipped with various delay primer detonators.

SAP bombs are painted olive drab with a yellow nose and tailband. Letters and numbers are black.

The thick metal body of the 1,000-pound SAP Bomb AN-M59A1 gives greater penetration than a GP bomb of comparable weight.

This bomb weighs 1,041.9 pounds of which 320 pounds is picratol filler. Overall length is 70.4 inches, and body diameter is 15.1 inches. The casing has double and single

Table 11-3. —Physical characteristics of low-drag GP bombs.

	Mk 81 Mod 1	Mk 82 Mod 0	Mk 82 Mod 1	Mk 83 Mod 2	Mk 84 Mod 1
Weight of assembled bomb, pounds. . .	260	512	531	985	1970
Weight of explosive filler, pounds . . .	100	192	192	445	945
Assembled length, inches . . .	76.1	90.9	90.9	119	154
Diameter, inches . .	9.0	10.8	10.8	14.0	18.0
Suspension center to center, inches . .	14.0	14.0	14.0	14.0	30.0
Nose fuze . . .	M990C (T905)	M990C (T905)	M990C (T905)	M990C (T905)	M990C (T905)
Tail fuze . . .	M990C (T905)	M990C (T905	M990C (T905)	M990C (T905)	M990C (T905)
Proximity fuze	VT AN-M166 VT AN-M168 VT AN-M168E1	VT AN-M166 VT AN-M168 VT AN-M168E1	VT AN-M166 VT AN-M168 VT AN-M168E1	VT AN-M166 VT AN-M168 VT AN-M168E1	VT AN-M166 VT AN-M168 VT AN-M168E1

welded-on suspension lugs. There is a tube type tail auxiliary booster and a small type adapter-booster. The A1 designation indicates a staked-in base plug and adapter-booster drilled for a locking pin. The tail fuze usually employed is the AN-M102A2, with delay primer detonator.

NOTE: All other versions of the SAP bomb are now obsolete.

Demolition Bombs

A typical demolition bomb has a short ogival nose, a cylindrical body, and a tapered aft end. A conical type fin assembly (fig. 11-5) is bolted to the rear of the bomb to improve its aerodynamic performance and accuracy in flight.

Demolition bombs produce a greater blast effect than GP bombs of comparable weight.

The bomb (fig. 11-5) is designed primarily for electric fuzing. Two conduits for the electric fuze cable harness connect the nose and tail fuze cavities with a charging receptacle located between the suspension lugs on the surface of the bomb case. When electrical fuzes are not used, a plug is threaded into the charging receptacle cavity. The steel nose fuze-hole plug and base fuze-hole plug are replaced in their respective cavities after electric fuzes have been installed.

If electrical fuzes are not available, mechanical fuzes may be used in the nose cavity, tail cavity, or both. Adapter-boosters must be installed in the fuze cavities to permit use of the mechanical fuzes.

The bomb uses a mechanical tail fuze which projects into the airstream on the side of the bomb fin cone, rather than straight out the aft end. To accomplish this, the fuze has a flexible arming stem. To install the fuze, an access cover is removed from the side of the fin cone and the fuze body is inserted through the opening and threaded into the fuze cavity. The arming head is secured to the side of the fin cone and the arming stem then is joined to the fuze body.

Two suspension lugs, spaced 14 inches apart, are threaded into lug inserts on the bomb case. All seams and crevices are sealed with an inert sealing compound to prevent leakage. Approximately 50 percent of the total bomb weight is explosive charge.

The bomb is painted olive drab. On bombs of recent issue, the identification data is stenciled in yellow letters in at least two places adjacent to a yellow band. On bombs of older issue, the identifying nomenclature was stenciled in black on the olive drab body. For permanent identification, nomenclature is stamped into the bomb body.

Demolition bombs are manufactured in two sizes. Detailed information on each is given in table 11.4.

Aircraft Depth Bombs

The aircraft depth bomb is designed for attacking submarines or underwater targets and

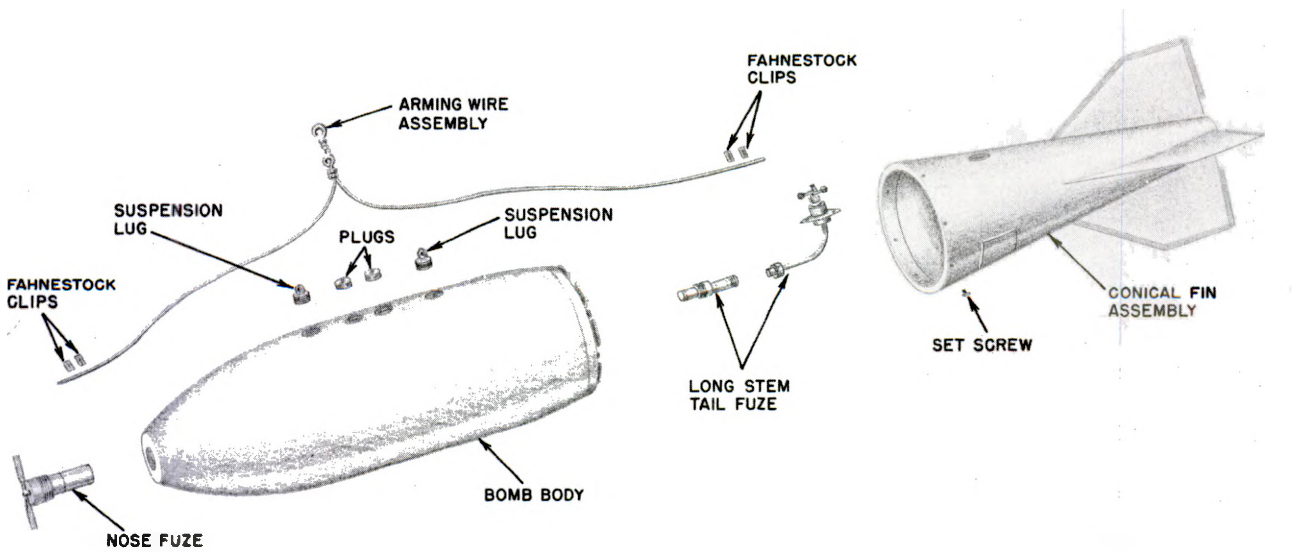


Figure 11-5.—Demolition bomb (mechanically fuzed), exploded view.

Table 11-4. —Physical characteristics of demolition bombs.

	M117	M118
Weight of assembled bomb (lb).	799 (tritonal)	3,020 (tritonal)
Weight of explosive filler (lb).	386	1,888
Assembled length (in.).	84	130
Diameter (in.).	16.1	24.13
Nose fuze.	AN-M103A1 VT Fuze T750 VT Fuze AN-M166 (electric) M990 (T905) (electric)	AN-M103A1 VT Fuze T750 VT Fuze AN-M116 (electric) M990 (T905) (electric)
Tail fuze.	M190 (T759) M990 (T905) (electric)	M192 (T761)
Adapter-booster for mechanical fuzing.	T45E1 (nose) T46E4 (tail)	T45E1 (nose) T46E4 (tail)

was widely used during World War II. In the past they have ranged in size from 325 pounds to 700 pounds, but the only one used at present is the AN-Mk 54 Mod 1, weighing approximately 350 pounds and loaded with HBX-1.

Depth bombs have a loading factor of about 70 percent and are armed either for impact or underwater explosion at a preset depth. Depth-setting is performed before takeoff. The setting range is from 25 to 125 feet.

The desired effect of a depth bomb is to create a pressure wave against underwater targets great enough to crush the hull plates of the target. Depth bombs may be fitted with both a nose impact fuze and a tail hydrostatic fuze, both should be used only when the aircraft has selective arming so that either fuze may be armed as desired. In this manner, advantage may be taken of the discovery of a surface target by arming the nose impact fuze. By leaving the nose fuze safe and only the hydrostatic tail fuze armed, an attack against a submerged submarine may be made.

The nose fuze generally used is the AN-M103A1, and the only hydrostatic fuze used is the AN-Mk 230 Mod 4, 5, or 6. When a nose fuze is used, it must be set on "instantaneous" as any delay would allow the very light bomb casing to rupture before detonation could take place, and a special arming vane must be used. The blast effect from a depth bomb is slightly greater than that from a

GP bomb of the same weight due to the higher loading factor.

Depth bombs are cylindrical and have flatnoses to prevent ricocheting when released at low altitudes and high speed. The flatnose explains why a special arming vane must be installed on the nose fuze.

Impact with the water from high altitudes can crush or warp the bomb body and distort the fuze cavities, causing a malfunction. As a result, depth bombs are normally released from comparatively low altitudes.

Depth bombs are painted olive drab with yellow nose and tail stripes.

The 350-Pound Aircraft Depth Bomb AN-Mk 54 Mod 1 is made of thin sheet metal, is flatnosed, and has fuze cavities fore and aft. Pellet type auxiliary boosters are used in both fuze seat liners. The bomb is 52.2 inches in overall length, has a body 13.5 inches in diameter, and is filled with 248 pounds of HBX-1. It has a ring type tail which is bolted on, and double and single suspension lugs. Each bomb is shipped with two screw-in hoisting lugs, and the body has seven tapped holes about the circumference. By positioning the lugs in the necessary hole or holes, any hoisting condition can be met.

Fragmentation Bombs

Fragmentation bombs cause destruction primarily by the bursting of their cases. The cases of these bombs are so constructed that, upon detonation, they break up into hundreds of fragments which will destroy personnel, animals, and light material targets such as motor transports and aircraft on the ground. Fragmentation bombs are fuzed to explode before penetration.

A fragmentation bomb usually consists of a thin steel cylinder around which is wound a heavy helical steel band. When the filler explodes, this coil of steel splinters.

Fragmentation bombs range in size from 4 to 260 pounds. Smaller bombs are usually dropped in clusters of 3, 6, or more. The cluster is formed by securing the bombs in a framework, usually made of tubing and sheet metal, called a cluster adapter. As the cluster is released from the aircraft, the bombs separate and cover a wide impact area. The releasing device of most clusters used by the Navy is entirely mechanical. Clusters are generally shipped assembled as complete rounds, with individual bomb fuzes already installed, although some newer types have fuzes packed with the cluster and not installed. The nomenclature used with clusters is more detailed than with other types of ammunition. The cluster adapter itself may have one AN designation; and when loaded with bombs, the resulting cluster will have a different AN designation. A complete nomenclature gives the weight class of the cluster, the type of cluster adapter, the number, weight, and type of bombs contained, and, in some cases, the type of fuzes installed in the bombs.

Fragmentation bombs are stabilized with either tail fins for high-level use or a parchute for low-level attacks. As the parachute-type bombs leave the cluster, the parachutes open and the bombs descend slowly. These bombs can be dropped from altitudes as low as 70 feet; without parachutes at this low altitude the launching aircraft would be directly overhead as the bombs exploded and the fragments might destroy the aircraft.

All fragmentation bombs 120 pounds and larger are both nose and tail fuzed; those smaller are nose fuzed only.

Fragmentation bombs are painted olive drab. Large bombs have yellow nose and tail stripes while small ones have the nose and tail painted yellow. Markings are in black.

THE 4-POUND BOMB AN-M83.—This is the only bomb of this type used today, and is a development of a similar German bomb used with considerable success, especially in the North African Campaign of World War II. It is the only fragmentation bomb used which has a TNT filler and has no helical steel outer band. The bomb is cylindrical, with a cast steel body containing approximately one-half pound of TNT. The fuze is set into the body, and has a cable extension on which the bomb case assembly (butterfly wings type) is mounted. When the bomb is released from the cluster, the butterfly wings open by spring action and, because of their construction, begin to rotate, arming the fuze and slowing the descent. (See fig. 11-6.) This bomb is often referred to as the "butterfly bomb" because of its appearance while falling.

Fuzes used in these bombs are installed during manufacture and no attempt to remove them must be made. Three fuze designations

Figure 11-6.—The 4-pound Fragmentation Bomb AN-M83 (closed and open).

are used, each with a different action, and each cluster usually contains bombs fuzed with all three types. Fuzes used are:

1. M129, which is set to detonate either in the air or upon impact with the ground. The aerial burst is not used by the Navy.

2. M130, a delay fuze, which is present to detonate either 10, 20, 30, 40, 50, or 60 minutes after impact.

3. M131, an antidisturbance fuze. After initial impact with the ground, any attempt to move the bomb will result in immediate detonation.

This bomb is always cluster loaded in one of two types of cluster. One is the 100-pound size Cluster AN-M28A2, which is the Cluster Adapter M15A2 loaded with 24 AN-M83 bombs. This cluster is already packed when received and requires only fuzing by the ordnance personnel. Total weight of this cluster is approximately 119 pounds. The other cluster used is the 500-pound size Cluster AN-M29A1 (fig. 11-7), which is the Cluster Adapter M16A1 loaded with 90 bombs. This cluster adapter is shipped empty, along with the bombs, which are packed in "wafers" of 10 each. These "wafers" are loaded into the cluster by the ordnance personnel, taking care to follow the proper prescribed procedure. This cluster weighs 415 pounds complete, and both clusters have provisions for either double or single suspension.

NOTE: To eliminate the possibility of the adapter opening due to the catapult's initial thrust, aircraft armed with these clusters are not catapulted. Clusters on all aircraft must be jettisoned before landing.

The fuze used in these clusters is the Mechanical Time Fuze AN-M146 which contains a charge of black powder sufficient to open the cluster, and which has a variable delay of 5 to 90 seconds. When used with either of the clusters mentioned above, the delay used is 5 to 8 seconds. Due to the dispersal of the bombs, the maximum release altitude is 5,000 feet with a fuze delay of 8 seconds, and minimum release altitude is 2,000 feet with a fuze delay of 5 seconds. The cluster will then open at approximately 1,500 feet.

THE 20-POUND BOMB AN-M41A1.—This is a high-level bomb stabilized by fins and generally carried 6 to a cluster. It is cylindrical, 22.3 inches long when fuzed, and the body is 3.6 inches in diameter. The filler is approximately 3 pounds of Composition B with TNT surrounds, and the body is wrapped with a helical steel band. (NOTE: Surrounds constitute the tapered ends of the bomb body as shown in figure 11-8.) The A1 modification of this bomb indicates the addition of a shoulder

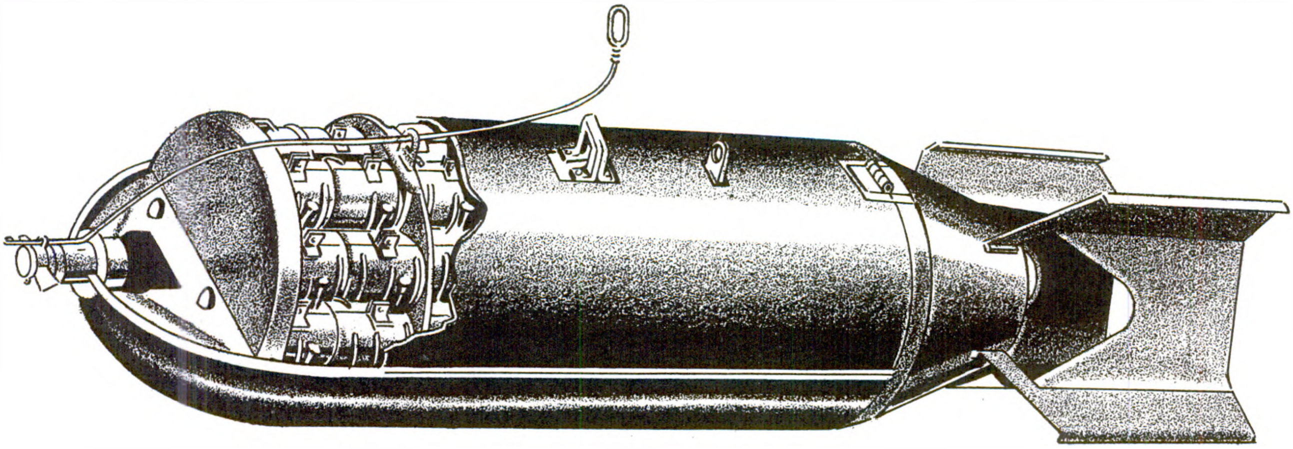


Figure 11-7.—The 500-Pound Fragmentation Bomb Cluster M29A1, cutaway view.

at the nose of the bomb to provide a bearing for the cluster adapter so the cluster bombs can be shipped unfuzed. Nose Fuze AN-M158 or AN-M110A1 is used in this bomb.

Six AN-M41A1 bombs are carried in the 100-Pound Fragmentation Bomb Cluster AN-M1A3. The bombs are fuzed just before being used. NOTE: Fragmentation bomb clusters with the AN-110A1 nose fuze should not be used unless marked "M110 fuzes renovated."

The bombs are supported in the cluster adapter, and each cluster of three bombs is encircled by a steel strap which is secured at one end to the adapter. These straps hold the bombs securely in the adapter. When suspended from a bomb rack or shackle, the arming wire holds the strap clamps closed until the cluster is released armed. Upon release, the cluster falls away, the arming wire pulls out, the strap clamps open, releasing the straps, and the individual bombs fall free. Until the bombs are free from the cluster, bomb fuze arming vanes are prevented from rotating by the vane stops in the cluster adapter. If the cluster is released unarmed, or safe, the cluster retains the arming wire, and bomb fuze vanes are prevented from rotating and arming.

THE 260-POUND BOMB AN-M81.—This is a high-level fin-stabilized fragmentation bomb. It is 43.7 inches in overall length and weighs approximately 263 pounds. The 1-inch bar steel body is wound around a 6.1-inch diameter internal steel case, giving a total body diameter of 8.1 inches. It has about 36 pounds of Composition B with TNT surrounds as a main charge. (See fig. 11-8.)

The box-type tail fins are held on by a locking ring, and either double or single suspension may be used. Both nose and tail fuzes are used: Nose Fuze AN-M103A1 (instantaneous) and Tail Fuze AN-M100A2 (nondelay). The tail fuze cavity has a small type adapter-booster installed. This bomb is never cluster loaded.

THE 220-POUND BOMB AN-M88.—This bomb is similar in construction to the AN-M81 and is exactly like it in external dimensions. However, the AN-M88 is made up of 3/4-inch bar steel wound around a 6.6-inch diameter internal steel case. The larger explosive cavity of the AN-M88 contains 41.4 pounds of Composition B with TNT surrounds. In this bomb, the ideal ratio of amount of explosive to size of outer steel band has been reached.

Fire Bombs

A fire bomb is a thinskinned container of gasoline gel designed for use against dug-in troops, supply installations, wooden structures, and land convoys. Fire bombs rupture upon impact or airburst to spread burning gasoline gel upon surrounding objects. One or more igniters and fuzes are used to ignite the gasoline mixture upon impact. Chief use of the fire bomb is in low-level attack. On high-level attack, a fire bomb will dig a crater and trap a large portion of the burning gel. This cratering effect can be reduced in high-level attacks by fuzing the bomb to rupture prior to impact.

There are four fire bombs currently used by the Navy. They are the Mk 77 Mod 0,

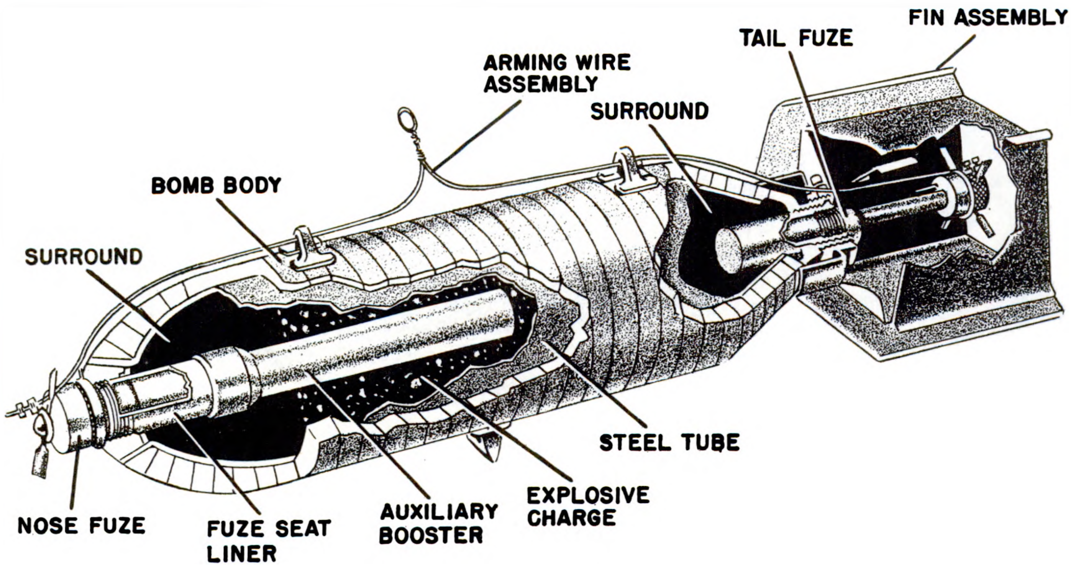


Figure 11-8.—Sectional view 260-Pound Fragmentation Bomb AN-M81.

Mk 77 Mod 1, Mk 78 Mod 2, and Mk 79 Mod 1. Although pertinent data on each is given in table 11-5, they are discussed briefly in the following paragraphs.

THE MK 77 MOD 0.—The Mk 77 Mod 0 is a 750-pound nonstabilized cigar-shaped bomb constructed of aluminum. It consists of three main sections and two end cones. A center tie rod holds the nose, center, and aft sections together. Aluminum ring adapters secure the nose and tail cones to the main sections. Tubes carry the arming wires and cone release wires from the outside of the bomb to the inside. When the release wires are withdrawn, springs in the ring adapters eject both adapters and cones, exposing the fuzes to the airstream.

A Conversion Kit Mk 19 Mod 0 may be attached to the Mk 77 Mod 0 bomb case to stabilize its flight by use of a shrouded fin assembly. (See fig. 11-9.) The kit also includes an adapter for a VT fuze and two setscrews to lock the igniter clamp which holds the VT fuze adapter.

THE MK 77 MOD 1.—Fire Bomb Mk 77 Mod 1, a modified Fire Bomb Mk 77 Mod 0, has 75-gallon capacity and weighs 500 pounds. The Mod 1 is similar in appearance and design to the Mod 0 except it is approximately 30 inches shorter in overall length.

THE MK 78 MOD 2.—The 750-Pound Fire Bomb Mk 78 Mod 2 is a nonstablized, 110-gallon capacity bomb, consisting of two thin sheet-steel half-shells welded together. (See fig. 11-10.) The bomb has two fuze wells located fore and aft on the upper surface. The wells house two igniters which are located in place with igniter caps. A filler opening for the gasoline gel is located on the upper surface of the bomb between the fore igniter well and the suspension lugs.

THE MK 79 MOD 1.—The 1,000-Pound Fire Bomb Mk 79 Mod 1 is a thinskinned, collapsible bomb of low-drag design. It consists of four basic sections—nose, main, aft, and tail—which telescope together for shipment and storage. The first three sections are constructed of sheet steel; the fourth section is a void space and is constructed of aluminum. Rubber fuel-resistant gaskets seal the points between all sections. Detachable aluminum fins are installed on the tail section to provide stability during flight. (See fig. 11-11.).

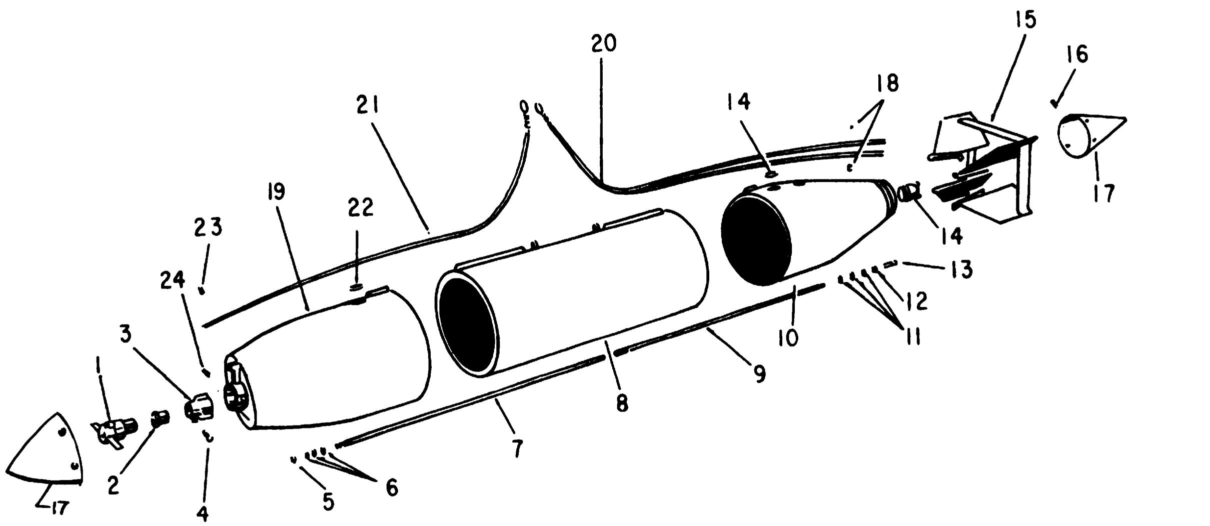
FIRE BOMB MIX.—Fire bomb mix, formerly called napalm, is a thickened fuel consisting of a mixture of aviation gasoline or jet fuel and a thickening or gelling agent. It ranges in consistency from a pourable liquid to a rubber jelly-like substance which sets into a jellied state (gel) if allowed to stand.

The preferred mixture is composed of approximately 94 percent (by weight) of gasoline or jet fuel (at 80° to 85° F) and approximately

Table 11-5. —Fire bombs.

	Mk 77 Mod 0	Mk 77 Mod 1	Mk 78 Mod 2	Mk 79 Mod 1
Weight, complete (lb).	750	500	760	912
Weight, empty (lb).	82	63	90	212
Capacity (gal).	110	75	110	112
Length (in.).	138.0	108.6	89.1	168.0
Diameter (in.).	18.63	18.63	26.0	19.63
Igniters (2 required).	M15 M16 M23	M15 M16 M23	M15 M16 M23	M23***
Fuzes, mechanical (2 required).	M157* AN-M173**	M157 AN-M173	M157 AN-M173	AN-M173***
Fuzes, electric (used with M20 proximity fuze sensing element).				Mk 257 Mod 0

*Fuze M157 is used only with Igniter M15 and M16.
**Fuze AN-M173 is used only with Igniter M23.
***Standard mechanical fuzing can be used as an alternate to electric fuzing in the Mk 79 Mod 1 fire bomb.



1. VT fuze.
2. VT fuze adapter.
3. Igniter adapter.
4. Clamp bolt.
5. Nut.
6. Washers.
7. Tie rod.
8. Center section.
9. Tie rod.
10. Tail section.
11. Washers.
12. Lockwashers.
13. Nut.
14. Igniter.
15. Conversion kit fin.
16. Screw.
17. Cones.
18. Fahnestock clips.
19. Nose section.
20. Double arming wire assembly.
21. Single arming wire assembly.
22. Filler cap.
23. Fahnestock clips.
24. Setscrew.

Figure 11-9. —Fire Bomb Mk 77 Mod 0 with Conversion Kit Mk 19 Mod 0.

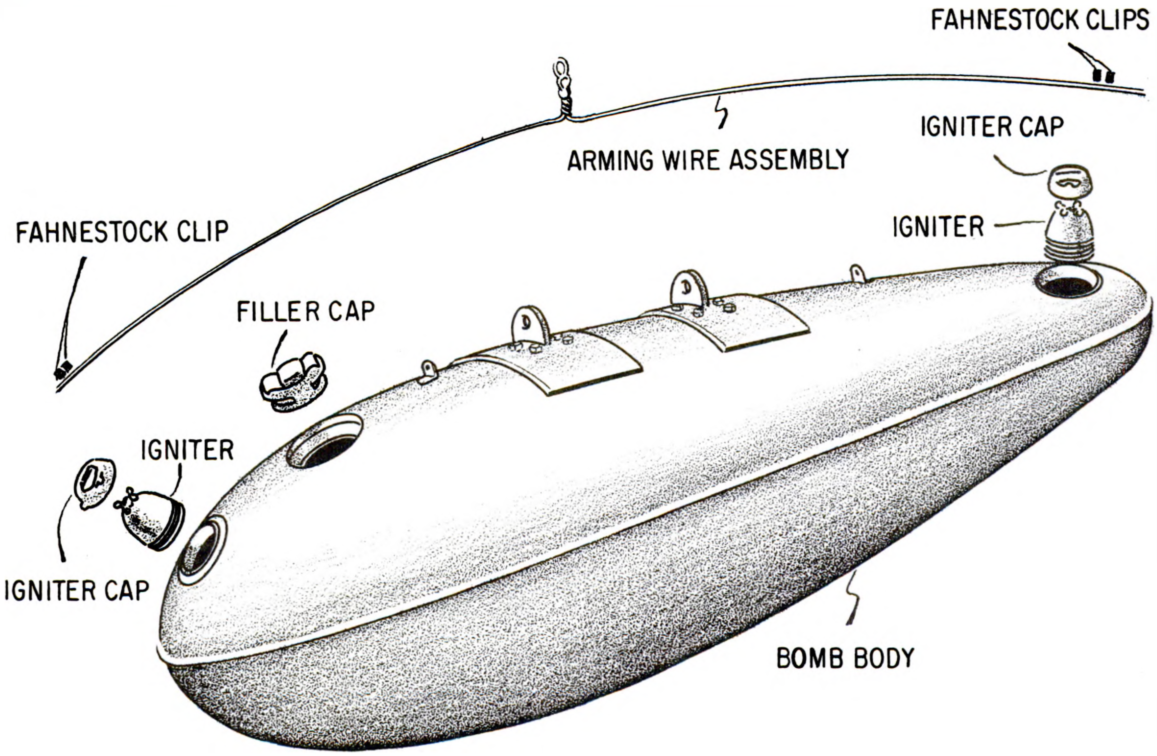


Figure 11-10.—Fire Bomb Mk 78 Mod 2.

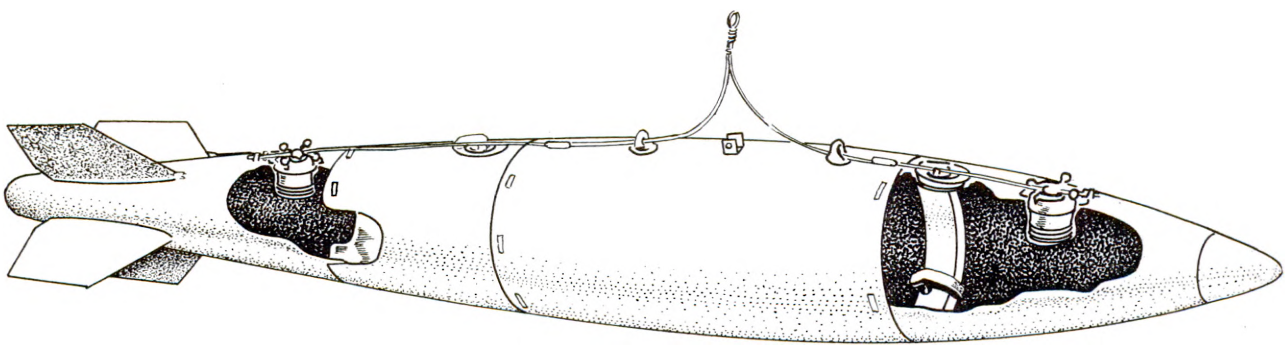


Figure 11-11.—Fire Bomb Mk 79 Mod 1.

6 percent (by weight) of type M2 thickener. A good mix is shown in figure 11-12. This mixture results in a gel of a consistency that insures the most effective area coverage, intensity, and duration of the conflagration.

Aviation gasoline and jet fuel are standard aircraft fuels carried on shipboard for use in propeller-driven and jet aircraft, and require no special treatment other than heating to the optimum temperature for preparation of the incendiary mixture.

Thickener M2 is a free-flowing powder consisting of pulverized aluminum soap of coconut fatty acids, oleic, and naphthenic acids mixed with an antiagglomerant, such as devolatilized silica aerogel. This thickener will not cake while in storage and, although somewhat hygroscopic, can be stored after the container

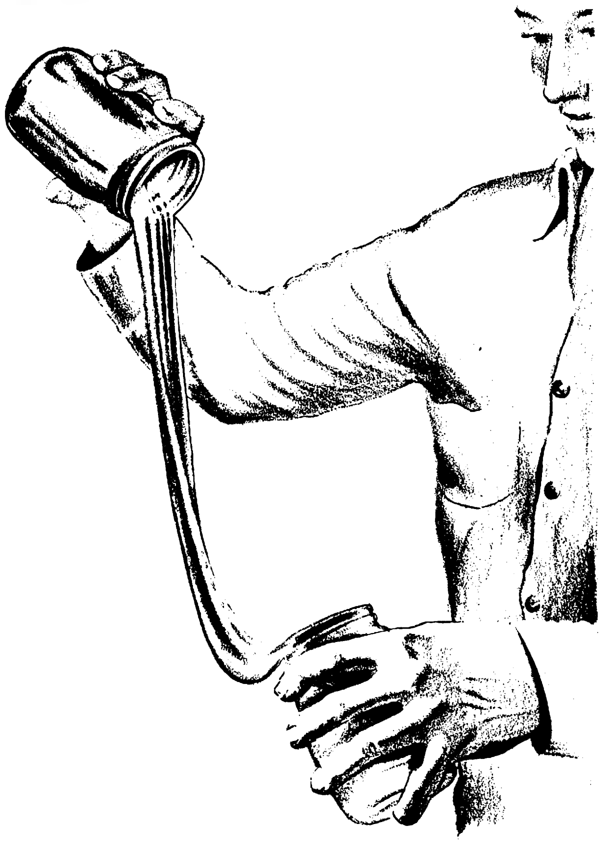


Figure 11-12.—Appearance of a good fire bomb mix.

has been opened if kept in a dry location. (CAUTION: Once filled, a bomb must be used or jettisoned.)

Chemical (Gas) Bombs

Chemical (gas) bombs resemble GP bombs in shape and size. The body of the chemical bomb serves as the filling container and support for the components. These bombs have a full-length burster charge with splits the bomb case and disperses the filling over the area to be contaminated. Chemical bombs are fuzed to explode instantaneously upon contact, or to provide an aerial burst.

Chemical bombs are painted gray, and have green or red colored bands to distinguish them from other types of bombs. Also, the weight, type filling, model, and lot number are stenciled or stamped on the bomb body.

Chemical bombs described in this chapter are war gas filled and are designed for antipersonnel attack in event of chemical warfare. They contain war gases which produce a powerful physiological effect on contact with the body.

The type of chemical filling may be classified as persistent or nonpersistent. A persistent war gas will remain in dangerous concentrations for more than 12 hours in the open. Nonpersistent types remain dangerous for shorter periods. When a particular chemical bomb is to be used, the persistency of the filler should be known. Mustard (symbol H) is the most persistent type of war gas, lasting for a period of time varying from a day in open terrain to several months in densely wooded areas.

Bombs containing casualty agents, capable of incapacitating or even killing personnel, are quickly identified by painted green bands. These agents include the blister gases (vesicants), such as mustard; choking gases (lung irritants), such as phosgene (CG); and the blood and nerve poisons, such as hydrocyanic acid (AC).

Harassing agents (gases of less potency but designed to force the enemy to use masks and otherwise retard his operations) are identified by painted red bands. These include the tear gases (or lachrymators) and the vomiting gases (or irritant smokes).

Personnel, experienced or inexperienced, must always use adequate protection when working around chemical ammunition. Gas masks provide effective protection in the open against all the above mentioned gases, except mustard and certain of the newer gases, for which special types of protective clothing and shields are provided for use aboard ships and at shore stations. Protection must be used when exposure to either the liquid or vapor is likely to occur.

Current available sizes of Navy chemical bombs are the 115-pound M70A1, the 500-pound AN-M78, the 1,000-pound AN-M79 and the more recent 500-pound Mk 94 Mod 0. Aircraft Bombs, Fuzes, and Associated Components, NavWeps OP 2216 (Volume 1), affords individual coverage on all chemical bombs except the 500-pound Mk 94 Mod 0 which is discussed in the following paragraphs.

500-POUND CHEMICAL (GAS) BOMB MK 94 MOD 0.—The Mk 94 Mod 0 chemical bomb (fig. 11-13) is essentially a Mk 82 GP fin-stabilized low-drag bomb which has been modified for GB filling. The modification consists

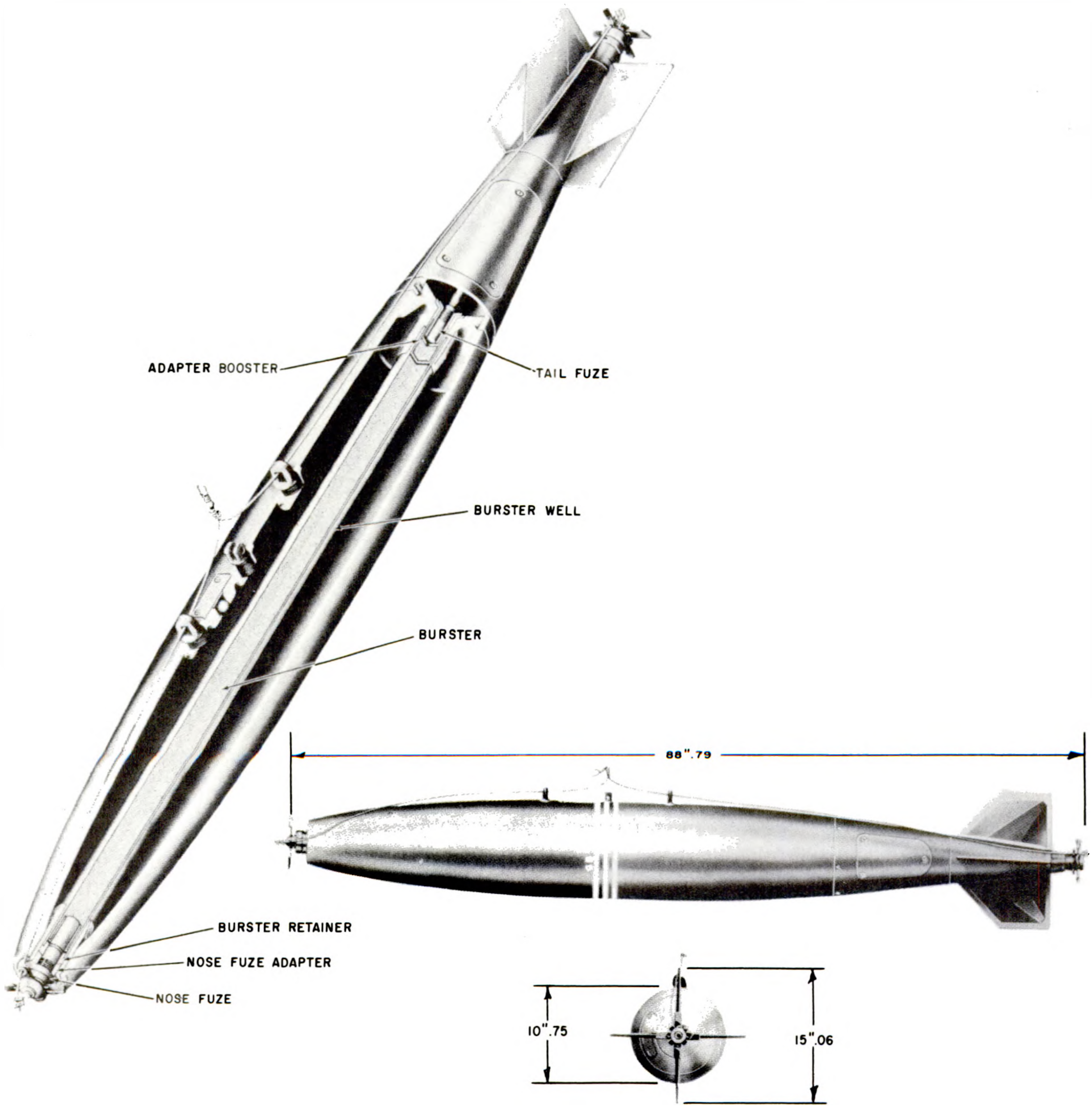


Figure 11-13.—500-Pound Chemical (Gas) Bomb Mk 94 Mod 0, cutaway view.

largely in the removal of the electric cable conduits from the low-drag bomb, and adding a burster, and a filling hole. When the bomb is being filled with a chemical agent a void is left for expansion. Helium is injected into this void and is used to check seal integrity. The filling hole is closed by installation of a steel ball welded in place as a primary seal, and a steel plate resistance welded to the body as the secondary seal.

The major components of the Mk 94 Mod 0 bomb (fig. 11-14) are the body section, fin assembly, arming wire assembly, nose fuze (M6A2), long stem tail fuze (M13), burster tube with charge (HBX-1) and suspension and hoisting lugs. The body is of steel construction with a

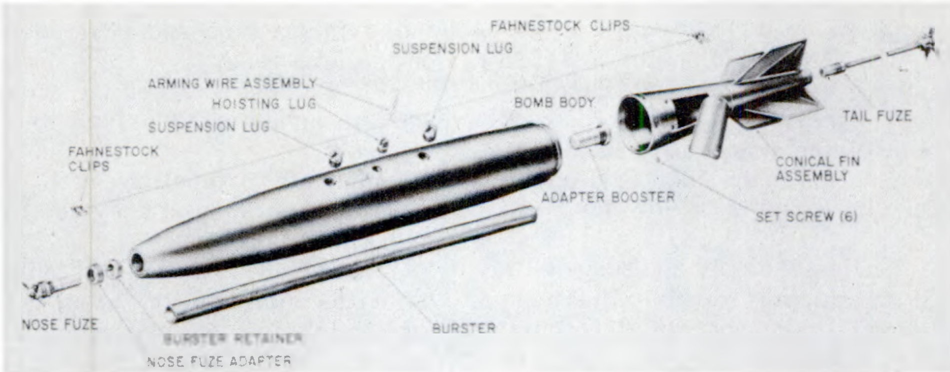


Figure 11-14.—500-Pound Chemical (Gas) Bomb Mk 94 Mod 0, exploded view.

minimum wall thickness of 0.4 inches. Two suspension lugs are spaced 14 inches apart, with a hoisting lug located at the center of gravity. The lugs are screwed into the body.

The burster, fuze, arming wire, and fin assembly are assembled to the bomb body to form a complete round. Assembly is normally accomplished in the field or aboard the aircraft carrier. When the bomb is released from the aircraft, the arming wires are withdrawn, permitting both fuzes to arm. The fuze detonates upon impact, setting off the fuze's booster which, in turn, sets off the burster exploding the bomb and dispersing the chemical agent. If the nose fuze fails, the tail fuze will act upon impact to detonate the adapter-booster and burster.

The bomb is painted grey; when it is filled with GB (sarin), three green bands are painted around the body between the two suspension lugs, and the marking GB-GAS and identifying nomenclature are stenciled in green on the body.

Shipping procedures for the Mk 94 Mod 0 chemical bomb are as follows: Shipping plugs are installed in the nose and tail of the body. A steel shipping cap is installed over the rear of the body. The burster, fuzes, hoisting lug, adapter-booster, arming wires, and fin assembly are packaged and shipped separately. The suspension lugs are packaged and shipped in the fin assembly crate. The bomb body has been successfully shipped, stored, and handled on pallets; however, field tests for the shipboard handling and storage of GB-filled bombs have not been completed. Consequently, procedures for storage, detection, and protection are not complete in this text.

For further information, the reader is referred to the following publications:

1. Chemical, Biological, and Radiological (CBR) Decontamination, Technical Manual 3-220.
2. Storage, Shipment, and Handling of Chemical Agents and Hazardous Chemicals, Technical Manual 3-250.
3. Chemical Bombs and Clusters, Technical Manual 3-400.
4. Chemical Corps Safety Directive No. 385-8.
5. Chemical Corps Reference Handbook, Field Manual 3-8.
6. Aircraft Bombs, Fuzes, and Associated Components (Volume 1, Chapter 12), NavWeps OP 2216.

A tail fuze adapter has been developed which prevents movement of the fuze due to vibration or rotation of the tail fuze assembly resulting from airloads on the vane.

An arming wire retainer has been used in conjunction with this bomb but serious deficiencies were encountered; therefore, procurement of this retainer for fleet use has been delayed.

The Mk 94 Mod 0 chemical bomb may be prepared for use without using the tail fuze adapter. The following steps should be performed when NOT using the tail fuze adapter:

1. By use of the E41A1 detection kit or its equivalent, determine whether any chemical agent has contaminated the exterior of the bomb. If no contamination exists, continue with the procedure outlined below.
2. Inspect the body for damage, cracks, and broken weldments which might develop leakage or weaken threaded lug inserts or their attachments to the bomb body.
3. Remove the shipping cap from the rear of the bomb body. Remove the nose and tail

shipping plugs. Remove the hoisting lug from the tail shipping plug.

4. Remove the Adapter-Booster M115A1 from its packing, and examine it carefully for serviceability; screw the adapter-booster into the tail end of the bomb body handtight. For detailed information on the Adapter-Booster M115A1, refer to chapter 3 of NavWeps OP 2216.

5. Remove the fin assembly and suspension lugs from the fin shipping crate. Place the fin assembly over the end of the bomb body with the locating pin of the fin assembly in one of the 16 receiving holes of the bomb body. To accommodate the aircraft, the fin assembly may be oriented 0°, 22.5°, 45°, or 67.5° from the centerlines of the suspension lug holes. Butt the fin assembly against the rear of the body and secure it with the six setscrews.

6. Assemble the two suspension lugs and the hoisting lug in their respective threaded holes.

7. Inspect the burster well thoroughly. Threads must be clean and all surfaces must be free of foreign matter.

8. Seat the burster tube assembly in the burster well handtight; do not use force. Install the burster retainer and the noze fuze adapter.

9. Open the access door of the fin assembly by unlocking the attaching fasteners.

10. Remove the fuzes and arming wire from their containers and examine them carefully for serviceability. (CAUTION: Do not remove the sealed pin from the arming vane.)

11. Insert the required tail fuze through the opening in the rear of the fin assembly. Grasp the fuze through the access door opening and screw the fuze into the adapter-booster until handtight. Do not apply torque at the vane end of the fuze.

12. Screw the required nose fuze into the nose fuze adapter until it seats handtight. Use no tools.

13. For detailed information on fuzing and defuzing, refer to the applicable section in chapter 2 of NavWeps OP 2216.

14. Install the bomb on the aircraft and adjust sway brace.

15. Thread the arming wire through the forward and aft suspension lugs and through the vane tabs of the two corresponding fuzes so that 4 inches protrude beyond the vane tabs. Arming wire must be free from kinks, burrs, and corrosion.

16. Slip two safety clips over each end of the arming wire and push them up to the tab on the fuze vane.

17. Remove the sealing wire from the fuze and the adhesive tape from the fuze collar, if present.

Adequate protection against contamination of personnel must be provided for when working with chemical bombs.

The Mk 94 GB filled bomb must be handled by a decontamination team until the bomb is ascertained to be uncontaminated. The remainder of the assembly operations may then be accomplished by the regular assembly crew.

The regular assembly crew should wear impregnable aprons and rubber boots. Protective masks and first aid equipment should be available for immediate use. Gloves are not recommended for the following reasons:

1. The decontamination team has certified that the bomb body is clean, and the component parts are clean because they have been shipped separately.

2. The present standardized gloves do not allow sufficient touch control.

3. Surgical gloves are not sufficiently resistant to tearing; e.g., if the glove is snagged on the arming vane. A supply of water should be available for washing exposed skin should any leakage occur.

The area should be monitored with an E41 automatic detector and the decontamination team should stand by during the remaining assembly operations. A sealable container into which damaged and leaking chemicals can be placed for disposal should be available.

All ship personnel should be thoroughly oriented regarding the hazards of, and protection from GB.

Four hundred gallons of 10 percent caustic solution or 40 percent calcium hypochlorite (HTH) or supertropical bleach (STB) slurry (enough to decon two Mk 94's) should be available with an M8A2 decon trailer or an M9 decon truck. Several ABC-M11 (1-1/2 quart) decon apparatus should also be available.

Pertinent data of the current chemical bombs are shown in table 11-6.

Smoke and Incendiary Bombs

Smoke and incendiary bombs are similar in outward appearance and many other details. The chief differences consist of their chemical filling, functioning, and use. Pertinent

Table 11-6. —Chemical bombs.

Designation	Filling type	Weight (lb) bomb empty	Body diameter (in.)	Length (in.)	Total weight (lb)	Fuze
115-lb M70A1	Distilled mustard (HD)	60.6	8.0	51.5	128.1	Nose fuze AN-M158
500-lb AN-M78	Phosgene (CG)	205	14.18	59.25	495	Nose fuzes M163, M164, M165 AN-M103A1, AN-M140A1, and AN-M166 (VT) Tail fuze AN-M101A2
	Cyanogen chloride (CK)	176	14.18	59.25	466	Same as above
500-lb Mk94Mod 0	Sarin (GB)	302	10.75	88.79	470	Nose fuzes AN-M139A1, AN-M140A1, AN-M103A1, Mk 243 Tail fuze AN-M195
1,000-lb AN-M79	Hydrocyanic acid (AC)	195	18.8	69.5	717.0	Nose fuzes M163, M164, M165, AN-M103A1, AN-M139A1, AN-M140A1, and AN-M168 (VT) Tail fuzes M162 and AN-M102A2
	Cyanogen chloride (CK)	351	18.8	69.5	873.0	Same as above
	Phosgene (CG)	415	18.8	69.5	937.0	Same as above

information on a current smoke bomb and a current incendiary bomb is covered in the following paragraphs.

SMOKE BOMBS.—Smoke bombs are generally used for screening purposes to conceal shore areas and the movement of troops and ships. Their bodies are constructed of thin metal, somewhat similar to that used for 100-pound practice bombs. The bomb is filled with a smoke agent. Functioning of a fuze and a burster shatters the bomb on impact, dispersing the smoke agent over a wide area. Atmospheric oxygen ignites the filling, causing it to burn and to produce smoke.

The 100-Pound Smoke Bomb AN-M47A4 has a cylindrical body, a rounded nose, and a tapered aft section to which a box-type fin assembly is welded. The bomb is constructed of thin sheet steel and is threaded at the nose to receive an axial burster well which extends to the aft end of the bomb body.

The AN-M47A4 smoke bomb is filled with PWP (plasticized white phosphorus) or WP. PWP is more effective than WP because of its longer burning, reduced pillaring, and antipersonnel effect.

Either the AN-M20 or the AN-M18 burster is used with this bomb. The burster is secured in place by an impact type nose fuze which is threaded into the forward end of the burster well. The AN-M18 burster is used when the bomb is to be dropped from low altitudes.

Upon impact of the bomb, functioning of the fuze detonates the burster. The burster shatters the bomb and disperses the agent over a circular area of 30 to 50 yards in radius. Atmospheric oxygen ignites and causes the agent to burn and produce smoke; an effective white smoke screen may be produced with a duration up to 5 minutes.

The base color of the bomb is blue-gray. A yellow band 1 inch in width, denoting the smoke filling, is painted around the midsection of the bomb. Identifying nomenclature is stenciled in yellow letters forward of the rear metal suspension band.

INCENDIARY BOMBS.—An incendiary bomb is designed for use against combustible land targets where large and numerous fires will cause serious damage, and for use over water to ignite oil slicks. The types of land targets against which the incendiary bomb is effective include warehouses, factories, docks, storage dumps, barracks, and residential and industrial structures. When ships in a harbor or oil storage tanks near a harbor are damaged, oil slicks are formed which are frequently of sufficient thickness to be ignited by incendiary bombs and to burn intensely.

The 100-Pound Incendiary Bomb AN-M47A4 uses the same body as the 100-Pound Smoke Bomb AN-M47A4.

Three types of incendiary fillings are used in the incendiary bomb: PT1, IM, and NP. PT1 is a complex mixture based on "goop," which is comprised of magnesium dust, magnesium oxide, and carbon, with a sufficient amount of petroleum distillate and asphalt to form a paste. IM (Oil, Incendiary, Isobutyl Methacrylate, Type I) is a mixture of 88.75 percent gasoline, 5 percent isobutyl methacrylate, 3 percent stearic acid, 2 percent calcium oxide, and 1.25 percent water. NP (Oil, Incendiary, Napalm Type I) is a mixture of 88.5 percent gasoline and 11.5 percent Napalm thickener.

The AN-M47A4 incendiary bomb uses Igniter AN-M9 (white phosphorus or sodium filled) with Burster AN-M13 (TNT and tetryl filled). Burster AN-M12 (black powder and magnesium) may be used in lieu of the AN-M9 igniter and an AN-M13 burster when the bomb is to be dropped on land targets. When the AN-M9 igniter and AN-M13 burster combination is used, a small coil spring is placed in the bottom of the inner tube of the igniter before the burster is installed to insure firm contact between the burster and the fuze. No spring is used when the AN-M12 burster is installed. Bursters and igniters are secured in the burster well by an impact type nose fuze which is threaded into the nose of the burster well.

With the burster well installed, the empty bomb weighs approximately 26 pounds. When filled and assembled with the fuze, burster, and igniter, the bomb weighs approximately 70 pounds.

When the incendiary bomb, equipped with a sodium igniter, impacts on the target, it bursts and scatters burning gobs of incendiary gel containing particles of sodium. These gobs of gel will float and the sodium will ignite spontaneously upon contact with water, thereby insuring the ignition of flammable oil slicks. If the incendiary bomb penetrates the surface of a wooden dock or pier and bursts below the dock, the incendiary gel will continue to burn regardless of the water present. If a white phosphorus-filled igniter is used, the scattering and ignition of the gel takes place, but ignition of the gel on water is not assured. Burning gobs of incendiary gel will produce a temperature of 50° to 675° C at a height of 3 inches above the flame over a maximum period of approximately 8 minutes.

The base color of the bomb is blue-gray. A purple band 1 inch in width, denoting the incendiary filling, is painted around the mid-section of the bomb. Identifying nomenclature, filling, lot number, date of loading, and identification mark of the loading facility are stenciled in purple letters on the bomb body.

Practice Bombs

Practice bombs, as the name indicates, are used to simulate the ballistic properties of service type bombs for target practice. The general types are miniature practice bombs, made of cast iron; subcaliber practice bombs with cast-metal or steel bodies, similar to miniature practice bombs; full-scale practice bombs, made of sheet metal and filled with water or wet sand; and nuclear weapons practice bombs.

Practice bombs are used for the training of bombing crews in markmanship. These bombs may use signals which produce a puff of smoke. The detonation of the signal makes it possible to spot the impact location of the bomb. The use of practice bombs instead of live bombs makes it possible to train crews more economically and safely than would be the case with service type bombs.

MINIATURE BOMBS.—Currently miniature practice bombs are made in one size, the AN-Mk 23. A spotting signal is used which fires on impact and enables the pilot to determine the exact striking point. The puff of white smoke created by the signal device is visible up to 14,000 feet in altitude. This signal, the AN-Mk 4, is discussed more thoroughly in chapter 13.

The AN-Mk 23 Mod 1 is a 3.0-pound miniature bomb, made of cast iron, and is 8.25 inches long by 2.2 inches in diameter. The complete round consists of the body, firing pin and cotter pin assembly, and AN-Mk 4 signal. It is used mostly in low-altitude bombing practice. Currently the Mk 23 practice bomb is dispensed from the Aero 4B practice bomb container, which carries quantities from one to eight.

PRACTICE BOMBS(WATER FILLED).—The full-scale practice bombs have approximately the same dimensions as currently used GP and low-drag bombs. They are constructed of sheet steel and are shipped empty. When filled with wet sand or water, they compare in weight with service bombs of equivalent size. The bombs are relatively fragile and must be handled with care as the fins are easily bent, resulting in an erratic flightpath.

Fins resemble those used by service bombs, although some have been modified to accommodate fuzes and marker signals. Low-drag practice bombs contain a blast tube which extends from the nose to the aft end of the bomb and allows for exit of the signal smoke. Data pertinent to practice bombs is given in table 11-7.

PRACTICE BOMBS (SUBCALIBER).—Subcaliber practice bombs are made in three distinct types. Although all three types fulfill the same function, each is quite different in design and appearance. A bomb of each type is discussed in the following paragraphs.

The 25-Pound Practice Bomb Mk 76 Mods 1 and 2 (fig. 11-15) have a cast-metal body similar to a miniature practice bomb. The Mods 1, 4, and 6 are designed for airburst and the Mod 2 for impact firing. For airburst firing, the bomb is equipped with either the AN-M146E3 or Mk 256 Mod 0 mechanical time fuze. Both are discussed later in this chapter. For impact firing, the firing pin assembly Mk 1 Mod 0 is used.

The Mk 76 and Mods can be suspended singly from racks and shackles, or carried in the Aero 8A practice bomb container.

Practice Bomb Mk 89 Mod 0 (fig. 11-16) is a 56-pound low-drag practice bomb, similar in shape to the low-drag series of GP bombs. The cast iron body is slender and has a pointed nose. The conical fin assembly is of welded sheet metal or of ALMAG cast construction. The tail fins are canted 2 degrees to impart spin to the bomb to insure greater stability. The bomb is 31.3 inches in length and 4 inches in diameter.

The standard Mk 1 Mod 0 firing pin assembly and Mk 4 signal are used in the forward end of the bomb and retained by a cotter pin. Two suspension lugs are spaced 14 inches apart on the bomb body. The threaded lugs must be removed and may be replaced by shipping plugs when the bomb is to be carried in the Aero 8A practice bomb container. Two 3/8-inch holes are drilled into the body at the center of gravity for use in loading the bomb in the Aero 8A practice bomb container. The Mk 89 Mod 0 practice bomb is being replaced with the

Table 11-7. —Physical characteristics of full-scale practice bombs.

	Mk 15 Mod 4	Mk 86 Mod 0	Mk 65 Mod 0	Mk 87 Mod 0	Mk 66 Mod 0	Mk 88 Mod 0	Mk 67 Mod 0
Type	GP	Low-drag	GP	Low-drag	GP	Low-drag	GP
Weight, pounds; Wet sand filled	97	217	443	333	884	783	1473
Water filled	60	141	249	221	480. 5	458	817
Length, in.	41	76	57	91	67	120	90
Diameter, in.	8. 0	9. 0	14. 0	10. 8	18. 6	14. 0	23. 0
Firing pin assembly.	Mk 1 Mod 0	Mk 1 Mod 0	None	Mk 1 Mod 0	None	Mk 1 Mod 0	None
Practice bomb signal.	AN-Mk 4	AN-Mk 4	Mk 6 Mod 0	AN-Mk 4	Mk 6 Mod 0	AN-Mk 4	Mk 6 Mod 0
Fuze	None	None	Mk 247 Mod 0	None	Mk 247 Mod 0	None	Mk 247 Mod 0
Suspension, center to center, in.	14	14	14	14	14	14	14 and 30

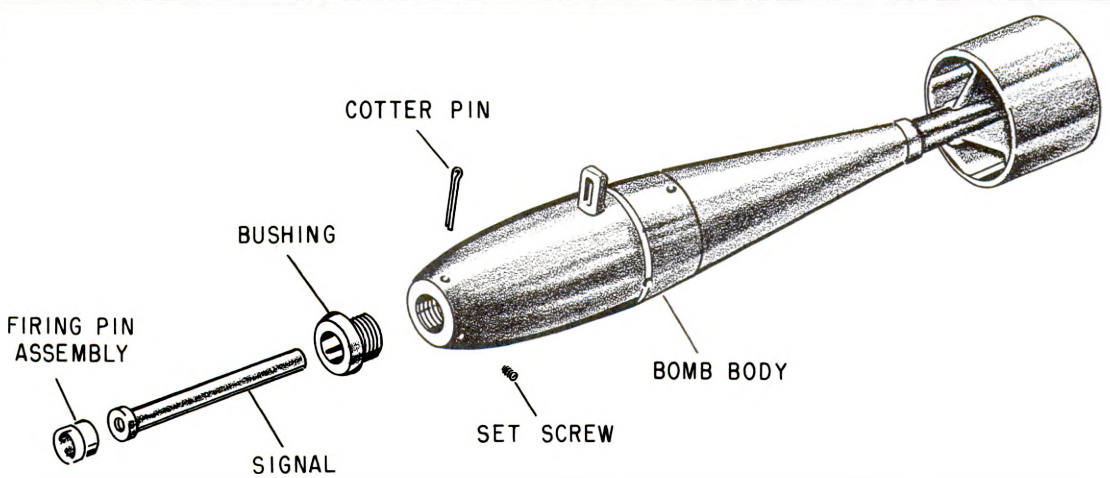


Figure 11-15. —Practice Bomb Mk 76 and Mods, exploded view.

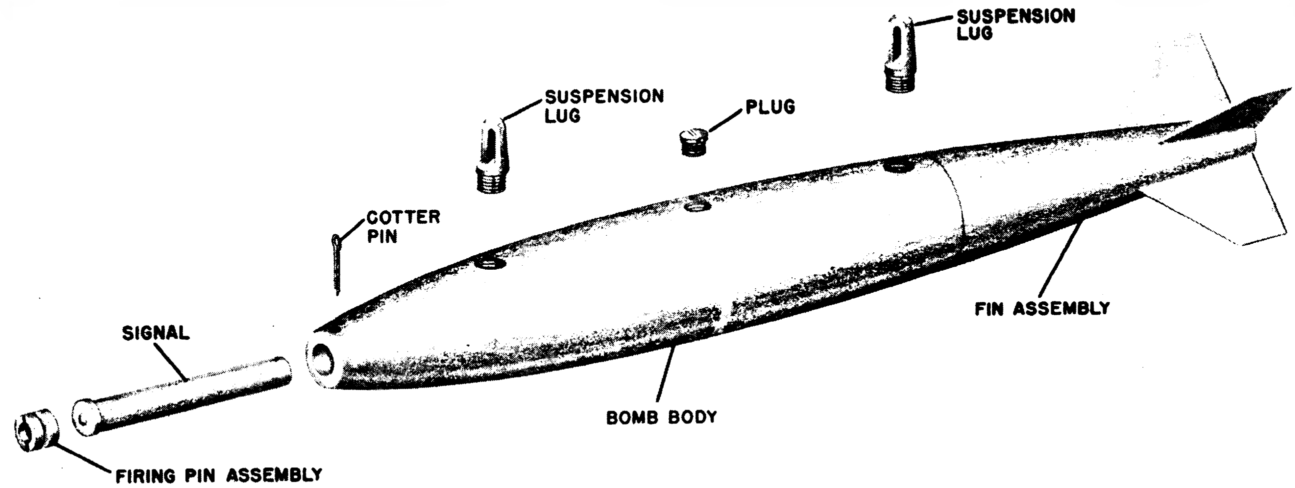


Figure 11-16.—56-Pound Practice Bomb Mk 89 Mod 0, exploded view.

Mk 89 Mod 1. This bomb is identical to the Mk 89 Mod 0 except that it has a dual capability for airburst or impact firing.

The 5-Pound Practice Bomb Mk 106 Mod 0 is a thin-cased, cylindrical bomb of the laydown type, designated for low altitude drops. It is 18.75 inches in length and 3.9 inches in diameter. The complete bomb is composed of a bomb body assembly, a Mk 4 Mod 3 practice bomb signal, and a modified AN-M173 impact fuze. (See fig. 11-17.)

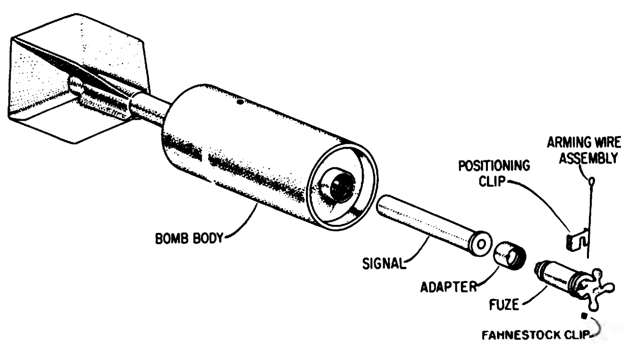


Figure 11-17.—Practice Bomb Mk 106 Mod 0.

The bomb body is composed of an inner and outer cylinder. The inner cylinder has internal threads on the forward end for receiving the modified AN-M173 fuze. It also forms the base for the outer cylinder and fin assembly. The AN-M173 impact fuze has been modified for use with the Mk 106 Mod 0 practice bomb by removing the tetryl booster and assembling a threaded adapter ring to the fuze body.

When the practice bomb is released, the airstream arms the fuze and, upon impact, the fuze fires the signal. The practice bomb must be dispersed from the Aero 8A practice bomb container.

NUCLEAR WEAPONS PRACTICE BOMBS.—Nuclear weapons practice bombs utilized presently by operating activities consist of three bombs. These bombs are discussed individually in the following paragraphs.

The 2,000-Pound PB Mk 104 Mod 0 (fig. 11-18) has a long, slender welded body and is composed of two sheet steel fore and aft conical sections and a heavy steelplate central cylindrical section. The body is internally reinforced in the sway brace and ejection areas. Internal bulkheads and a solidified filler provide for rigidity of the casing. The bomb has a conical nose cap and a tapered aft end to which four fins (two folding) are attached.

Of the four fins on the tail cone, two 180° opposed are premanently fixed and the other two 180° opposed are folded and latched until the bomb is released. There is a fin latch release of the folding fins by an explosive actuator at separation of the bomb. The fixed fins have no angle of incidence whereas the folding fins have a 1.5° cant, which provides a roll moment for spin stabilization in a clockwise direction as viewed from the aft end of the bomb. Two suspension lugs, 30 inches apart, are threaded into recesses in the bomb body.

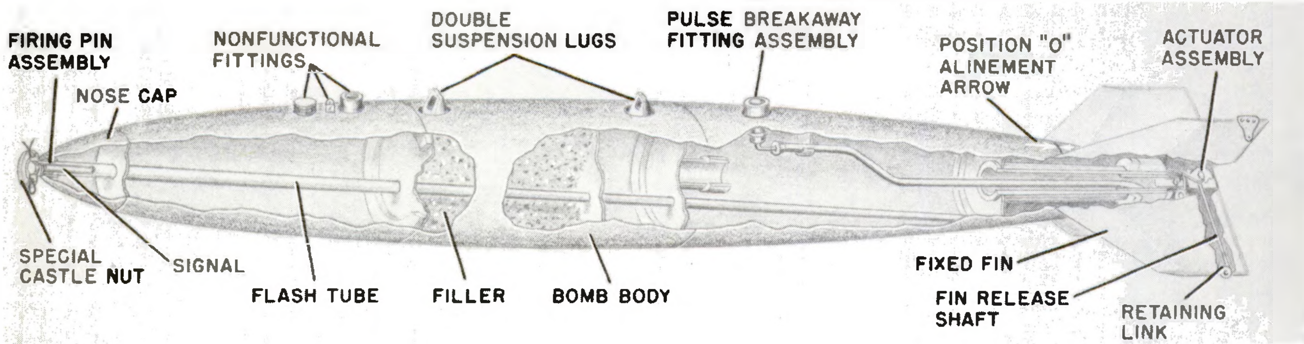


Figure 11-18. —2,000-Pound Practice Bomb Mk 104 Mod 0, cutaway view.

A blast tube, extending at a slight angle down and aft from the nose cap of the bomb to the lower rear of the aft cone weldment, houses a pyrotechnic charge and firing-pin assembly.

The bomb is filled with a concrete and steel shot mixture which is cast in place by the manufacturer of the bomb.

The Mk 104 Mod 0 weighs approximately 2,020 pounds when assembled of which 1,234 pounds are concrete and steel shot filler. It is 107.6 inches in length, 20 inches in diameter, and has a 32-inch fin span.

Bombs of recent issue are painted orange, with identifying nomenclature in white, and notations for field-handling personnel in black.

Bombs of older issue are painted black, with identifying nomenclature in white, and notations for field-handling personnel in yellow.

The 2,000-Pound PB Mk 104 Mod 0 is similar in size and shape to the Mk 28 Nuclear Weapon and is the primary full-scale practice bomb for the Mk 28 series. It is used with Firing-Pin Assembly Mk 1 Mod 0 and Signal Mk 4 Mod 3, both of which are seated in the forward end of the flash tube and locked in place by a cotter pin. The cotter pin also secures the castellated nut holding the nose cap in position.

Fittings on the top centerline of the forward cone weldment are dimensionally similar to the corresponding parent weapon fittings. They are nonfunctional and are of value only as drill features.

Practice Depth Bomb Mk 100 Mod 0 (fig. 11-19) is a practice bomb for Depth Bomb Mk 90 Mod 0 The nose section of the practice bomb has an afterbody and a parachute pack attached to it.

This practice bomb weighs approximately 2,500 pounds, is 31.34 inches in diameter, and 125.2 inches in length with the parachute pack installed.

The practice bomb has four functions:

1. Trains flight personnel in the use of Control Boxes Aero 2A, Aero 2B, and Aero 3B.
2. Provides a means for target practice.
3. Provides the pilot with information about how the aircraft will respond when it is carrying the service bomb.
4. Trains ground personnel in methods of loading the service bomb on the aircraft.

The monitoring system, the Inflight Insertion Mechanism (IFI) operation, and the manual safety switch of the service bomb are simulated in the practice bomb by means of a weapon response simulator. The simulated signals are required for training personnel in the operation of Control Boxes Aero 2A, Aero 2B, and Aero 3B. A marker can be inserted in place of the eyebolt at the nose of the practice bomb for use in target practice. The marker produces a deep red color on the water surface at the point where the bomb enters the water.

The service bomb is described in Navy SWOP (Special Weapons Ordnance Publication) B90-1, Assembly, Test, and Storage Procedures. For information on postloading, pretakeoff, and inflight procedures, refer to the applicable NavWeps Special Weapons Check List for the air craft involved. The procedures included in the NavWeps Special Weapons Check List also apply to the practice bomb.

The practice depth bomb consists of the following major components:

1. Nose section.
2. Afterbody.
3. Parachute Pack Mk 25 Mod 0.
4. Practice Bomb Marker Mk 17 Mod 0.
5. Weapon Response Simulator Mk 4 Mod 0.

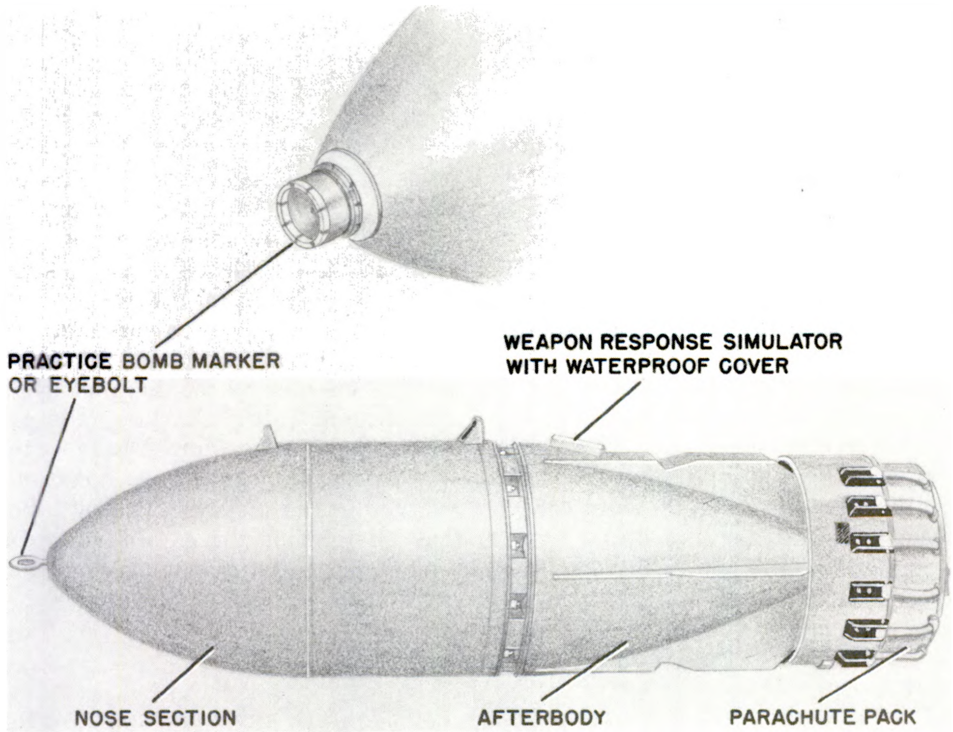


Figure 11-19. —Practice Depth Bomb Mk 100 Mod 0, major components.

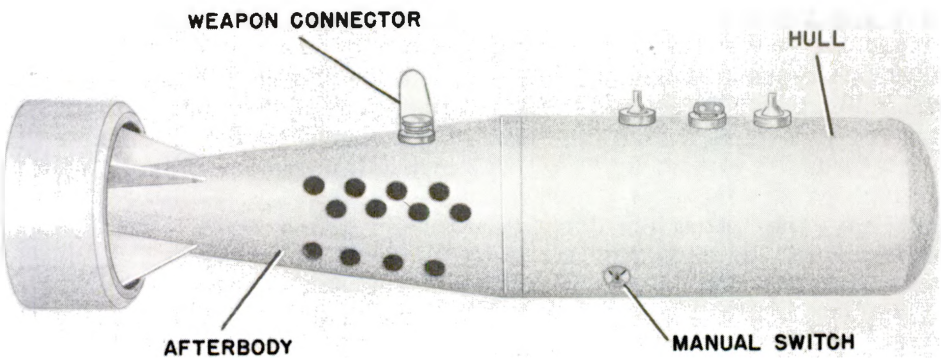


Figure 11-20. —Practice Depth Bomb Mk 102 Mod 0.

Practice Depth Bomb Mk 102 Mod 0 (fig. 11-20) is a nonexpendable practice bomb for Depth Bomb Mk 101 Mod 0. This practice bomb weighs approximately 1,200 pounds, is 18 inches in diameter, and 92.4 inches in length.

The practice bomb simulates the external outline and the weight of the service bomb. It provides a means of electrical connection with internal switches and wiring to simulate the service bomb electrically when used with Control Box Aero 6A; Monitor Test Set T-3024, and Safety Switch Test Set T-3026. It also includes a switch that can be adjusted to simulate various fault conditions.

The functions of the practice bomb are:

1. Trains personnel in the use of the Control Box; Aero 6A; Monitor Test Set

T-3024; Safety Switch Test Set T-3026.

2. Aids in training aircrews in the operation and capabilities of Magnetic Anomaly Detection (MAD) equipment when used with the Mk 102.

3. Trains pilots and ground personnel in procedures for handling the service bomb and loading it onto the aircraft.

4. Provides pilots with information on how the aircraft will respond when carrying the service bomb.

5. Depth Dummy Bomb Mk 108 Mod 0 provides a means of checking aircraft fit and separation characteristics.

The weapon response simulator assembly simulates the weapon connector, the MC-725 Arming-Safing Motor Switch (often called the inflight safety switch), the manual safety switch, and monitor circuits of the service bomb. In addition, a selector-type fault switch makes it possible for an instructor to simulate defects in the circuits and switches of the service bomb by rotating the fault switch to a desired position in setting up a training problem.

The service bomb is described in Navy SWOP B101-1. Postloading, pretakeoff, and inflight procedures are the same for the practice bomb as for the service bomb and are found in the applicable NavWeps Special Weapons Check List.

Practice Depth Bomb Mk 102 Mod 0 has three major components; a hull assembly, an afterbody, and a weapon response simulator assembly. The simulator assembly consists of a weapon connector and a manual switch for the practice bomb.

For a more detailed coverage of nuclear weapons practice bombs, the reader is referred to Chapter 11 of NavWeps OP 2216, Volume 1 (Aircraft Bomb Fuzes and Associated Components).

BOMB FUZES INSERVICE USE

There are many bomb fuzes classified for service use. This chapter contains general data on most bomb fuzes that will be encountered by the Aviation Weapons Officer and describes the operation of representative types most commonly used.

A fuze may be defined as a device for causing the detonation of an explosive charge at the proper time after certain conditions have been fulfilled. It is a mechanical device and should not be confused with another type fuse used in explosives. This latter type fuse is a slow burning cord intended to convey fire to an explosive charge without danger to the person lighting it. Fuses are mostly used commercially; a good example is a dynamite fuse.

As discussed earlier in this chapter, bombs must be manufactured to withstand reasonable heat and be insensitive to shock or ordinary handling. They must also be capable of being dropped safe in times of an emergency.

Detonation of a bomb is controlled by the action of a fuze. It provides the sensitive explosive elements (the primer and detonator) and the necessary mechanical action to detonate the main burster charge. The primer is fired by the mechanical action causing the detonator to explode. The primer-detonator explosion is relayed to the main charge by a booster charge, thus completing the explosive train.

(NOTE: Explosive trains have been discussed previously in this text.)

CLASSIFICATION

There are several ways in which bomb fuzes may be classified. However, for purposes of this course, they are classified according to their location in the bomb—namely, nose, tail, side, and multiposition.

(NOTE: Multiposition fuzes are those fuzes which can function regardless of the point at which they are installed.)

Each type of bomb fuze may be further classified according to their method of functioning; for example, impact, time, proximity, hydrostatic, and antidisturbance fuzes.

Impact Fuzes

There are two kinds of impact fuzes—mechanical and electrical. The mechanical impact fuze is actuated by a firing pin being driven into a primer by direct contact (nose fuzes) or by inertial means (tail and multiposition fuzes). The electrical impact fuze is actuated by electrical energy passing through an electric detonator. The action may be instantaneous, whereby the fuze acts to explode the bomb immediately; or delayed whereby the fuze will not explode the bomb until a definite time has elapsed. This delay allows the bomb to penetrate the target before exploding. It also permits a low-flying aircraft to clear the area after dropping a bomb.

Time Fuzes

This type fuze explodes the bomb at a predetermined time after release, by mechanical or chemical action.

The mechanical method uses a mechanism similar to an alarm clock. A trigger arm assembly, which retains a spring-loaded firing pin, rides on the edge of a circular disk. The disk has one notch on the edge. When released armed, the clockwork turns the disk. This allows a lever to drop through the notch, freeing the spring-loaded firing pin. The firing pin strikes the primer and fires the explosive train.

The chemical action in time fuzes is initiated, at the time of arming, by the breaking of a capsule containing a solvent. The chemical dissolves a retaining ring which has been holding back a spring-loaded firing pin. The compressed spring expands and drives the firing pin into a primer, thereby detonating the fuze.

Hydrostatic Fuzes

Hydrostatic fuzes are water pressure activated fuzes which are used in depth bombs or in GP bombs when used against underwater targets. Water, entering the ports in the fuze body, expands a bellows. As pressure increases with water depth, the bellows expand causing alinement of the explosive elements and detonation of the fuze.

Antidisturbance Fuzes

Antidisturbance fuzes are ready to function a few seconds after impact. The mechanism is extremely sensitive, and any movement after impact will cause the fuze to be detonated. A sequence of mechanical actions while in flight and during impact prepares the antidisturbance device of the fuze.

Proximity Fuzes

Proximity (or VT) fuzes contain miniature combination radio transmitters and receivers and are always located in the nose. They detonate before impact when any substantial object is detected a predetermined distance away.

NOTE: The symbol "VT" has no significance as an abbreviation; it was devised for uses such as shipment orders, stock cards, and loader's lists.

IDENTIFICATION

Bomb fuzes are designated by numbers; Army/Air Force-designed fuzes are numbered from 100 to 199 while Navy-designed fuzes are numbered from 200 to 299. All Navy fuzes are safe for carrier landings and takeoffs; some Army/Air Force-designed fuzes are not.

To be classified as carrier-safe, fuzes must meet certain qualifications. Nose fuzes must have a delayed arming time and usually a broken firing train in the unarmed condition. Tail fuzes must have only a delayed arming time although some also have a broken firing train.

Standardized fuzes which fit all AN standard bombs have the prefix AN. Like bombs, the letter M preceding the assigned number indicates an Army-designed fuze while Mk or Mark indicates that the fuze was developed by the Navy.

Fuzes are identified by the information marked on the shipping container and stamped on the fuze body. They may be further identified by inspection. Fuzes of one series—that is, those having the same mechanism and action but designed for bombs of different sizes—are distinguished among themselves by the length of the arming stem. Special-purpose fuzes, such as the hydrostatic, have a distinctive appearance and method of operation.

SPECIAL SAFETY FEATURES

Some fuzes incorporate special safety features. The most important features are: detonator safe, shear safe, and delay arming.

Fuzes that are detonator safe do not have the elements of their firing train in proper position for firing until the fuze becomes fully armed. The elements remain firmly fixed and out of alinement in the fuze body while the fuze is unarmed. This increases safety during shipping, stowing, and handling of the fuze. The arming action of the fuze alines the firing train.

A shear safe fuze will not become armed if its arming mechanism is damaged or completely severed from the fuze body. The arming mechanism of a fuze protrudes the farthest from the bomb, and might be severed from the fuze body if the bomb were accidentally dropped. Shear safe fuzes afford additional security for carrier operations and for externally mounted bombs.

Delay arming mechanically slows the arming of the fuze. It keeps a fuze in the safe condition until the bomb has fallen a sufficient distance away from the aircraft; thus, minimizing the effects of a premature explosion. Delay arming helps to make carrier operations safe because a bomb accidentally released during landing or takeoff ordinarily will not have sufficient air travel to fully arm the fuze.

Both nose and tail fuzes have two general methods of arming–arming vanes and arming pins. The arming vane type requires air travel to turn the vanes thus lining up the explosive train (in nose fuzes) and unlocking the striker or firing pin. The arming pin type holds the striker locked (and a safety block in place in nose fuzes) until the bomb is released armed. As soon as the arming wire pulls out of the arming pin, the pin jumps out and the fuze is armed. The arming pin type is not carrier-safe when a means of delaying the arming is not incorporated.

The functioning time of a fuze is the time it takes the fuze to detonate after impact. An instantaneous fuze will detonate in 0.0003 second or less, a nondelay fuze will detonate in 0.0003 to 0.0005 second, and a delay fuze takes more than 0.0005 second to detonate.

NOSE FUZES

There is a wide variety of nose fuzes utilized by the Navy. Some of the more pertinent nose fuzes are discussed in the following paragraphs.

Nose Fuze AN-M103A1

Impact Nose Fuze AN-M103A1 is vane operated and delay armed. Its action can be either instantaneous or delayed, depending on the setting of the control pin. The fuze is armed by air travel and requires from 510 feet to 5,425 feet travel depending on the type of arming vane used and the size of the bomb. The fuze may be equipped with any of four different sizes of arming vanes, depending on the bomb in which the fuze is to be installed and the required arming distance.

The fuze contains two explosive trains (fig. 11-21), one for delay and one for instantaneous action. The delay action explosive train consists of a primer, delay element, relay, detonator, booster lead-in, and booster. The primer and delay element assembly, containing the delay element and relay, are assembled in the fuze body and are sealed for protection against moisture.

The instantaneous explosive train consists of a detonator, booster lead-in, and booster. The same detonator is used in both explosive trains. It is alined with one of the explosive trains during the arming operation. Its final position depends upon the preset position of the setting pin.

The fuze is shipped and stowed with the setting pin in the deep slot or delay position. To set for instantaneous action, lift the pin, rotate it one-quarter turn, and drop it into shallow slot. The portion of the fuze body, adjacent to the setting pin, is stamped DEEP SLOT DELAY–SHALLOW SLOT INST.

The arming vane, reduction gears, and arming screw are assembled in one unit with the vane cup; the safety disks are held between the flange of the striker and the fuze body by the vane cup. When the arming vane is rotated by the airstream, the arming screw unscrews from the striker body carrying the vane gears and vane cup with it. Because of the reduction gears, the vane turns 65 1/3 revolutions to every complete turn of the arming screw. When the vane cup has progressed one-fourth inch, the safety disks are released. Positive ejection is insured by a fat spring assembled within the circle of disks. The arming vane continues to rotate until the arming screw has progressed one-half inch. Then the entire assembly becomes disengated from the fuze and falls free, leaving the fuze fully armed.

CAUTION: If the delay arming assembly (vane, vane cup, and gears) is missing, or has unscrewed from the striker far enough to allow the safety disks to be ejected, the fuze is armed. If the clearance between the vane cup and fuze body is greater than one-eighth inch, the fuze is partially armed.

Nose Fuzes AN-M139A1 and AN-M140A1

These fuzes are identical to the AN-M103A1 except for their firing delay elements. The AN-M103A1 has a 0.1-second delay element, the AN-M139A1 has a 0.01-second delay element, and the AN-M140A1 has a 0.025-second delay element. Black wedge markings on the fuze head (fig. 11-22) identify the delay time of the fuze. Outwardly, these three fuzes appear identical; they have the same shape and are of the same size. The delay action desired will govern selection of the proper fuze.

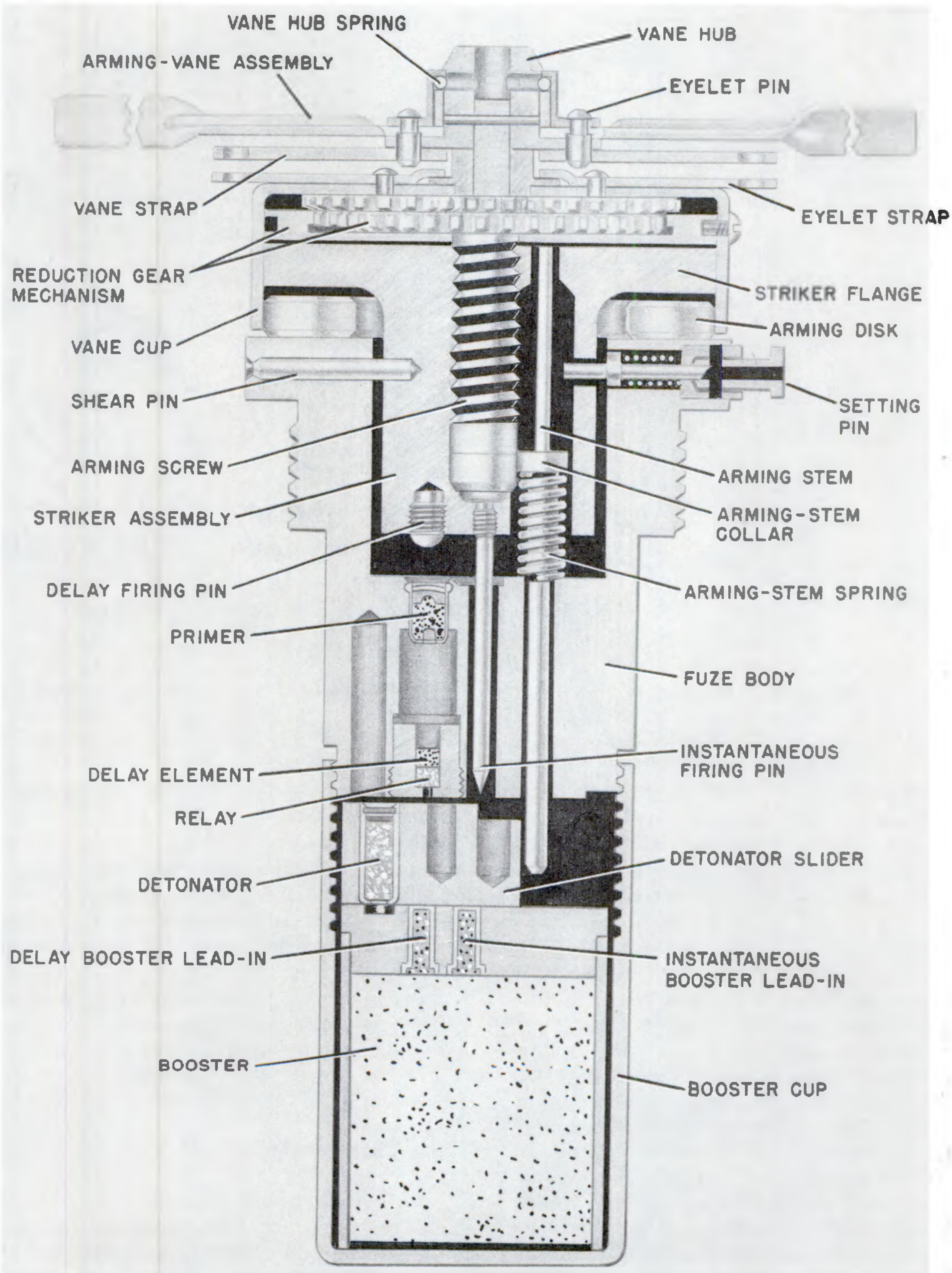


Figure 11-21.—Impact Nose Fuze AN-M103A1, cross section.

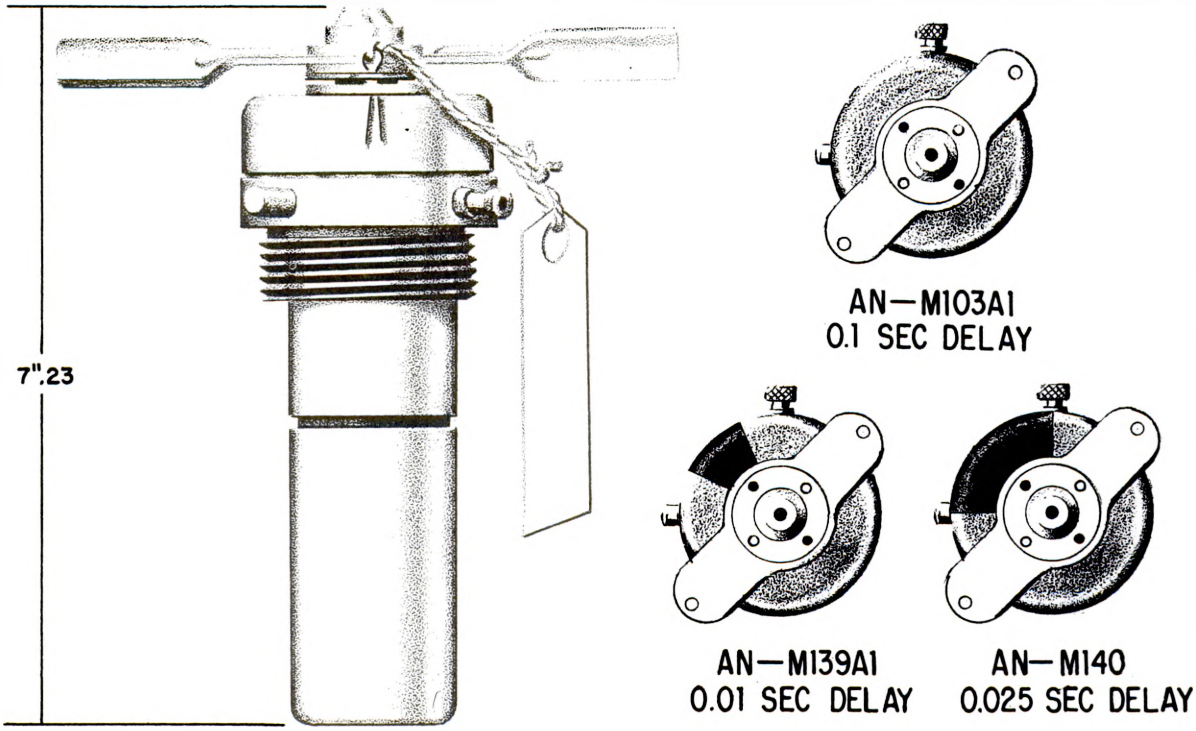


Figure 11-22.—Nose Fuzes AN-M103A1, AN-M139A1, and AN-M140A1.

Nose Fuze AN-M158

The AN-M158 (fig. 11-23) is a detonator-safe fuze. It is an arming vane type, delay arming, impact fuze and is used in the 20-pound Fragmentation Bomb AN-M41A1 and the 115-pound Chemical Bomb M70. The AN-M158 requires about 1,200 feet of air travel to arm, functions instantaneously, and is safe for carrier landings and takeoffs.

The principle of operation of the fuze is as follows: After the arming wire has been withdrawn, or the bomb freed from the cluster adapter, the windstream rotates the arming vanes and attached arming hub. The upper gear is attached to the arming hub and rotates with it. Both upper and lower gears mesh with the pinion gear. The lower gear has one more tooth than the upper gear; therefore, it lags behind the upper gear one tooth for each revolution of the vanes. This lagging causes the arming sleeve, to which the lower gear is attached, to thread up into the arming hub. The firing pin and striker move upward with the arming sleeve, freeing the detonator shutter after about 1,200 feet of air travel. The shutter is forced over by its spring, alining the detonator with the firing pin and booster lead-in. The shutter is held in this armed position by a spring-loaded detent. The fuze is completely armed when the shutter moves into the armed position.

On impact the striker forces the firing pin against its spring and into the detonator. If dropped safe, the detonator remains out of line with the firing pin and booster lead-in, and even though the fuze is crushed on impact, the booster will not detonate.

CAUTION: If the striker has risen more than one-fourth inch above the vane assembly, the fuze must be considered armed. If the vanes on an armed fuze are turned counterclockwise, the fuze may detonate.

Nose Fuze AN-M159

This fuze is identical to the AN-M158 except that the booster has been replaced by a smaller metal holder containing a column of tetryl. This difference in booster volume of the two fuzes causes a difference in fuze length, the AN-M159 being one-half inch shorter.

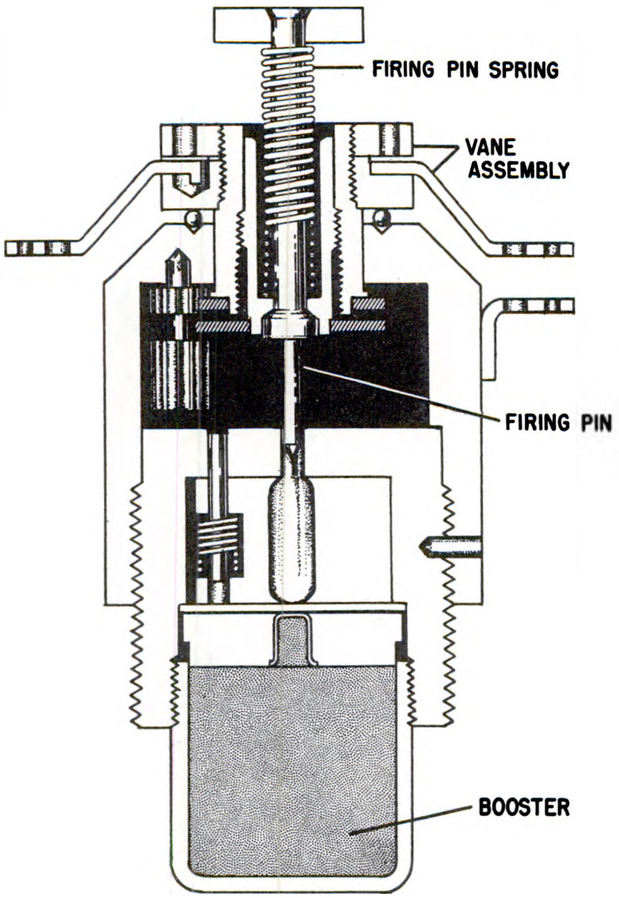


Figure 11-23.—Armed view of the Nose Fuze AN-M158.

Nose Fuze Mk 243 Mod 0

This is a water-discriminating vane-operated fuze used as an alternate to the AN-M103A1. It is designed to be used in conjunction with the Tail Fuze AN-M100A2 series fitted with a 0.24-second primer detonator against marine targets. If a direct hit is made against a surface target, the Mk 243 Mod 0 fuze will function with a delay of 0.25 second; if a near miss occurs, the nose fuze will fail to function while the tail fuze will detonate the bomb beneath the surface for maximum mining effect. (See fig. 11-24.)

The principle of operation is that an impact upon the striker must be sufficiently severe to shear three brass threads and allow the striker to impact the firing pin of the delay element. Drops from 20,000 feet onto water have resulted in no nose fuze action.

Nose Fuze Mk 244 Mod 1

This fuze is constructed similarly to the Mk 243. However, it is not a water-discriminating fuze. It has an added striker plate which increases the striker surface seven times. Also, the number of shear threads supporting the striker on the Mk 244 Mod 1 is only half the number of those on the Mk 243 Mod 0. Thus, the Mk 244 Mod 1 will function when dropped on soft ground from an altitude of 1,000 feet, or on water from an altitude of 3,000 feet. The difference between the strikers of the two fuzes is illustrated in figure 11-25.

Nose Fuze AN-M146

The AN-M146 fuze (fig. 11-26) is detonator-safe, combines vane and pin arming, and is time and impact functioning. The impact feature is for insurance only rather than for

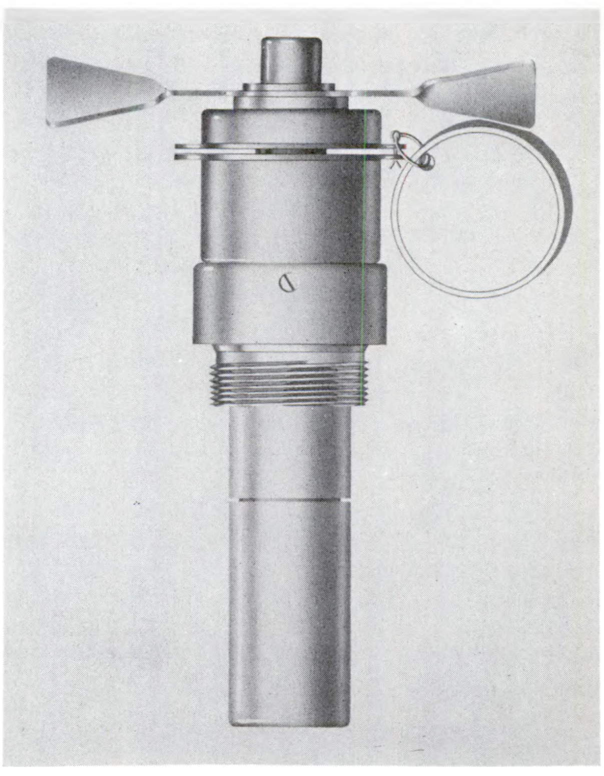


Figure 11-24.—Nose Fuze Mk 243 Mod 0.

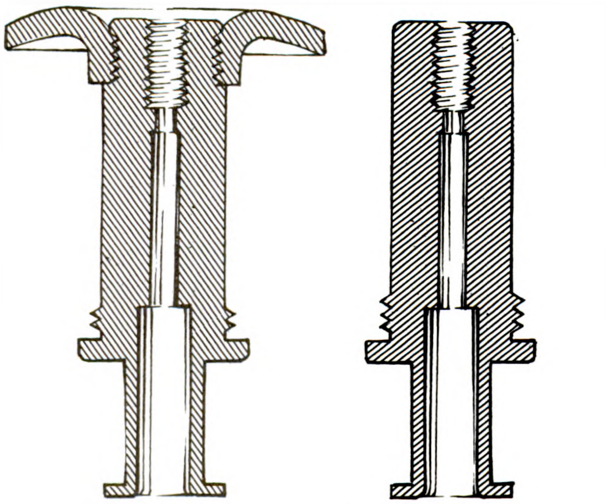


Figure 11-25.--Comparison of strikers of Nose Fuzes Mk 243 Mod 0 and Mk 244 Mod 1.

deliberate selection; it operates only when the time setting exceeds the time of fall. The AN-M146 may be set to function any time between 5 and 92 seconds after release. It has a black powder booster which is used for ignition purposes and can be used in the photoflash Bomb AN-M46, "butterfly bomb" Clusters AN-M28A2 and AN-M29A1, and chemical bombs when a black powder burster is installed.

The fuze consists of a body, which contains the time element and explosive train, and a head, which contains the mechanical arming and firing system. The time settings are engraved around the base of the head in one-half second increments numbered every 3 seconds, and an index mark for time setting is engraved in the body just below the head. A thumbscrew is provided to lock the head in position when the setting has been made.

CAUTION: This fuze is considered armed when any of the following conditions exist: Absence of the safety block; complete or partial ejection of the arming pin; and failure of the trigger arm assembly to support the striker as evidenced by the striker bearing down tightly against the safety block.

Nose Fuze AN-M145

The AN-M145 is essentially the same as the AN-M146 except that in place of the black powder charge, it is fitted with a tetryl pellet and clay pellet booster. It is used in certain aimable bomb clusters.

Fuze, Mechanical Time, Mk 256 Mod 0

The Mk 256 Mod 0 (fig. 11-27) is a mechanical time, airburst fuze that is designed for use with Practice Bombs Mk 76 Mods 4 and 6 and Mk 89 Mod 1. The fuze can be preset manually to operate at any time ranging from 5 to 87 seconds, after release from the aircraft. The Practice Bomb Signal Mk 4 Mod 3 is inserted in the fuze prior to installing the fuze in the bomb. There are no explosive components in the Mk 256 Mod 0.

The fuze consists basically of an aluminum head and a steel body held together by an internal coupling ring. The aluminum head is inscribed with markings representing 1 second time intervals. The steel body has an index mark inscribed on its surface. A lockscrew on the body located above the inscription "Tighten After Setting," is loosened to permit the head to rotate so that the desired time marking can be alined with the index mark. The lockscrew is then tightened.

Two cotter pins are used with the fuze. The one in the head provides a positive lock on the spring-loaded firing pin during shipping and handling. The second cotter pin provides a positive lock on the spring-loaded arming pin. The cotter pins are joined by a short length of twisted wire. A warning tag attached to one of the cotter pins alerts the ordnance personnel to remove the cotter pins after the arming wire is installed in the arming pin.

Proximity (VT) Fuzes

VT nose fuzes are designed to produce airbursts automatically. In general, no preliminary setting or adjustment is required, since functioning of the fuze is governed only by its proximity to the target.

These VT fuzes are physically interchangeable with Nose Fuze AN-M103A1. The use of VT fuzes is advantageous in air-to-ground operation where airbursts at heights of 20 to 125 feet above the target increases bomb effectiveness, such as when attacking exposed troops, parked aircraft, vehicles, and similar targets. These fuzes are not suitable for use against targets which require penetration and

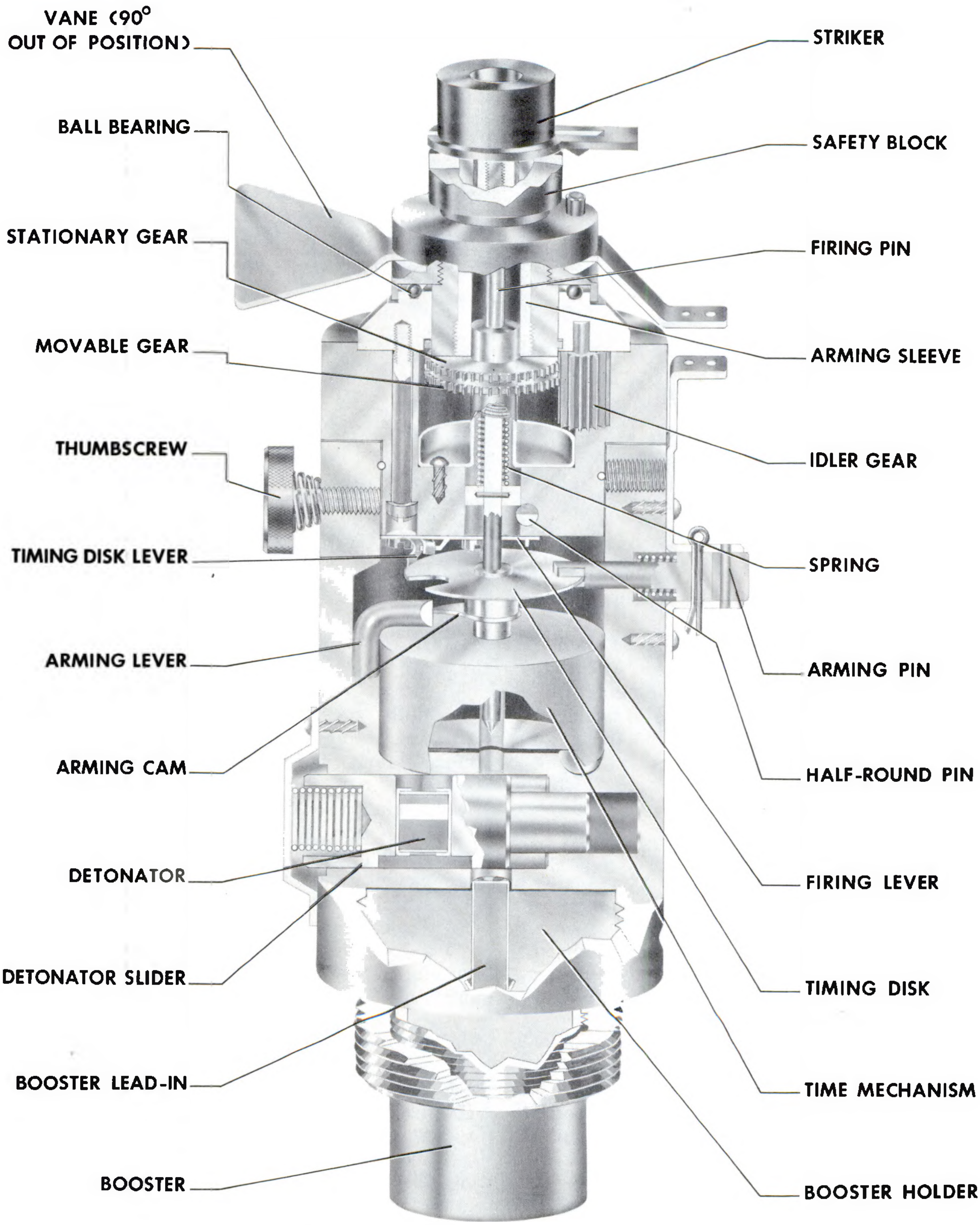


Figure 11-26.—Nose Fuze AN-M146.

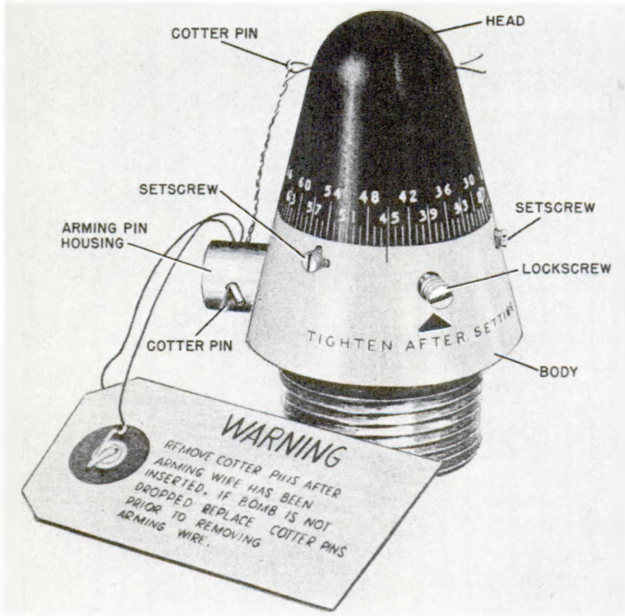


Figure 11-27.—Fuze, Mechanical Time, Mk 256 Mod 0.

detonation within the target for effective destruction. (See fig. 11-28.)

The two basic types of VT fuzes for bombs can be readily identified by their external appearance. The ring type has a metal ring around its arming vane. This type is used for both bomb and rocket fuzing. The bar type (fig. 11-29) has two metal bars extending radially, like handles, from the fuze nose. This type is used for bomb fuzing only. The choice of the ring or bar type for bomb fuzing is determined by the tactical situation involved.

The Navy in some tactical situations also uses a proximity sensing element (Mk 20) in conjunction with electrical fuzing of low-drag bombs. The sensing element is classified Confidential and the Aviation Weapons Officer should consult NavWeps OP 2216 (Volume 2) for detailed information.

The height at which the fuze detonates depends upon a number of factors, including the nature of the target, the bomb-fuze combination employed, and target approach conditions (bomb striking angle and speed). Bar type fuzes generally burst slightly higher than ring type fuzes, and show less variation in burst height as bomb type is varied. Either type when released over average land will function in a majority of cases within 20 to 125 feet of the target.

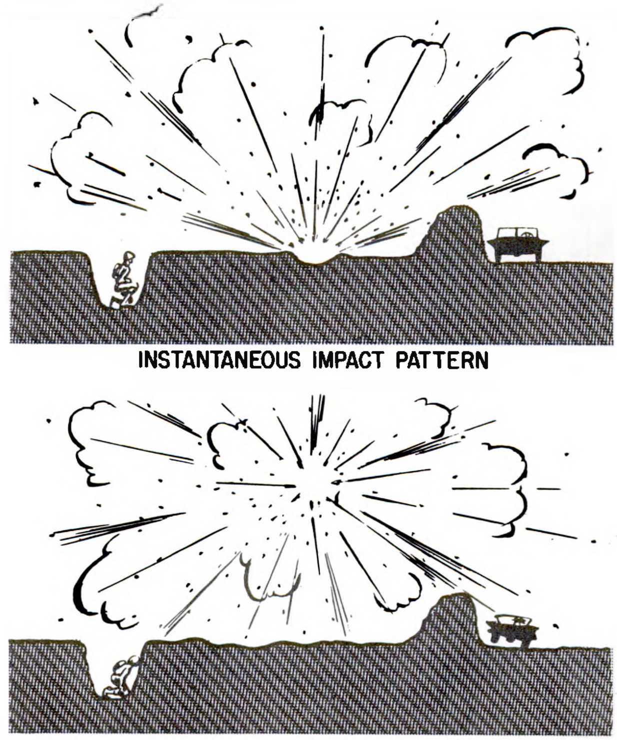


Figure 11-28.—Comparison, instantaneous and airburst.

With both types, the average functioning height over sea water is about twice as great as over average land, while the functioning height over arid land, snow, or ice is lower.

The ring type VT fuze generally has a plastic cone seated on the metal case of the upper fuze body. To this cone is attached the metal antenna ring and the 10-bladed metal arming vane which it surrounds. The arming vane is kept from rotating until armed release by a spring-loaded vane locking pin which may be positioned in any one of four holes spaced 90° apart in the antenna ring. Two wrench lugs are located 180° apart on the fuze body to permit the proper fuze wrench to be applied; unlike most fuzes, VT fuzes must be tightened with a wrench. A lockwasher is positioned between the bomb and the upper fuze body to insure a positive lock.

Ring type fuzes are most sensitive to passing targets, that is objects abreast of the fuze rather than ahead of it. For this reason, ring type fuzes are affected by the angles at which they approach the target, these angles depending

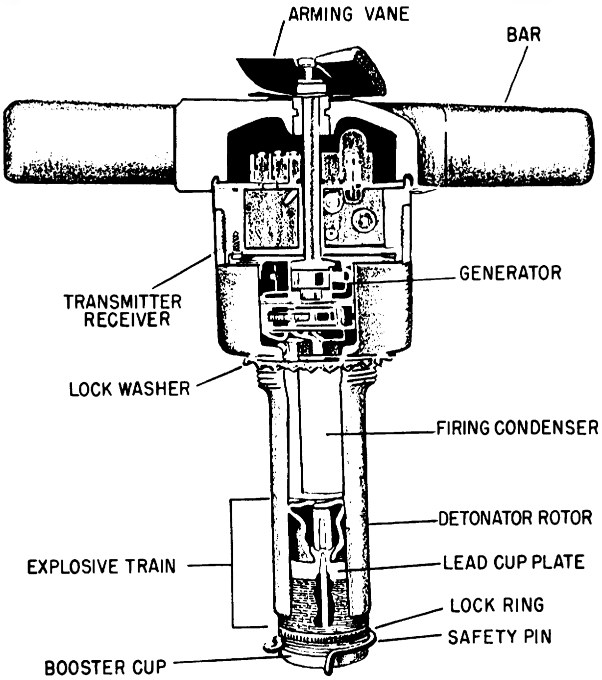


Figure 11-29.—VT Nose Fuze AN-M166E1 sectioned.

on the altitude, airspeed, and approach angle of launching aircraft when the bomb is released.

Bar type fuzes differ in appearance from the ring type in that the plastic nose portion is not conical and the antenna consists of two handle-like bars. The arming vane has three blades, is made of plastic, and is kept from rotating by a spring-loaded vane locking arm which is held in place by the arming wire. Bar type fuzes also require the use of two wrench lugs and lockwasher.

The sensitivity range of the bar type fuze extends ahead of it and the fuze is most strongly affected by a target directly in its path rather than to the side.

OPERATION.—The operation of both types is the same. On armed release, the arming wire is pulled out of the vane locking pin or arm, allowing the spring-loaded pin or arm to jump clear and free the vane. The vane begins to rotate in the airstream and through a gear reduction system turns the detonator rotor into the armed position so that firing the detonator will set off the booster. Movement of the rotor into the armed position also completes electrical connections between the detonator and the electronic firing head. The rotation of the arming vane drives a generator which supplies power to operate the firing head and charge the firing capacitor. Upon approach to the target, the radio signals sent out by the firing head are reflected by the target and are picked up by the firing head receiver, which, at the proper time, causes an electronic switch to close and fire the detonator.

The vane must turn a minimum of 1,000 revolutions to complete arming. Even after becoming fully armed the electrical firing circuit cannot function unless the arming vane is rotating at a speed equal to that which would be induced by an airspeed of 80 knots or more. Further, the detonator is not electrically connected to the firing circuit until the rotor is in the fully armed position. The detonator is alined into the armed position. In most models, a safety pin holds the arming assembly in the safe position until the pin is withdrawn when assembling the fuze to a bomb.

The safe air travel (SAT) is the distance a bomb must travel along its trajectory before the fuze can function. Due to manufacturers' tolerances and other factors, the SAT of supposedly identical fuzes may vary considerably. Because of this, each lot of fuzes is tested in the 100-Pound GP Bomb AN-M30A1 to determine the minimum SAT (MIN. SAT) of the entire lot. The MIN. SAT (the least air travel required to arm any fuze in the lot when used with the 100-pound GP bomb) is marked on each fuze. However, on larger bombs, the minimum air travel required for arming will be greater than the MIN. SAT marked on the fuze, by percentages ranging from 2 percent up to 58 percent, depending upon the size of the bomb. The MIN. SAT of most fuzes is either 2,000 or 3,600 feet and is set by the manufacturer.

ARMING DELAY, AIR TRAVEL, M1A1.—The arming delay, air travel ((A), (B), and (C) of fig. 11-30) is an accessory device which may be attached to the fuze to delay the start of the arming operation until a preset amount of air travel has been completed. The device is secured to the fuze so as to hold the vane locking pin (or arm) in place. It remains in place until the set amount of air travel is completed and then releases itself. When released, it is forced away from the fuze by the vane locking pin (or arm) spring which ejects the locking pin (or arm) spring thus ejecting the locking pin (or arm) so that the arming vane is free to turn.

The arming delay contains an air vane, a reduction gear train, a setting dial, and a latch for attaching the assembly to the antenna ring or

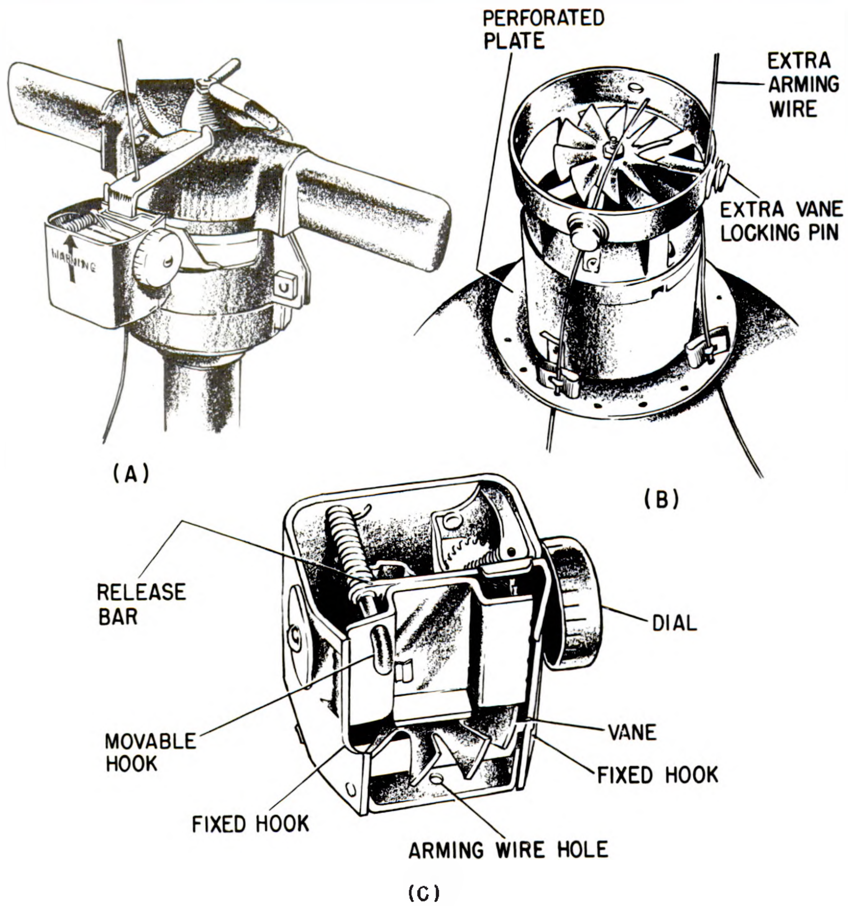


Figure 11-30.—(A) Arming Delay M1A1 installed on bar type fuze; (B) Arming Delay M1A1 installed on ring type fuze; (C) Arming Delay M1A1 detail.

strap bracket of the fuze. The latch consists of two fixed hooks and one movable hook. The movable hook is attached to a spring-actuated release bar which is held in the latched position by the flange of the setting dial. When the set air travel is completed, the setting dial returns to zero, where a notch in the flange releases the bar. The setting dial is mounted on one end of the geared shaft which is held engaged with the gear train by a spring.

SPECIAL PRECAUTIONS AND INSTRUCTIONS.—VT fuzes are shipped in sealed containers and should not be removed until just prior to use, since warm, humid weather in particular causes fairly rapid deterioration. The arming vane of each fuze is sealed at the factory so that it cannot rotate. This insures that the arming mechanism will remain in the safe position until the seal is removed. If the seal of any fuze is found to be broken when unpacked, the fuze should be handled with caution.

Both models of VT fuzes (ring type and bar type) discussed in this section are equipped with a safety pin, inserted into the arming mechanism through a groove in the booster cup. The pin prevents movement of the arming mechanism and must be removed prior to fuzing the bomb. If the fuze is later removed from the bomb and returned to storage, the safety pin must be reinserted. If the pin will not go into place, it is an indication that the arming components are no longer in the safe position and the fuze must be destroyed according to current instructions.

When installing ring type VT fuzes on bombs, an auxiliary safety device must be used. The auxiliary safety device (fig. 11-30 (B)) uses a perforated plate and three safety (Fahnestock) clips to increase the force necessary to withdraw the arming wire. Additional safety is provided by means of a second arming wire and vane locking pin.

When installing the bar type fuze, a second vane locking arm is installed. A Fahnestock clip is then placed on each wire, forward of (but adjacent to) the vane locking arm.

A complete discussion of the various VT fuzes used by the Navy including their physical characteristics and general safety precautions is given in VT Fuzes for Bombs and Fin-Stabilized Rockets, NavWeps OP 2219.

TAIL FUZES

AN-M100 Series Tail Fuzes

The AN-M100 series tail fuzes (fig. 11-31), which are used with bombs designed for the box-fin assemblies, consist of three different length fuzes: AN-M100A2, AN-M101A2, and AN-M102A2.

The overall length of the fuzes varies because of differences in the length of the arming-stem tube. These differences in length are necessary to properly locate the arming vane assembly in the airstream so that the same time fuze can be used with various size bombs. These fuzes are vane-operated and function on impact by an inertia type firing mechanism.

They are identical in every respect except length of the arming stem and arming-stem tube, and consequently in overall length and weight. When issued, the fuzes are equipped with a 0.025-second delay M14 primer detonator, which can be interchanged with other M14 primer detonators to give a selection of time delays.

Tail Fuze AN-M100A2 is used in 100-pound and 250-pound GP bombs and in 220-pound fragmentaton bombs. Tail Fuze AN-M101A2 is used in 500-pound GP, SAP, incendiary, and chemical bombs. Tail Fuze AN-M102A2 is used in 1,000-pound and 2,000-pound GP bombs and 1,000-pound SAP bombs. All three fuzes require air travel of 445 to 650 feet to arm. These fuzes are safe for landings and takeoffs anywhere, including the decks of carriers.

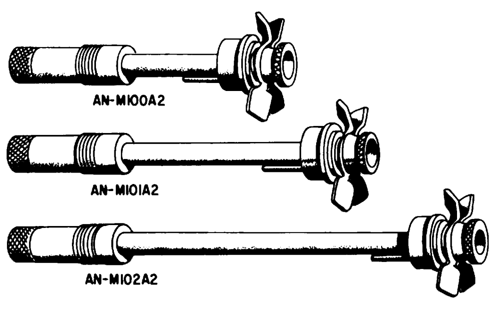


Figure 11-31.—AN-M100 series tail fuzes.

Mechanical operation of the following two sets (series) of fuzes are identical to the AN-M100 series tail fuzes but their usage differs as listed.

Tail Fuzes M172, AN-M184, and AN-M185 are used with conical-fin assemblies. Tail Fuzes AN-M185, AN-M194, and AN-M195 are used in low-drag bombs.

Fuzes M160, M161, and M162 are similar to the AN-M100A2 series except for the arming stem which has finer threads (28 single threads to the inch against 20 double threads in the AN-M100 series) and a longer engagement with the firing plunger (0.75 inch against 0.50 inch). The M160 therefore requires a longer arming time. The M160 series fuzes are distinguished from the AN-M100 group by a yellow band 3 inches wide painted around the arming-stem case.

Fuzes AN-M101A2C and AN-M102A2C were the first of the slower-arming tail fuzes. They have the sam number of threads per inch as the M160 series, but have the shorter engagemext of the AN-M100 series fuzes. The yellow band is painted on, as in the M160 series fuzes.

Fuzes AN-M175, M176, and AN-M177 are long-length fuzes developed for use with specific conical bomb fin assemblies. They are externally identical to the AN-M100A2 series tail fuze. The arming stem of the AN-M175 series, however, has finer threads than that of the AN-M100A2 series, increasing the air travel to arm.

NOTE: The above listed series of tail fuzes all use the interchangeable M14 primer detonator.

The mechanical operation of the various series of fuzes listed above is based on the AN-M100 series principle. Therefore, to eliminate duplication, the coverage in this text is limied to the operation of the parent AN-M100 series tail fuzes.

The principle of operation is as follows (fig. 11-32): When the bomb is released armed, the arming wire is withdrawn, allowing the airstream to turn the 4-bladed arming vane. The vane and bearing cup rotate together, and the pinion gear, meshed with both stationary and movable gears, moves around these gears. The stationary gear is kept from rotating by the carrier stop and has one less tooth than the movable gear, so that the pinion "walks" the movable gear around one tooth each time the pinion circles. Since the movable gear is secured to the arming stem, as the movable gear is walked around, it unscrews the arming stem from the firing plunger. Thirty rotations of the arming vane results in one rotation of the arming stem, and after 150 to 170 vane rotations, the arming stem is unscrewed from the firing plunger and the fuze is armed. The plunger is restrained from strikeing the primer by an anticreep spring, until impact of the bomb. The arming vane continues to rotate and after approximately 200 more revolutions the arming stem has unscrewed from the fuze body cap and the entire arming assembly (arming vane, gear mechanism, and arming stem) is carried away from the bomb by the airstream.

On impact of the bomb, the firing plunger is carried forward by inertia, overcoming the anticreep spring and striking the primer. The very slight lag due to the inertia of the firing plunger is the reason nondelay tail fuzes function slower than instantaneous nose fuzes, in which the force of impact drives the striker or firing pin directly into the detonator.

CAUTION: If the arming assembly is missing, the fuze is armed. If the arming assembly is in place, the fuze may still be armed; if the distance between the arming assembly eyelet and the arming-stem cup flange is less than one-half inch, the fuze is partially armed. If the distance is between one-half and three-fourths inch, arming is questionable and the fuze should be considered armed. If the distance is greater than three-fourths inch, or when the carrier stop pin protrudes below the vane cup less than 1 inch, the fuze is armed.

Primer detonator M14 used with these fuzes and primer detonator M16 used in other fuzes are not interchangeable. They may be distinguished by the knurling around the base, the M14 having one wide knurled band while the M16 has two narrow knurled bands. To change primer detonators, the one installed in the fuze is unscrewed by hand and the primer detonator to be installed is inspected, then screwed down in the fuze handtight.

Primer detonators have the delay time (or "nondelay") stamped on their bottom face and in addition use a color code on the bottom face to indicate delay. This color marking is as follows:

Nondelay—entire surface painted white.

0.01-second—30° segment of face painted black.

0.025-second—90° segment of face painted black.

0.10-second—entire surface painted black.

0.24-second—entire surface painted green.

Tail Fuzes M115, M116, and M117

These are arming vane type, delay arming, impact fuzes designed for low-level masthead or skip bombing. Primer detonators M16A1 are used, giving a delay of 8 to 11 seconds for use against shore targets, or 4 to 5 seconds for use against ship targets. This delay is to enable the releasing aircraft to clear the target before detonation. These fuzes can be used in 1,000-pound SAP bombs, and 100-pound to 2,000-pound GP bombs.

The M115, M116, and M117 are similar in external appearance to the AN-M100A2, AN-M101A2, and AN-M102A2 and have the same respective arming-stem tube lengths. They are carrier-safe, and have the same required air travel to arm as the AN-M100A2 series (450 to 650 feet).

The arming assembly (arming vane, gear mechanism, and arming stem) is identical to that used in the AN-M100A2 series fuze, and provides the same gear reduction. However, the firing mechanism is different.

The firing mechanism (fig. 11-33) consists of a firing pin and cocked firing pin spring, plunger, locking balls, anticreep spring, and retainer. The firing pin and spring are assembled inside the plunger with the firing pin spring in a compressed position behind the firing pin. They are held in this position by two locking balls in the plunger which are kept in place by the inside surface of the fuze body.

When the bomb is released armed, the arming stem unscrews from the plunger and fuze body cap in the same manner described for the AN-M100A2. The anticreep spring keeps the plunger assembly from moving forward until impact, when it is overcome by the inertia of the plunger. After moving a short distance forward, the locking balls pass a step on the inner surface of the fuze body and the balls jump out, thereby unlocking the firing pin. The compressed firing pin spring then drives the firing pin forward against the primer, which explodes and sets off the delay. After burning through, the delay sets off the relay which fires the detonator, the booster, and the bomb.

The fuze is supersensitive. The anticreep spring is just strong enough to balance the weight of the plunger assembly and only slight retardation of the bomb is necessary to initiate

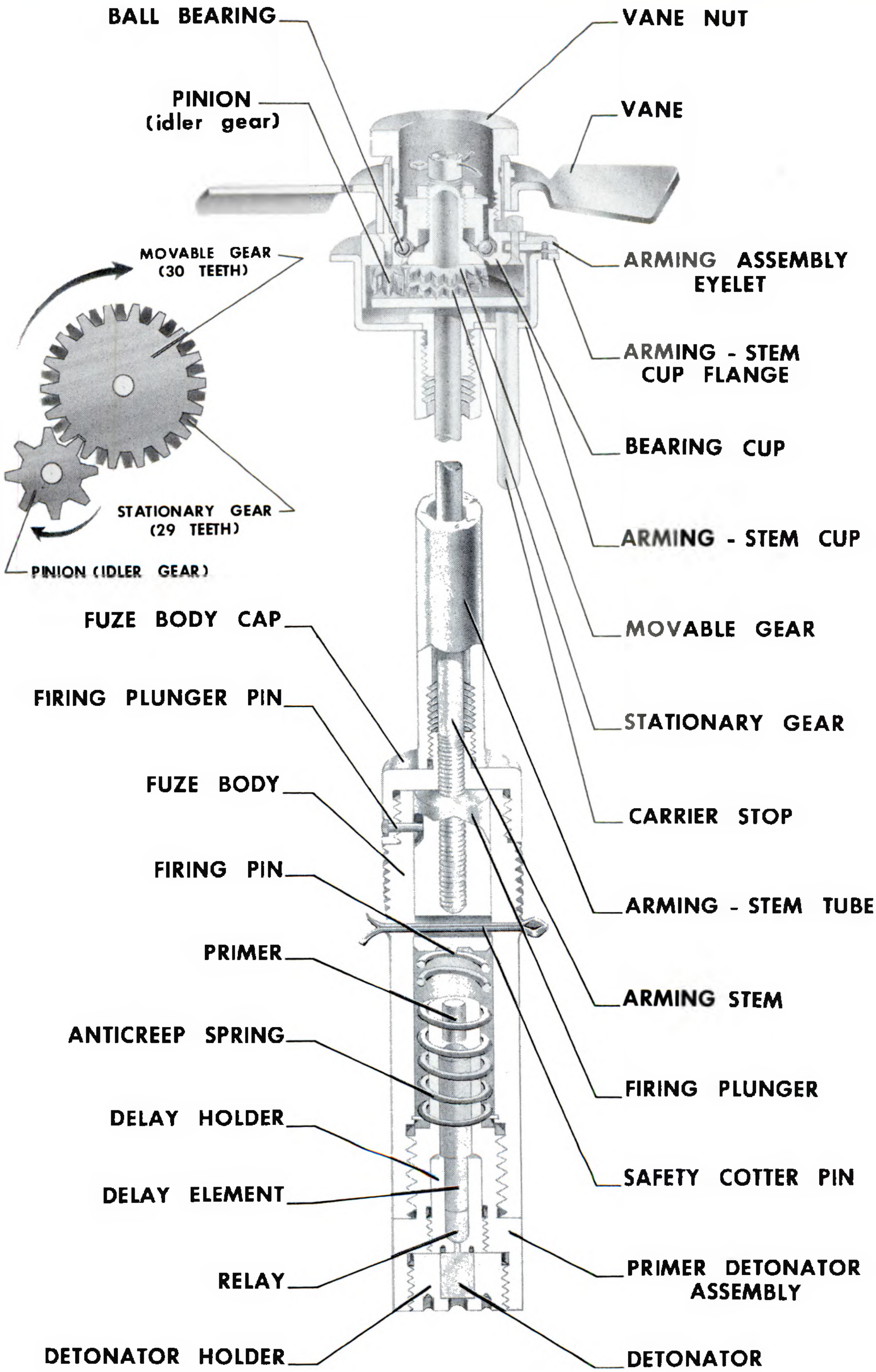


Figure 11-32.—Tail Fuze AN-M100A2 sectioned.

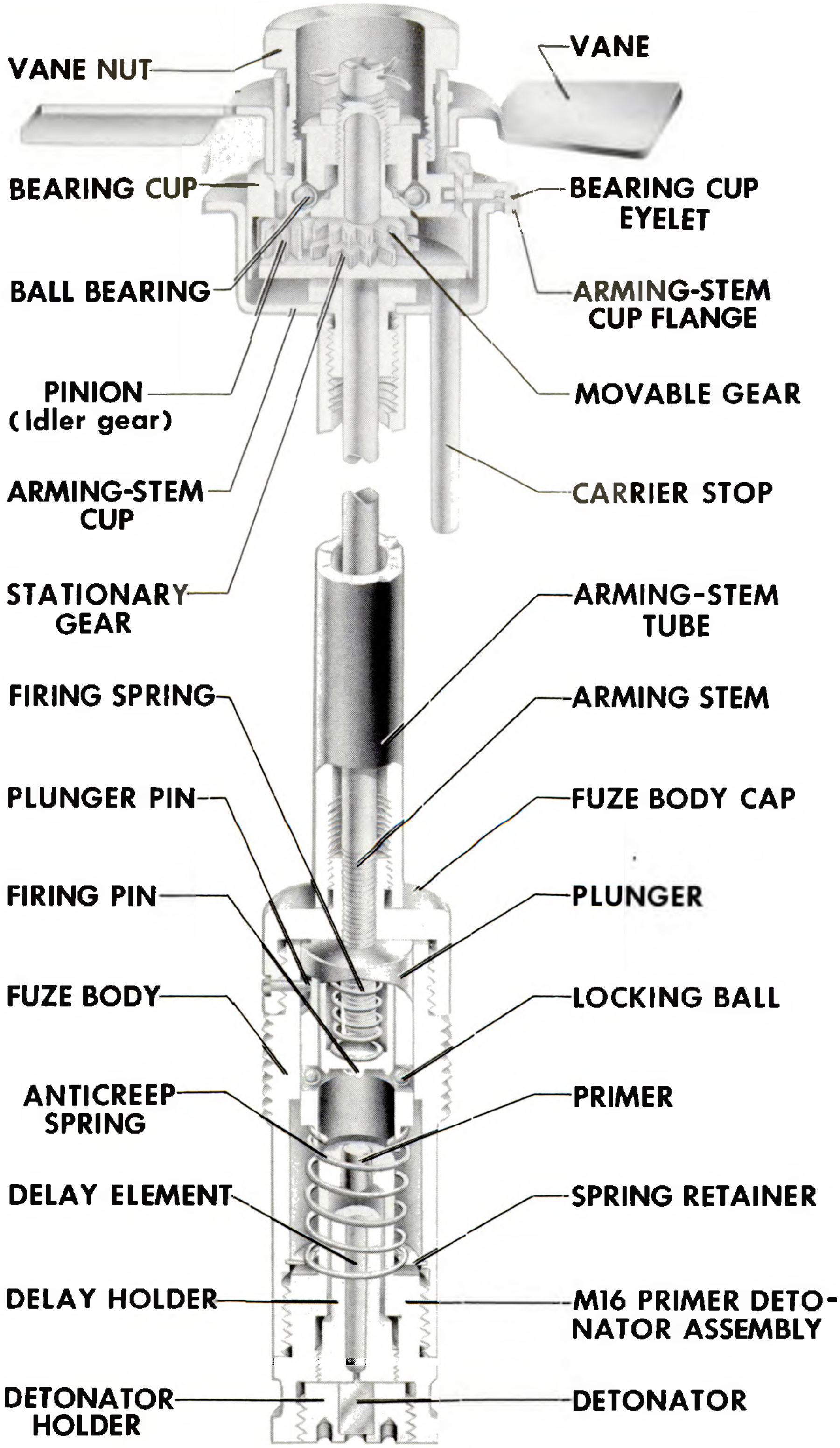


Figure 11-33.–Tail fuzes M115, M116, and M117.

fuze action. With the fuze armed, impact with water or any light structure will result in fuze action.

The delay time of the M16A1 primer detonator is stamped on the end, and primer detonators are installed in the same manner as M14 primer detonators are installed in AN-M100A2 series fuzes. Do not attempt to interchange M14 primer detonators with M16A1 primer detonators; the threads are different and damage will result. M16A1 primer detonators may be distinguished by the double knurled band around the base. As issued, the fuze has the 4- to 5-second delay primer detonator installed. External indications of arming of these fuzes are the same as those listed for the AN-M100A2 series.

NOTE: The M115 series is also the parent fuze for a series of long-dimensional fuzes (M181, M182, and M183) developed for use with the conical bomb fin assemblies.

Tail Fuzes M123A1, M124A1, and M125A1

These are vane operated, long delay, tail fuzes. They act to detonate the bomb after a delay of from 1 to 144 hours. Less than 100 feet of air travel is necessary to initiate this delay action. An antiwithdrawal feature, which will detonate the bomb instantaneously if an attempt is made to remove the fuze once it has been installed, is incorporated in the series. (See fig. 11-34.)

Fuze AN-M123A1 may be used in GP bombs up to 250 pounds. AN-M124A1 is used in 500-pound GP bombs. AN-M125A1 is used in 1,000-pound and larger GP and SAP bombs. The stem tube length is the only difference between fuzes of this series.

The fuzes should be used only in those bombs having adapter-booster and base filler plug locking devices. Otherwise an enemy could easily disarm a bomb by simply removing the base plug or the adapter-booster with the fuze still installed.

The delay times are determined by the strength of an alcohol-acetone solution which dissolves a celluloid collar. For the longer delays celluloid disks are added which must also be dissolved. These delays are installed by the manufacturer and may not be changed. Delays available are as follows: 1, 2, 6, 12, 24, 36, 72, and 144 hours. The nomenclature, model, delay, and other information is stamped on the fuze body below the threads, where it cannot be seen when installed. Any given delay time is decreased by high temperatures and increased by low temperatures.

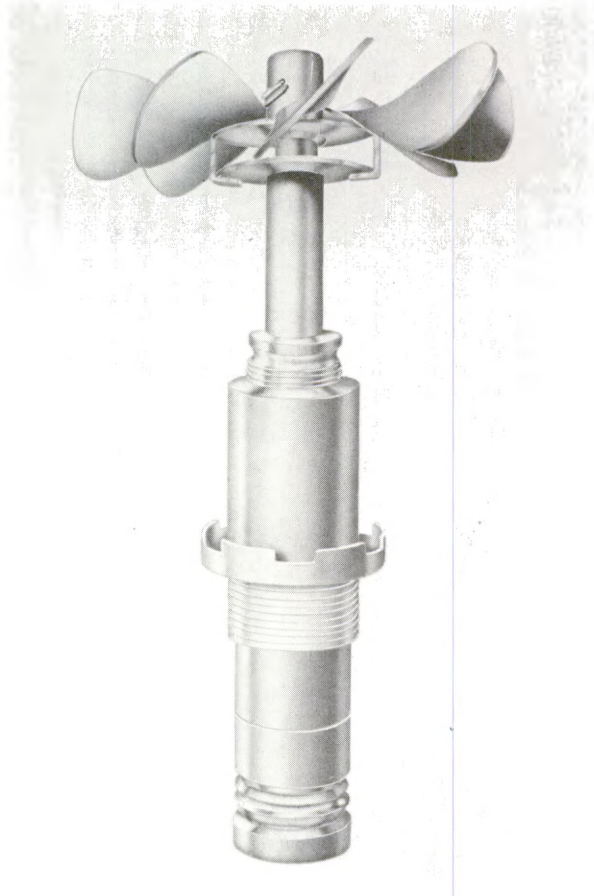


Figure 11-34.—Tail Fuze AN-M123A1.

The arming vane is attached directly to the arming stem, and the stem in these fuzes screws into the body during armed release. The body assembly consists of the fuze body and the fuze body extension. The fuze body contains the firing pin and sleeve assembly, a delay wad, and a glass ampoule filled with solvent. The fuze body extension contains the detonator holder screwed into the base, and a locking ball and groove (antiwithdrawal device) in the side.

The firing pin (fig. 11-35) is held in place against the action of a compressed firing pin spring by the firing pin balls, which in turn are held in place under the firing pin screw by

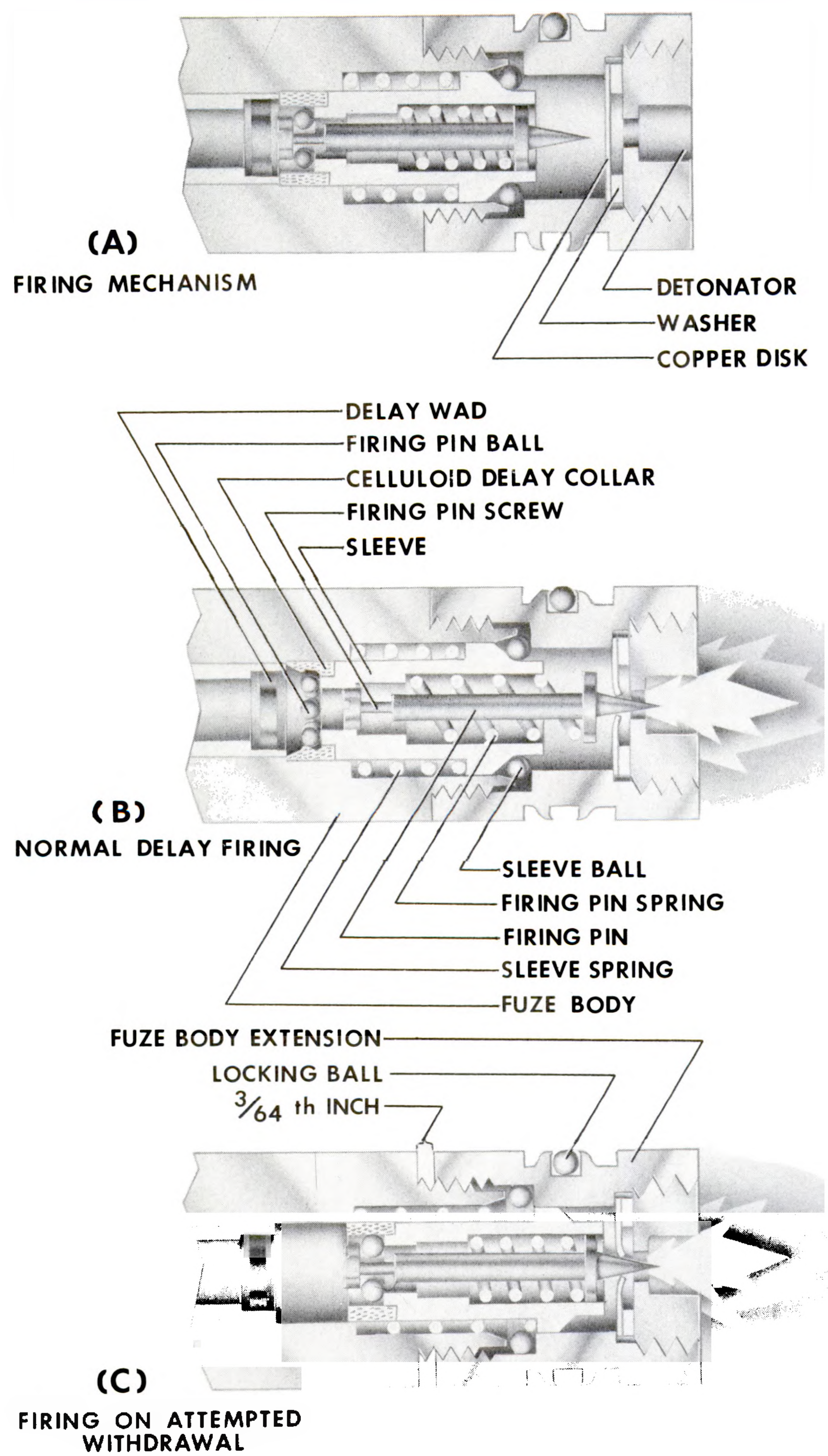


Figure 11-35.–Tail Fuze M123A1 cutaway view.

a celluloid collar. This assembly is mounted in a sleeve. The sleeve is held in place against the action of a compressed sleeve spring by a circle of balls bearing on a shoulder of the sleeve and held in position by the lip of the fuze body.

When the fuze is released armed, the arming vane rotates, turning the arming stem into the fuze body, breaking the glass ampoule, and seating a collar on the stem against a rubber washer, thus sealing the outer end of the fuze. The alcohol-acetone solvent from the ampoule filters through the delay wad and starts to dissolve the celluloid collar. The collar dissolves sufficiently to release the firing pin balls in approximately the specified time. When released, the balls are forced outward by the firing pin screw and the firing pin is driven against the detonator by the firing pin spring. When a delay of 24 to 144 hours is used, the solvent must first dissolve a celluloid disk before starting action on the celluloid collar.

Antiwithdrawal action is as follows: The ball groove on the body extension is shallow on one end and deep at the other, so that as the fuze is being installed in the bomb, the locking ball is in the deep section and clear of the adapter-booster wall. But once installed, if the fuze is turned counterclockwise (unscrewed), the ball is forced into the shallow end so that it jams between the body extension and adapter-booster, locking the body extension in place. Any further motion of the fuze in the direction of unscrewing will unscrew the body from the body extension, and when the two have separated three sixty-fourths of an inch—a quarter turn of the fuze body—the sleeve balls are released and moved outward. The sleeve, carrying the firing pin, is driven forward by the sleeve spring, causing the firing pin to strike the detonator and explode the bomb.

These fuzes should not be installed until just prior to takeoff. Check for leaks by looking into and smelling the detonator cavity; the solvent has a distinctive odor and may be easily detected. A copper disk and aluminum washer is then inserted into the detonator cavity; these items serve to seal the lower end of the fuze against solvent leakage. The primer detonator used in the fuze is shipped separately, and is then screwed tightly into the detonator cavity. Screw the fuze into the bomb, install arming vane, arming wire, and secure the locknut. The shipping clip must be removed from the locking ball prior to installation.

The following precautions should be observed:

1. These fuzes must be regarded as armed at all times. Any fuze which has been dropped more than 10 feet, or subjected to temperatures above 170°F, or which has had the vanes free to rotate must be considered armed and must be destroyed.

2. Follow instructions in the shipping box regarding use and disposition after exposure to high storage temperatures.

3. The natural tendency when engaging the threads of mating parts (as when installing a fuze) is to turn one part back and forth until the threads engage. Do not do this. Extreme caution must be used to assemble the fuze to the bomb with a screwing-in motion only. The antiwithdrawal device will detonate the fuze if it is rotated backward in the adapter even before the threads are engaged. Never, for any reason, attempt to remove the fuze from a bomb. It will detonate.

NOTE: Bombs fuzed with these fuzes cannot be released SAFE. Impact will cause the solvent ampoule to shatter and initiate the delay train, even when the arming wire is in place.

Tail Long-Delay Fuzes M132, M133, and M134

These vane-operated delay fuzes have a nominal fixed 10-minute delay which actually will vary from 6 to 80 minutes depending on temperature. The arming mechanism has a gear reduction system, but only 100 feet of air travel is required for arming. Fuzes M132, M133, and M134 may be used in the same bombs as Fuzes AN-M123A1, AN-M124A1, and AN-M125A1, respectively. (See fig. 11-36.)

These fuzes contain an antiwithdrawal device which is identical to that used in the AN-M123A1 series. The time delay mechanism is somewhat different as it has a metal bellow containing a red colored solvent. The solvent acts upon a celluloid cylinder to produce the delay action.

When shipped, the detonator holder is not installed, and the fuze cavity is plugged with a wad of absorbent cotton. If there has been a leakage of solvent, the red color will be plainly visible on the cotton when removed.

General installatin instructions already given for the AN-M123A1 series fuzes also apply to the M132 series. Unlike most fuzes the fuze is tightened in the bomb with a wrench.

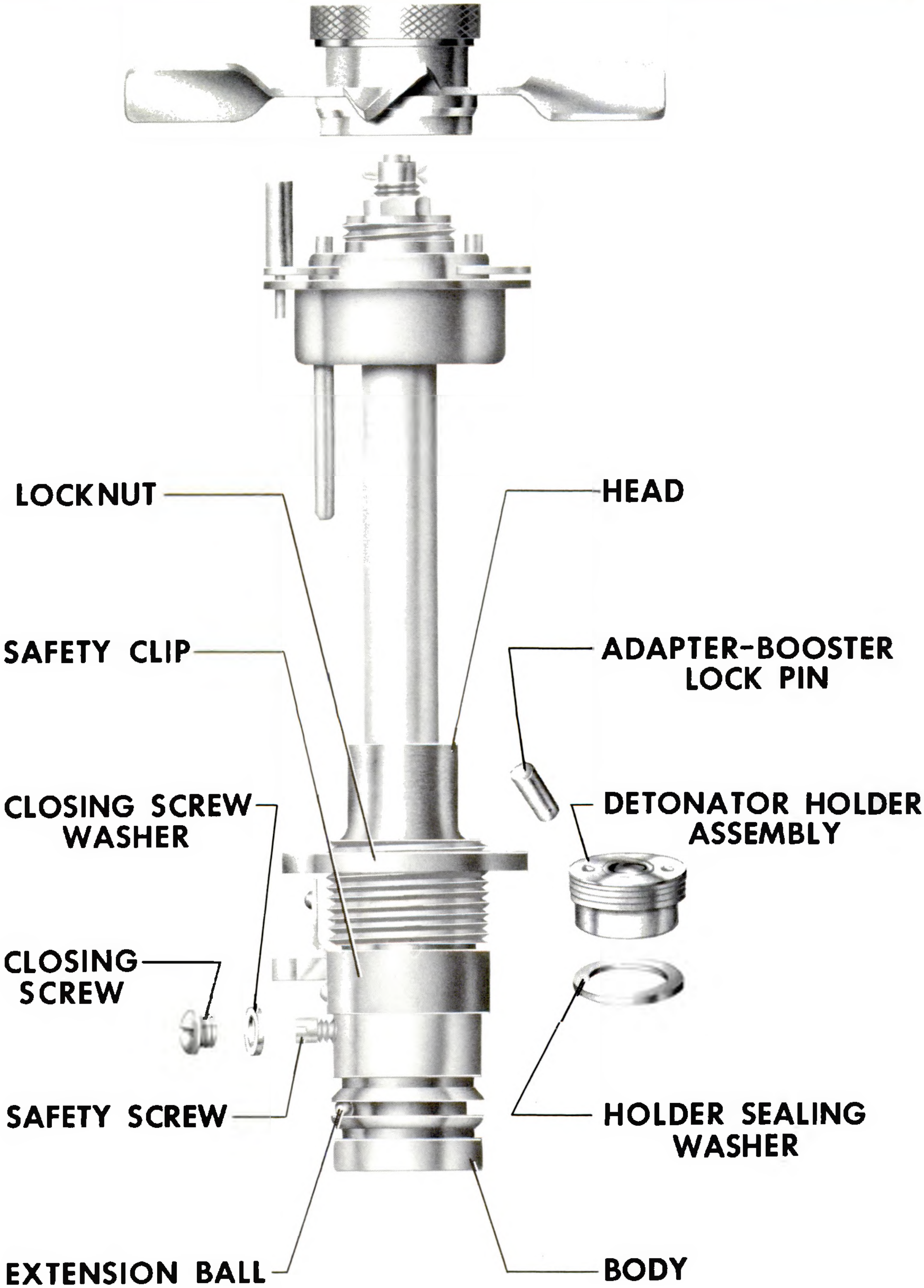


Figure 11-36.–Tail Long-Delay Fuze M132.

Special precautions previously noted for the AN-M123A1 series fuzes apply to the subject fuzes and must be followed. Bombs with these fuzes installed must never be returned to carriers or airfields. Once installed, no attempt must be made to remove the fuze from the bomb.

SIDE FUZES

Side fuzes are currently used by the Navy in fragmentation bombs. They are available in three types; namely, impact, time, and antidisturbance. Each type is discussed in detail in this section.

Side Fuze M129

The side fuze M129 was designed for the M83 fragmentation bomb and is armed by the "butterfly" wings of the bomb. It can be preset to detonate in the air or instantaneously upon impact.

Approximately 50 feet of air travel is required to arm the fuze. If set for an aerial burst, the fuze is detonated 2 1/2 seconds after arming. For ground burst, the delay train action is initiated after the fuze has completed 50 feet of air travel. Two and one-half seconds later, the delay train is halted and is not reactivated until impact occurs, which results in detonation.

The words air and ground (fig. 11-37) are embossed on the outside of the fuze cap and indicate the position of the setting plug. The setting is made at the time of manufacture, and only fuzes set for ground burst are supplied to the Navy. No attempt should be made by anyone, except authorized personnel, to change this setting, to remove the fuze from the bomb, or to perform any work on the fuze.

Side Fuze M130

The Mechanical Time, Side Fuze M130 was designed specifically for the M83 fragmentation bomb and is also armed by the "butterfly" wings of the bomb. Its time train is initiated after 50 feet of air travel has been completed. Detonation will occur 10, 20, 30, 40, 50, or 60 minutes after arming, depending upon the setting made at the time of manufacture.

The fuze is received installed in a bomb, eliminating a fuzing operation. Once assembled into the bomb, there is no method of differentiating between this fuze and the M131 antidisturbance fuze (fig. 11-37). Because the fuze time setting is made when the fuze is manufactured, no attempt should be made by anyone, except authorized personel, to perform any work on the fuze.

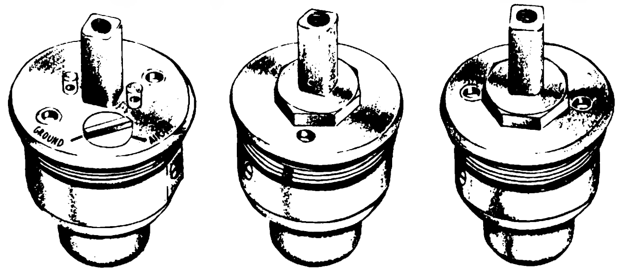


Figure 11-37.—Side Fuzes M129, M130, and M131.

Side Fuze M131

The M131 fuze is a mechanical antidisturbance side fuze and is similar in appearance to the M130 (fig. 11-37). It was also designed for and used only with the M83 fragmentation bomb. It is a time fuze also, and the time train is initiated after 50 feet of air travel has been completed. Detonation occurs after impact, and after a second shock initiates the sensitive antidisturbance mechanism.

CAUTION: When fully armed, this fuze is extremely sensitive and very dangerous. Only a slight vibration is needed to initiate the antidisturbance mechanism, and explode the bomb. Do not handle armed or questionably armed M131 fuzes; the fuze and bomb should be destroyed by authorized personnel. The fuze is installed in the bomb by the manufacturer and shipped as a complete unit.

MULTIPOSITION FUZES

A multiposition fuze is one that can function from any position in which it is installed. They are currently used by the Navy in fire bombs.

Multiposition Fuze AN-M173

This fuze is an inertia firing impact fuze which was designed principally for use in Fire Bombs Mk 77 Mod 0 and Mk 78 Mod 1. It must be installed in Igniter M23 which is used to ignite the fire bomb once the fuze is detonated. (See fig. 11-38.)

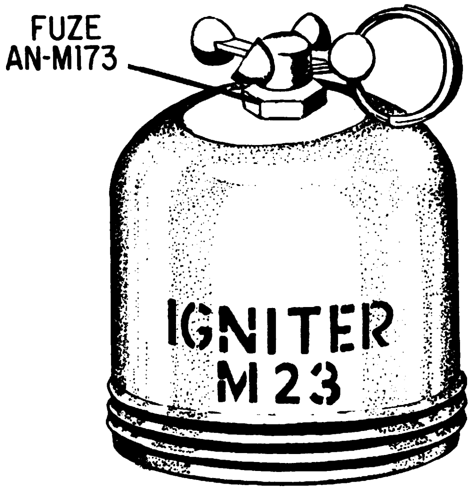


Figure 11-38.–Multiposition Fuze AN-M173 installed in Igniter M23.

The fuze is shipped and stowed sealed in a metal can. A safety cotter pin passes through two holes, drilled off center through the anemometer hub. This locks the anemometer vanes in place and prevents premature arming of the fuze. Attached to the safety cotter pin is a pull ring and instruction tag.

FUZING.–Prior to installing the fuze and igniter in a bomb, examine them for any obvious physical defects especially damaged threads, damaged anemometer vanes, or corrosion. Use only serviceable fuzes and igniters. Assemble the fuze and igniter as shown in figure 11-38.

To install the fuzed igniter in a bomb, unscrew the igniter adapters and screw the igniter into the nose and tail end plate castings. Next turn the igniter to aline the offcentered holes of the anemometer vane hubs, and insert the arming wires into the nose and tail fuzes. Attach two Fahnestock clips to the ends of each igniter arming wire and remove the safety pins from the fuzes.

CAUTION: Prior to removing the fuze from a bomb, insure that it is safe to handle. If the anemometer hub has separated from the fuze head by 1/8-inch or more, or if the anemometer vanes are completely removed from the fuze, the fuze is armed. If this condition exists, the bomb, igniter, and fuze must be disposed of by authorized personnel.

OPERATION.–When the bomb is dropped armed, the arming wire is retained in the bomb rack and withdrawn from the fuze. This frees the anemometer vanes which rotate in the airstream to arm the fuze.

After 18 revolutions (approximately 120 feet of air travel), the fuze will detonate when the force of impact is directed along its axis. After 34 revolutions of the anemometer vanes (approximately 220 feet of air travel), the fuze is fully armed so that impact forces from any direction will cause detonation ("all-ways" action). With an additional 15 revolutions, the anemometer vanes are released into the airstream.

Upon impact, the fuze detonates instantaneously to scatter the igniter filler and light the gasoline gel.

ARMING.–The anemometer vanes are directly connected to the arming screw by a pin. The arming screw is threaded into the fuze head. At the inner end of the arming screw is the thinner arming stem. The arming stem locks the firing plunger in place (fig. 11-39).

Next to the fuze head, within the fuze body, are the firing plunger and primer holder. The primer holder is a hollow cylindrical capsule with a round inward end and an open outward end. The primer is positioned in a seat at the inward end of the primer holder. The primer is always in line with the firing pin.

The locking balls prevent the firing plunger from being driven into the primer holder, and detonating the fuze (fig. 11-39). The locking balls extend from the firing plunger and bear against an internal shoulder of the primer holder. These locking balls are held outward, in their extended position, by the arming stem. The arming stem extends into the upper cavity of the firing plunger and seats between the two locking balls. The recess for the locking balls is beveled to prevent them from falling out.

As the anemometer vanes rotate and the arming screw separates from the fuze head, the arming stem is withdrawn from the firing plunger. When the arming stem is withdrawn sufficiently, so that it no longer holds the locking balls outward, the fuze is armed. When the anemometer vanes have completed approximately 50 revolutions, they are completely freed from the fuze head and released into the airstream.

Premature firing of the fuze is prevented by the anticreep spring. The anticreep spring holds the firing plunger away from the primer,

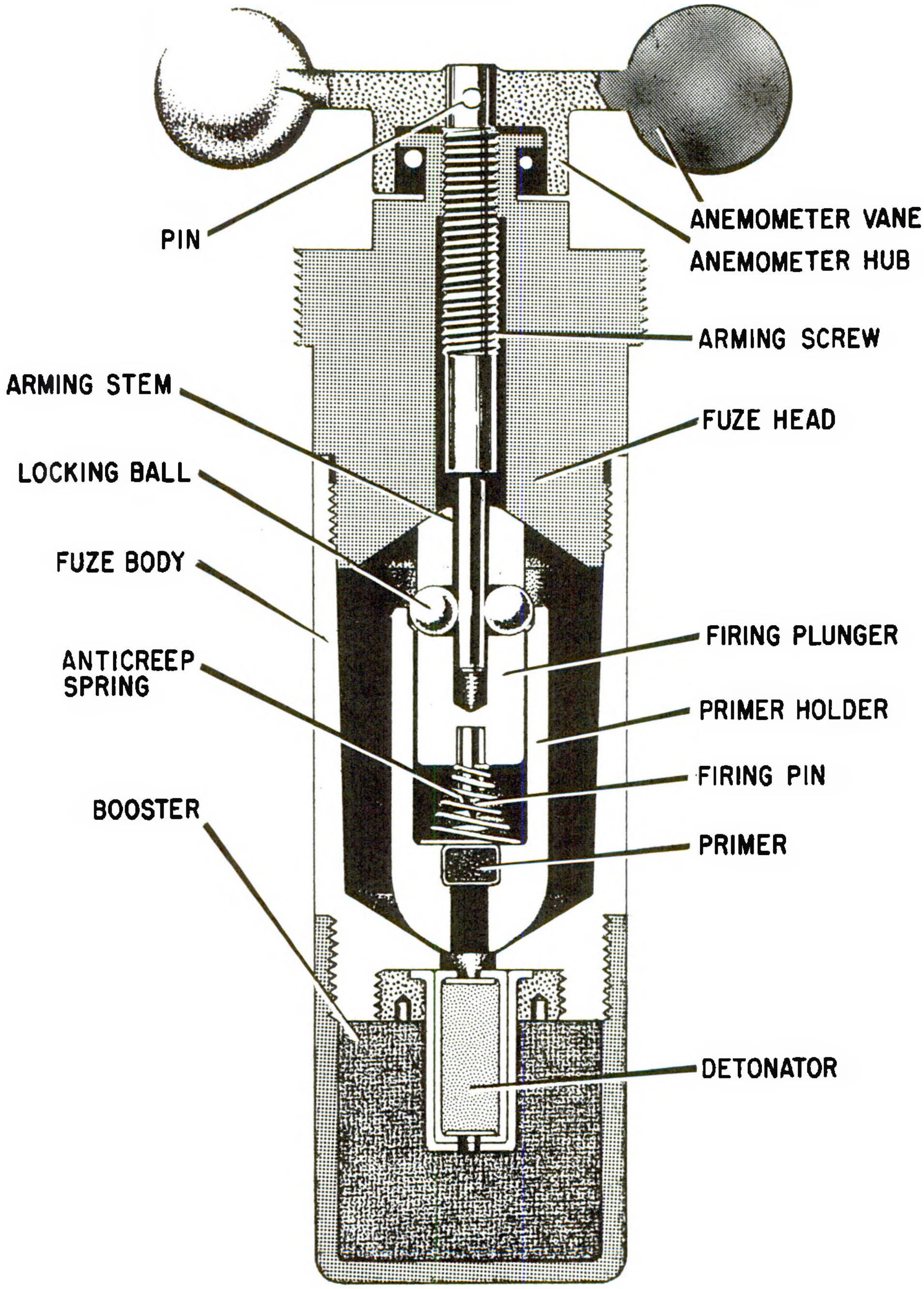


Figure 11-39. – Multiposition Fuze AN-M173 cutaway view.

after arming is completed. This spring is only strong enough to offset the weight of the firing plunger; additional weight or force will overcome the spring's strength.

ACTION. – The shock, produced by impact along the fuze axis, drives the firing plunger inward, forcing the locking balls into the firing plunger, and compressing the anticreep spring.

Shock, produced by impact along the sides of the fuze, causes the firing plunger and the primer holder to be forced together by the tapered end of the fuze head and the tapered inside surface of the fuze body. This forces the locking balls into the firing plunger and causes the firing plunger to compress the anticreep spring.

The flash from the primer is sufficiently strong so that regardless of the position at which the primer fires in the fuze body, the flame will ignite the detonator.

For complete coverage of all the various types and models of mechanical fuzes used by the Navy, refer to Aircraft Bombs, Fuzes, and Associated Components, NavWeps OP 2216, Volume 1.

ELECTRIC FUZES

The use of the mechanical fuzes discussed throughout this chapter is limited to aircraft of moderate speeds. The performance of arming wires and arming vanes of mechanical fuzes becomes erratic and unsafe at high speeds (over 425 knots). It has been demonstrated that the flutter induced in an external arming wire at high speeds can pull the wire from the fuze (allowing the fuze to arm), or it can break the wire from fatigue (causing a dud). The forces on vanes at high speeds are so great that they sometimes bend and sometimes wrap the arming wire around the fuze arming shaft. To overcome these disadvantages, an electric fuze has been developed.

The electric fuze has three important advantages over the presently used mechanical fuze:

1. It can replace several of the fuzes now required, because it provides a number of selectable arming and impact delays and it can be used in either the nose or tail position on any low-drag bomb.
2. The arming delays provided are fixed times regardless of aircraft speed, whereas the presently used mechanical fuzes become armed at dangerously close separation distances when released at high speed, because arming occurs after a fixed distance of air travel.
3. The arming and impact delays can be selected by the pilot up until the time of actual drop.

The electric bomb fuze remains safe until it is energized by the electrical charging system carried in the aircraft. Because of the interlocks provided in the release equipment, this charging can occur only after the bomb has been released from the rack or shackle and has commenced its separation from the aircraft, but while it still is connected electrically to the aircraft's bomb arming unit. At this time the fuze receives a d-c energizing charge together with the particular RF signals required for selection of the desired arming and impact times.

New low-drag GP bombs have been designed primarily for use with electric fuzes. A fuze well is provided in both the nose and tail of the bomb. An electric fuze may be installed in either or both wells. When a sensing element is used, (a sensing element contains no detonator or booster and must be used in conjunction with an electric fuze) it is installed in the nose well, and the electric fuze is mounted in the tail well.

A receptable well located at the top of the bomb (fig. 11-40) accommodates the electric charging cable plug which connects the fuzes with the launching aircraft's bomb arming unit. Two steel conduits lead from this receptable to the fuze wells. The electric cable assembly (fig. 11-41) is installed in the conduits and delivers the pulses from the charging cable to the fuze in the tail well and the fuze, or sensing element, in the nose well. By not sending a charging pulse to the fuzing system, the pilot can release the bomb safe.

Due to classification, electric fuzes are not discussed in detail in this text. The Aviation Weapons Officer is referred to Aircraft Bombs, Fuzes, and Associated Components, NavWeps OP 2216, Volume 2 (Confidential) for a complete coverage.

BOMB SAFETY PRECAUTIONS

The great hazard with bomb type ammunition is not so much from instability or deterioration of the explosives, but from the enormous destructive effect of the accidental detonation of one round followed by instantaneous detonation of all rounds nearby.

Bombs must be handled with extreme care and must not be subjected to rough treatment in any handling operation. Thin-case bombs,

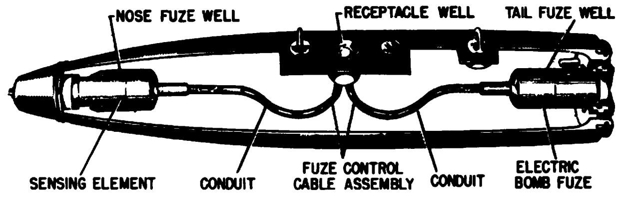


Figure 11-40. –Typical fuzes low-drag bomb.

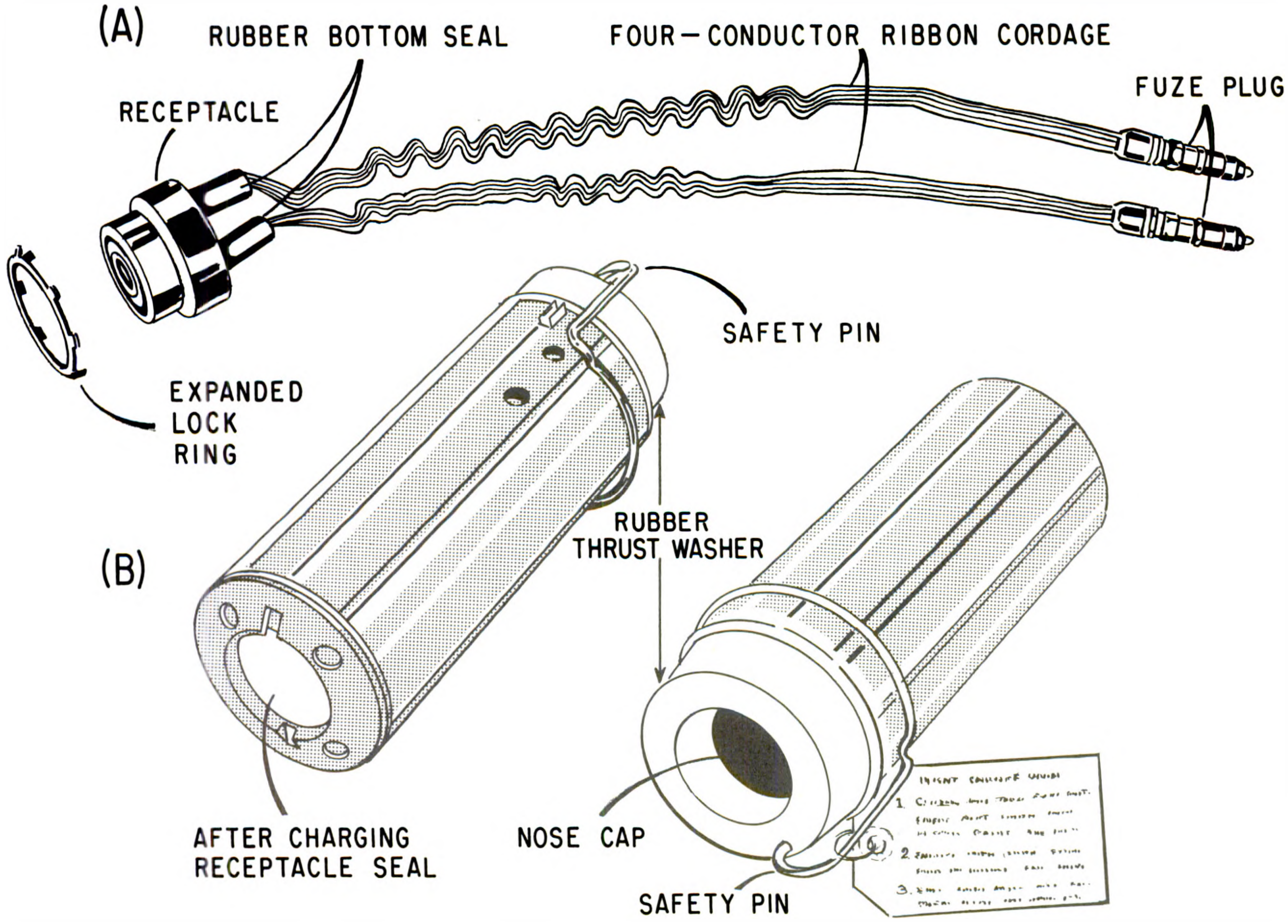


Figure 11-41.—Typical cable assembly and electric fuze.

such as depth bombs, must be handled carefully to avoid dents in the casing.

Live loaded bombs must never be used to check the functioning of bomb racks, shackles, or other release mechanisms.

Bomb type ammunition must be stored separately from other ammunition; and where possible, each type, such as torpedo warheads, depth bombs, mines and bombs, should be stored separately.

Ammunitions filled with TNT should be frequently inspected for exudation and, if exudate is present, it must be removed immediately by means of the authorized solvents.

Bombs should be stored in the metal crates or shipping bands in which they are shipped. Particular care must be taken that bombs do not become rusty or corroded; and if they do, the affected parts must be carefully cleaned and painted.

Practice and drill bombs must not be stored in the same magazine with explosive bombs.

Before installing fuzes in bombs, the fuse cavity threads must be carefully inspected and wiped clean. Where pellet-type auxiliary boosters are required, a check should be made that boosters are installed in the correct number.

During assembly of bombs, all bolts must be used on bombs having bolt-on tail fins. When a fin locknut is used, it must be securely tightened.

Bomb clusters are more likely to be damaged by rough handling than individual bombs. They must be handled with more than ordinary care when they contain fuzed bombs. Chemical bombs filled with poisonous gas are extremely dangerous to handle and special stowage and shipping procedures apply to all toxic-loaded bombs. Handling or disassembly should not be attempted except by authorized and competent personnel who are adequately protected by gas masks and special clothing and equipment where necessary.

Practice bombs with signals installed are also extremely dangerous. In this condition these bombs are always armed and, if dropped, there is a good possibility of explosion. The resulting smoke and flame can burn personnel or damage aircraft, and in some cases the bomb body is shattered, resulting in serious injury. When installing the signals in the bombs, the signal must not be forced in place, and the loaders must not place their heads in line with the nose or tail of the bomb.

Arming wires must be free from kinks, burrs, dirt, and corrosion. They must be installed correctly in order to function properly on sale or armed drops and safety (Fahnestock) clips must be used in the correct number.

FUZE SAFETY PRECAUTIONS

Fuzes contain a charge of high explosive and, therefore, must be handled carefully. In addition to the precautions noted throughout this course, the following must also be observed.

Fuzes are packed in sealed, moisture-proof containers. They should not be unsealed until required for use. Fuzes unpacked and not used should be returned to their original condition and repacked. The containers should be resealed with adhesive tape, and these fuzes should be used prior to those that are still hermetically sealed.

Fuzes should be protected against excessive heat. Fuzes must be handled carefully at all times. Boxes should be carried or wheeled. They must not be dropped, tumbled, dragged, or thrown. They should not be struck with a hammer or similar tool, either to open the box or to aline it in a stowage stack.

Fuzes should not be packed or unpacked in a magazine. When the fuze is unpacked, it should be examined to insure that the shipping seals are intact, the safety blocks or arming pin are in place, and that the arming stem is not unscrewed. Safety cotter pins, shipping wires and seals should be left in place until the arming wire is assembled to the fuze. Arming vane assemblies should not be bent or distorted.

Only those primer detonators that are authorized for the particular fuze should be used. Fuzes damaged to such an extent that they appear unfit for use should be disposed of by authorized personnel.

CAUTION: Fuzes are not stowed with other types of explosives. Normally, mechanical fuzes will not be used with aircraft capable of speeds in excess of approximately 425 knots.

CHAPTER 12

AIRBORNE UNDERWATER ORDNANCE AND NUCLEAR WEAPONS

Underwater ordnance is by no means a recent application of naval warfare; in fact, various types of mines and torpedoes were used in the late 1800's. Numerous changes in design and aerial delivery techniques have kept mines and torpedoes current lethal weapons. In recent years, nuclear weapons have been added to the airborne underwater ordnance array. The use of nuclear weapons in airborne ordnance has extended the role of these weapons in antisubmarine warfare, destroying enemy shipping, naval blockades, and other major roles.

AVIATION WEAPONS OFFICER'S RESPONSIBILITIES

The scope of the Aviation Weapons Officer's responsibilities pertaining to torpedoes, is limited normally to the process of transporting the torpedoes from the supply point to the carrying aircraft, mounting the torpedoes on the aircraft, and making the final required connections.

Torpedoes are assembled and checked in the torpedo shop, where all final adjustments are made by qualified torpedomen. They are then designated as "fully ready torpedoes." However, final preparation for firing is required which includes the following:

1. Attaching the torpedo to the aircraft's releasing gear.
2. Securing the air stabilizer static line.
3. Inserting the proper arming wires.
4. Performing a final visual inspection.

The Aviation Weapons Officer's responsibilities for aerial mines are the same as with aerial torpedoes. (NOTE: Qualified minemen are responsible for assembly, testing, and stowage of aerial mines.) Coordination between the aviation ordnance shop and the torpedo/mine shop is necessary to insure a smooth transition of weapons from one division to another, thereby maintain an uninterrupted chain to meet the planned operation.

The Aviation Weapons Officer's responsibility in regard to nuclear weapons (both above surface and underwater types) is a major one. It behooves the Aviation Weapons Officer to fully understand all phases associated with the use of these weapons and to insure that ordnance personnel perform the following:

1. All checklists are dutifully followed in proper sequence.
2. All pertinent safety precautions are rigidly observed.
3. All classified publications are properly safeguarded.

AERIAL TORPEDOES

The aircraft torpedo, self-steered and self-propelled, remains a lethal weapon for use against submarines and combatant vessels of all classes. Carrying a varying payload up to several hundred pounds of explosives, the torpedo has a speed usually in excess of that of a fast warship, and a range over 2 nautical miles.

The aircraft torpedo was widely used during World War II and influenced tactics considerably in a large number of naval engagements. Early use of this type of torpedo in the Pacific produced a low percentage of hits. However, improved squadron tactics and improvements in the torpedo itself made this device highly effective as the war progressed. By the end of the war, damage inflicted an enemy shipping by aerial torpedoes was second only to that inflicted by submarines.

EFFECTIVENESS

During the war, the effectiveness of torpedoes, in comparison with bombs and rockets, varied with the situation. Torpedo attacks on damaged vessels are more likely to be effective than attacks upon targets attempting evasive action. Even in shallow water, ships are vulnerable to torpedo attack when specialized launching techniques are used.

The aircraft torpedo, in addition to its uses against submarines and shipping, has been used with good results against piers, docks, dams, and hydroelectric powerplants.

DEVELOPMENT

Robert Fulton developed a weapon, and adopted the name "torpedo" (from a fish emitting an electric ray capable of producing a numbing shock). The original idea was for the explosive charges to be attached to the bottoms of ships by stealth. For many years thereafter, the word torpedo was applied to any explosive charge designed to be set off under enemy ships. Later, static charges became known as "mines" while torpedo came to mean the self-propelled steel explosive "fish."

Robert Whitehead, a Scottish engineer, developed the first practical automotive, self-propelled torpedo in the 1860's. This torpedo was so successful, and so far surpassed its competitors, that it was soon adopted by all the navies of the world. It contained two essential elements: a compact compressed-air engine to propel the craft, and a hydrostatic valve mechanism controlling horizontal rudders that kept the torpedo running at a constant depth. The early torpedoes traveled only in the direction aimed since they were without guiding gyroscopes. Later on they were equipped with gyroscopes which could be preset.

Whitehead's 6-knot machine with a range of a few hundred yards was greatly improved by subsequent inventors. Speeds in excess of 40 knots and ranges of several miles were possible with these improved torpedoes. During World War I, the torpedo became a major weapon.

During that war, the Germans, at one time, had reduced Britian to 3 weeks' food supply by their devastating use of the torpedo against ships in Britian's supply line, and would have starved her out except for the advent of American destroyers and newly made depth charges. In World War II, the Germans developed another innovation in the torpedo. Instead of a unit driven by steam or compressed air, a direct-current electric motor was used. The efficiency of this motor was better than 96 percent, and the usual tell-tale bubble-wake of the escaping gases was nonexistent.

The next significant development in torpedoes was the aerial torpedo. Experiments in dropping torpedoes from aircraft were performed as early as 1910, and some use was made of aircraft torpedoes in World War I. Following this war, the United States Navy led the world in torpedo aircraft development for many years, developing special torpedoes and special aircraft—first seaplanes; then carrier torpedo aircraft, and currently antisubmarine aircraft and helicopters.

New methods, techniques, and torpedoes have been developed which are classified and are not discussed in this text. However, publications on these developments are available to the Aviation Weapons Officer and may be obtained by consulting the applicable NavWeps Ordnance Pamphlet.

PROBLEMS IN TORPEDO DESIGN

The current problems of aircraft torpedo design parallel, in general, the design problems of waterborne types. The following are some of the factors with which research is concerned:

1. Reduction of the weight per unit of energy of the energy sources.
2. Reduction of the weight per unit of power of the prime mover.
3. Decrease in noise output of the torpedo during its run.
4. Increase of effectiveness of explosive.
5. Increase in speed and range.
6. Improved control systems, a problem which assumes greater magnitude with every increase of speed.
7. Improvement of hydrodynamic and aerodynamic stability, along with increases of strength to withstand water impact, and improvement in water-entry characteristics.
8. Development of exploders and target-seeking devices that will not be susceptible to countermeasures.
9. Improved countermeasures against all exploders and target-seeking devices.

AIRCRAFT TORPEDOES IN SERVICE USE

Numerous versions of the Aircraft Torpedoes Mk 43 Mods 1 and 3 and Mk 44 Mods 0 and 1 are presently being used in operational units. Aircraft-launched torpedoes are delicate, precision type mechanisms which require care in handling. There are several types of aircraft-launched torpedoes currently in service use. Although they vary in size, weight, and performance capabilities, they have several characteristics in common.

They are all of the acoustic type (either active, passive, or both); they were designed as antisubmarine weapons; and they are powered by a self-contained propulsion system.

Due to classification and the limited scope of responsibilities the Aviation Weapons Officer has pertaining to aircraft torpedoes, they are not discussed extensively in this text. However, nonclassified information on aircraft torpedo accessories is listed in tables 12-1, 12-2, and 12-3, and discussed thereafter. In table 12-1, the reader is reminded that the classified NavWeps OP's pertaining to current torpedoes are listed therein for handy reference. Weight characteristics of these torpeodes are included in table 12-1. Tables 12-2 and 12-3 show the accessories which are used with each weapon for launching from fixed-wing aircraft and helicopters.

When readied for operation, the aircraft-launched torpedo is equipped with suspension and stabilization accessories prior to being suspended on the aircraft.

When the torpedo has been secured to the aircraft bomb rack (fig. 12-1), final attachments of arming wires, release wires, and static lines are made between the aircraft, the arming devices, and the torpedo components. These torpedo components are the starting mechanisms, primary batteries, the exploder, the suspension bands, and the air stabilizer.

STABILIZERS

Aircraft-launched torpedoes use air stabilizers of the parachute type for stabilization and deceleration to accurately and safely control the torpedoes throughout the air trajectory and water entry. (See fig. 12-2.)

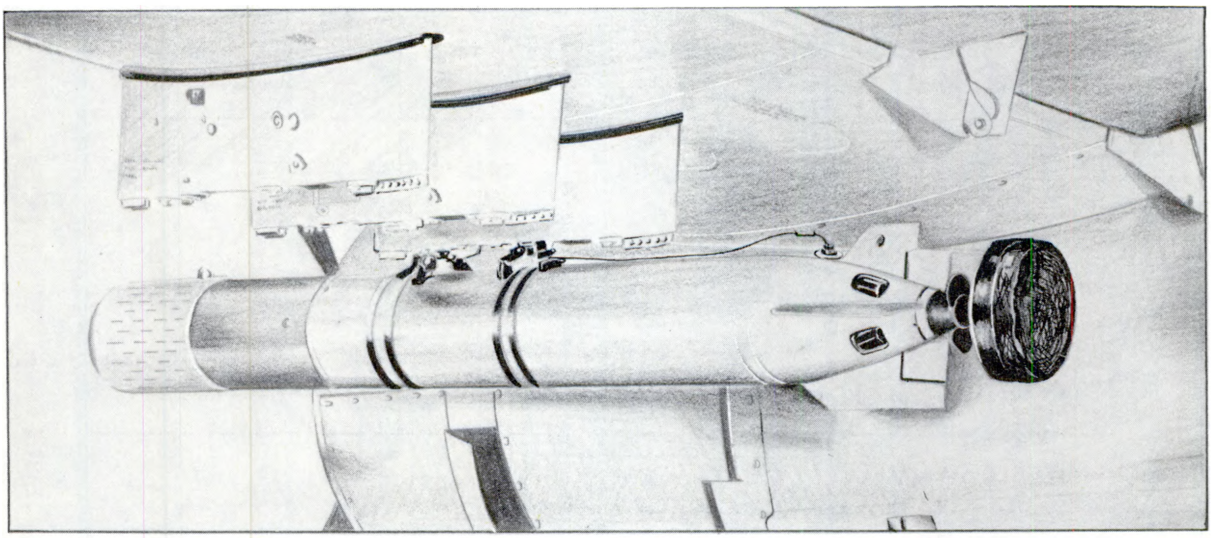


Figure 12-1.—Torpedo Mk 43 Mod 1 installed on the S-2D aircraft.

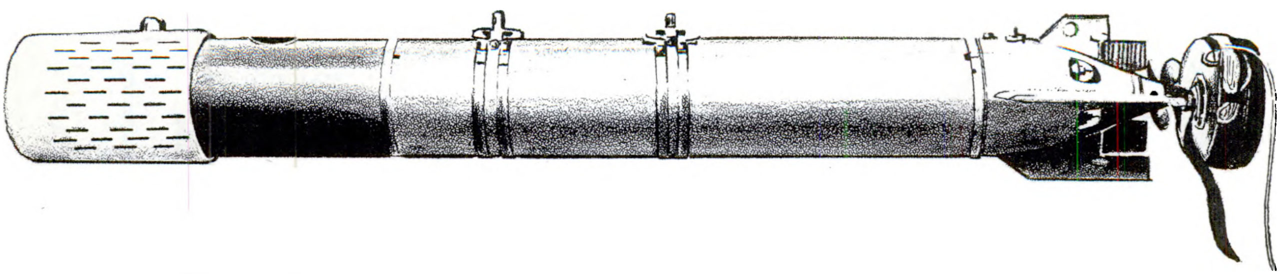


Figure 12-2.—Torpedo Mk 43 Mod 1 with air stabilizer, suspension bands, and drag ring installed.

Table 12-1. —Aircraft torpedo characteristics.

Weapon Mk-Mod	OP	Length (in.)	Diameter (in.)	Weight (lb.)	
				War	Exercise
43-1	2504	91.5	10.00	256	224
	2506				
43-3	2438	91.8	10.00	260	230
44-0	2435	100.0	12.75	425	414
44-1	2890	101.3	12.75	435	435

Table 12-2. —Torpedo accessories (launching from aircraft).

Torpedo Mk-Mod	Air stabilizer Mk-Mod	Drag ring Mk-Mod	Suspension bands Mk-Mod
43-1	*24-2	3-1	59-0
	24-1	3-1	59-0
	24-0	3-1	59-0
44-0, 1	24-2	None	64-2
	24-1	None	64-2
	26-0	None	64-2

*Alternate

Table 12-3. —Torpedo accessories (launching from helicopters).

Torpedo Mk-Mod	Air stabilizer Mk-Mod	Drag ring Mk-Mod	Suspension bands Mk-Mod
43-1	24-0, 24-1, 24-2	3-1	59-0
43-3	None	3-1	59-0
44-0, 1	24-1, 24-2, 26-0	None	64-2

Air stabilizers are attached externally to the torpedo shaft by a release mechanism. They are not required during underwater operation of the torpedo and must be separated from the torpedo by a release mechanism at water entry.

SUSPENSION BANDS

Suspension bands are used to suspend aircraft-launched torpedoes from the bomb racks or shackles of torpedo-carrying aircraft. The bands wrap around the body of the torpedo and are secured to the torpedo by means of tension bolts or screws. Suspension bands are used in pairs and are available in different sizes to fit the various diameters of aircraft-launched torpedoes.

After the suspension bands have been installed on the torpedo, the torpedo is loaded and secured internally or externally aboard the aircraft by engaging the suspension band lugs in the bomb rack hooks or shackle hooks (fig. 12-3) of the aircraft. To launch the torpedo, the bomb rack/shackle hooks are released either electrically or mechanically. When the torpedo drops, the suspension bands break away, and the torpedo enters the water clean.

The suspension bands that the Aviation Weapons Officer will probably encounter in the fleet are the Mk 59 Mod 0 (fig. 12-4), which has an approximate capacity of 250 pounds, and the Mk 64 Mods 0 and 1 (fig. 12-3). The Mk 64 Mods 0, 1, and 2 can carry torpedoes weighing approximately 430 pounds.

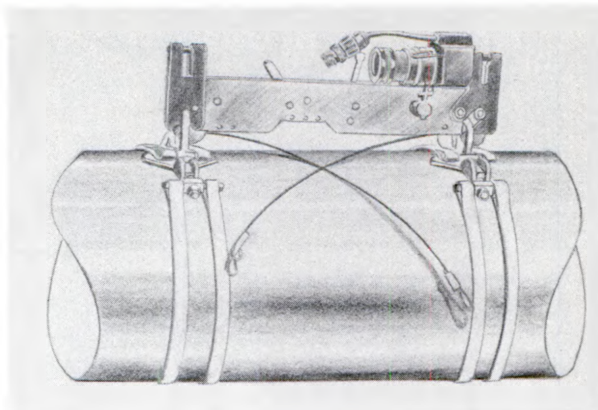


Figure 12-3.—A Mk 8 shackle attached to Mk 64 Mod 1 suspension bands.

DRAG RINGS

Drag rings (fig. 12-2) are used on the nose of air-launched torpedoes to improve torpedo water-entry directional stability and resistance to water-entry impact forces. A drag ring lessens the tendency of a torpedo to skip or broach upon water entry. It also absorbs the shock of impact on the nose area of the torpedo at water entry protecting the intricate mechanism of the torpedo. The ring separates from the torpedo by shattering into pieces shortly after entry into the water.

NOSE CAPS

A nose cap includes the features of a drag ring and in addition streamlines the torpedo nose during high-speed external air flight. At the present time, nose caps of varying design are under evaluation by the Naval Aircraft Torpedo Unit. However, none have been approved at present for use by the Bureau of Naval Weapons.

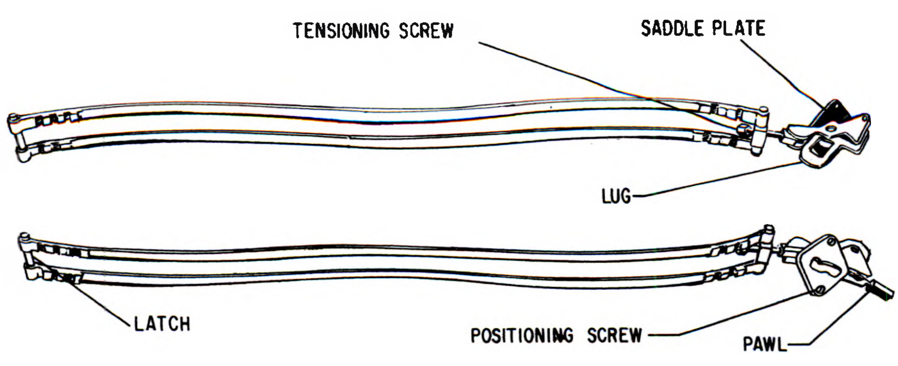


Figure 12-4.—Suspension Bands Mk 59 Mod 0.

If more information is desired concerning aircraft torpedo accessories and other pertinent data, refer to NavWeps OP 1207, U.S. Navy Aircraft Torpedoes, Accessories and Trajectory Data.

HANDLING AND LOADING PROCEDURES

The handling of torpedoes is similar to the handling of other types of ammunition containing high explosives and therefore is covered in chapter 17 of this text. However, loading procedures are presented to familiarize the reader with a typical situation. A Mk 44 type torpedo has been selected to be covered in a step-by-step method.

The war shot torpedo should have the exploder installed, the propeller guard removed, and the initial search depth and floor depth preset into the torpedo.

External Installation

To install the Torpedo Mk 44 Mods 0 and 1 on an external station, proceed as follows:

1. Check to see that the safety pin is installed in the salt water scoop lanyard pin.
2. Hoist the torpedo and attach it to the bomb rack.
3. Adjust the sway braces so that the torpedo is centered and free of excessive sway or side motion.
4. If the bomb rack Aero 14 series is used, attach the loop end of the release wire from the forward suspension band to the aft sway brace arm. The loop end of the release wire from the aft suspension band is attached to the forward sway brace arm.
5. If the bomb rack Aero 15 series is used, attach the loop end of the release wire from the forward suspension band to the aft sway brace screw directly above the sway brace pad; attach the loop end of the release wire from the aft suspension band to the forward sway brace screw directly above the sway brace pad.
6. Attach the arming wire (Mk 1 or 2) to the exploder arming wire on the torpedo and to the aircraft nose-arming solenoid. The exploder arming wire can be extracted from any direction in azimuth and down to 60 degrees from the vertical.
7. Attach the arming wire to the salt water scoop pin on the torpedo and to a fixed point on the aircraft.
8. Attach the air stabilizer static line to a shackle or other point of attachment on the aircraft or on the aft end of the bomb rack. Leave no slack between the air stabilizer and the attaching point on the aircraft. Cut off and discard excess static lines.

Bomb Bay Installation

To install the Torpedo Mk 44 Mods 0 and 1 in a bomb bay, proceed as follows:

1. For P-2 type aircraft bomb bay installation, install the bomb shackle (fig. 12-3) to the suspension band on the torpedo and position the release wires. Hoist the torpedo to the selected bomb station. Attach the loop ends of the release wires to the Bomb Shackle Mk 8 (fig. 12-3) suspension pins.
2. Install the torpedo in the desired bomb station and remove the hoisting cable.
3. Install the torpedo arming wires to the respective arming solenoids.
4. Attach the air stabilizer static line to the lanyard attaching station directly to the rear of the torpedo or bomb station attachment point. For upper bomb bay station static line attachments, retain sufficient slack (24 in.) under the elastic holders of the air stabilizer pack to prevent deployment of the parachute prior to bomb bay exit. Sew excess slack under elastic holders with three loops of 8-pound thread. For lower bomb bay station installations or for aircraft bomb bays having no upper station, leave no slack between the air stabilizer and attaching point on the aircraft.

SAFETY PRECAUTIONS

In most cases the safety precautions that apply to bombs also apply to torpedoes. However, additional precautions should be observed.

To assure successful airdrops and to prevent possible damage to the aircraft, the following general precautions must be observed:

1. Replace torpedo mechanical starting lanyards after each mission as repeated use could result in fatigue failure of the spring clip.
2. Replace suspension bands after catapult takeoff and arrestment landing.
3. Apply a protective covering of a heavy-duty tape to the underwing skin surface of the aircraft where the lanyards and static lines

trail and bear against the wing after the weapon has been released.

4. Tighten sway braces only enough to control excessive sway. Overtightening them will cause an overload on bomb racks and suspension bands.

5. Make a preflight inspection of aircraft accessories (bomb racks, firing, and arming circuits), assembled accessories on the torpedo, and of the torpedo installation in the aircraft.

6. Remove bomb rack or shackle safety pin prior to flight.

AIRCRAFT MINES

One of the first military applications of gunpowder was its use in setting off a stationary charge under the enemy before he realized he was in danger. This could be accomplished by secretly digging beneath an enemy position and planting the charge, or by planting the charge where he was expected to go. The term mine was applied to the charges because the technique was similar to that used in metallurgical mining.

Mines became really important in the Russo-Japanese War of 1904-05 when both sides used them liberally. The Russians not only pioneered in the development of the contact mine but specialized in minelaying as their principal naval technique. Mines were widely used in World War I, particularly in the defense of Great Britian.

During World War II, aerial minelaying became one of the major offensive operations in the Pacific, and almost every type of bombing aircraft was used. Mines were used to block enemy harbors and sink enemy ships; defensive mines were laid to prevent enemy infiltration of harbors and sea lanes. In the course of the war, 25,000 mines of all types were laid by the United States, of which 85 percent were aircraft mines. These aircraft mines sank 650,000 tons of shipping and damaged another 1,400,000 tons; the total tonnage sunk and damaged represents one quarter of the prewar strength of the Japanese merchant marine. It may be readily seen why minelaying is one of the principal missions of naval aviation.

CLASSIFICATION

Mines are classified according to the method of planting, the method of actuation, and their position in the water after planting. Since this chapter is concerned only with mines that are laid by aircraft, the discussion is limited to the latter two classifications.

Position in Water

The three types of aircraft mines, according to the position they assume in the water, are bottom, moored, and drifting.

Naval bottom mines (formerly called ground mines) have negative buoyancy and come to rest on the ocean floor, thereby preventing the mine from being swept by the usual mine sweeping equipment. Because of this position, the operational depth of bottom mines is restricted by the actuation range of the firing mechanism and the effective radius of the explosive charge. In general, if bottom mines are planted in depths exceeding 30 fathoms, they are not efficient against surface craft. Since this type mine usually lies a greater distance from the target than a moored mine, larger explosive charges are used.

Moored mines have buoyant mine cases that are held at a predetermined depth beneath the surface of the water by a wire or chain mooring. They are usually moored some distance below the surface, shallow enough to be detonated by a passing ship but deep enough to render visual detection difficult. An anchor, which rests on the ocean floor, is attached to the mooring.

Drifting mines have an overall buoyancy of approximately zero, and they are adjusted to float unanchored on or just below the surface of the water. A special type of drifting mine is the oscillating mine. It rides at a predetermined depth beneath the surface, according to the adjustment of the buoyancy chamber and a preset hydrostatic mechanism. The nature of the mechanism is such that the mine rises and falls gently as it seeks its point of balance.

Actuation Methods

The firing mechanisms, or actuation methods, in mines may be divided into three groups—contact, influence, and controlled. Contact types require that the ship actually come in contact with the mine or a float connected to it in order to detonate the charge. This type is not currently used in aircraft mines. Influence-operated firing mechanisms operate when subjected to appropriate influence by the presence of a ship near the mine. Controlled firing mechanisms are controlled electrically from a distant point, usually a control station ashore, from which an observer exercises selective firing control of each mine or group of mines. The firing control exercised in a controlled mine field permits safe passage of friendly vessels. Since controlled mines require connecting cables, it should be obvious that they are not suitable for laying by aircraft. Control mines are used for harbor defense.

Influence-Operated Mechanisms

Since influence-operated mechanisms are the only type currently used in aircraft mines, they are discussed in detail. Influence firing mechanisms may be subdivided into three general categories—acoustic, pressure, and magnetic.

ACOUSTIC TYPE.—The acoustic mine is operated by an enclosed microphone which picks up the sound waves generated by the rotating screws or other machinery of nearby ships. An anticountermine device prevents detonation caused by the shock of explosions set off in attempts to sweep acoustic mines.

PRESSURE TYPE.—The pressure mine firing mechanism is actuated by a decrease in the pressure of the water surrounding it, ordinarily caused only by a large ship passing over it. The pressure-type firing mechanism is used in conjunction with a magnetic-influence mechanism, and this combination makes minesweeping almost impossible.

MAGNETIC TYPE. — Magnetic-influence mines are of the dip-needle or induction type and are operated by the changes in the earth's magnetic field caused by the passage of a vessel. The needle type is best for use against slow ships, while the induction type is best for use against fast ships.

The dip-needle mechanism is operated by a change in the vertical magnetic field at the mine. A change in the field causes a horizontally pivoted magnetic needle to turn. If the change is sufficient, the needle will close a pair of electrical contacts in the firing circuit. This type of mechanism can be used in either ground or moored mines.

The induction mechanism, like the dip-needle type, is operated by a change in the magnetic field. It differs in that its actuation depends primarily upon the rate at which the field changes rather than an amount of change. A change in the magnetic field causes an emf to be induced in the winding of a coil. This emf and the resulting current are proportional to the rate of change of the magnetic field; and when it is sufficient, a relay is actuated which closes the firing circuit. This type mechanism is used in ground mines.

MINE ACCESSORIES

Some mines laid from aircraft employ parachutes to prevent excessive terminal velocities. The parachute reduces the impact velocity and protects the mine components from damage resulting if the mine were allowed to fall freely and strike the water. A mine parachute is issued in a pack consisting of a plastic and canvas housing into which the parachute is packed in a way that assures its opening properly when it is pulled from the pack. A short, lightweight cord, known as a static line, is attached to the chute. When the mine is loaded in the aircraft for planting, the static line is secured to the aircraft so that it will open the pack and pull out the chute as the mine falls away. A release mechanism, which operates by impact paddle or inertia weight on impact with the water, allows the parachute to separate from the mine, once it has been planted. This prevents the mine from being dragged about by currents or being exploded prematurely by motion.

With the proper parachute, any mine can be dropped from unlimited altitudes. The size of a parachute for a given mine is a matter of design compromise. The aim is to have it so large that, without too much restriction on aircraft speed, the mine will not be damaged by the drop but, on the other hand, it must not be so large as to permit too great a "drift" while the mine is falling from high altitudes. However, mines must not be dropped from altitudes too low to allow parachutes to open and to slow the descent of the mine to a predetermined velocity. Also, aircraft speed at the instant of drop must be compatible with altitude; that is, at all altitudes there are certain aircraft speeds which must not be exceeded at the instant of drop, but these speeds increase with altitude.

Air dryers are used in mines to absorb moisture that might cause corrosion and electrical leakage. Various methods of delayed arming and sterilizing are possible in aircraft-laid mines. The choice depends on availability of the various delay and sterilizer devices which are incorporated in the mine, and upon operational requirements. Two wells house the safety features and other accessories which prevent the mine from exploding until it has been submerged for some time. Figure 12-5 shows the location of the accessories in a typical mine. The accessories and their locations differ for different types of mines.

MINE SAFETY FEATURES

Principal mine safety features are:
1. The clock delay.
2. The clock starters.
3. The extender mechanisms.

The clock delay mechanism prevents firing until after the mine has been submerged for a predetermined period of time after planting. (Another clock, motor-wound, is also used sometimes to sterilize the mine after a selected period of armed life.) A switch in the detonator circuit of the mine, which controls the firing mechanism, remains open until the clock delay device has run its predetermined time—from 8 minutes to 10 days, depending on the type of clock.

A hydrostatically operated device, known as the clock starter, starts the clock delay mechanism when subjected to sufficient pressure. Some hydrostatic clock starters need only one pressure impulse, others will stop the clock should pressure be removed before the clock has run its predetermined time. The clock starter, however, cannot operate until a safety piece has been removed, nor thereafter until enough hydrostatic pressure is applied by the surrounding water. In some mechanisms the safety piece is a soluble washer or plug, and in others a pin or wire which must be pulled clear.

The extender mechanism is a pressure-operated device which holds the detonator away from the booster until subjected to pressure (as by submergence), when it moves the detonator close to the booster so that its firing will explode the booster and hence the main charge. A wooden washer, an arming cell (electrolytic delay), safety cotter pins, or arming wires are used to lock the extender safe—that is, with the detonator away from the booster until time for planting.

If the wooden washer is used, it is replaced, when the mine is prepared for planting, by a soluble washer which prevents the extender mechanism from operating until it has been submerged long enough for the washer to be dissolved. Upon the removal of hydrostatic or mechanical operating pressure from the extenders, they will retract from the armed position. The same type of soluble washer may be used interchangeably in some clock starters

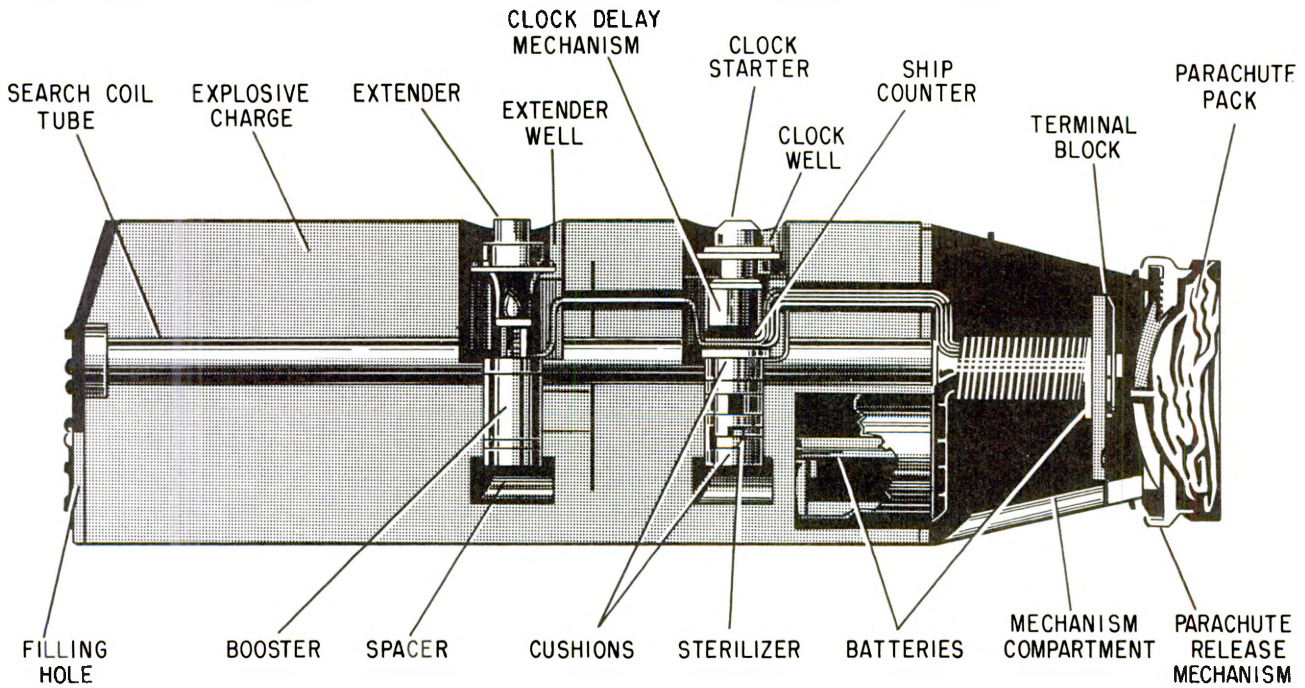


Figure 12-5.—Cutaway view of a typical aircraft mine and accessories.

and extenders. These washers are made with varying delay periods (for example 10, 15, and 45 minutes; 3, and 4 hours; and 1, 2, and 3 days) as indicated by the color and size of the washer. The rate of solubility of the washer varies with water temperatures, causing some variation in the delay.

Arming cells in some mechanisms replace soluble washers. The arming cell, an electrolytic device, is believed to be somewhat more reliable than a soluble washer, but is also affected by depth and water temperature.

Another delay device often employed in aircraft mines is called the ship counter. This mechanism requires a predetermined number of ships to actuate the mine firing circuit before the mine actually explodes.

The choice of the proper combination of safety features—that is, soluble washers, arming cells, and/or arming wires—as well as the choice of delay arming time, sterilizing time, sensitivity settings, and shipcounter settings to be used, depends upon planting conditions and is directed by the officer in charge of mining operations.

PLANTING

There are advantages and disadvantages in aircraft minelaying. One of the most important advantages is that aircraft can drop mines into enemy-controlled harbors and rivers inaccessible to surface vessels and submarines. Most aircraft mining is carried out at night, particularly when the sky is heavily overcast, and drops are controlled visually or by radar from very low altitudes. Night planting, of course, prevents accurate spotting by the enemy observers. Daylight operation has the advantage of increased accuracy in laying, but normally would be observed immediately, thereby simplifying enemy defensive and sweeping operations.

The efficacy of aerial minelaying depends largely on accurate navigation. The charting of course and desired point of release for each aircraft is worked out in advance of flight. The routes to the point of release, the altitude, and the approach should be chosen to avoid enemy interference, to take advantage of weather conditions, and to avoid detection. In all cases, current mine-planting restrictions as to aircraft altitude and speed at the point of drop, applying to the particular type of mine, should be observed.

The trajectory of a mine differs from that of a bomb. Because of its parachute, a mine falls more slowly and has less range and more trail than a bomb. When a mine is dropped from high altitudes where wind velocities are great, its drift must be taken into account in arriving at the dropping position.

Range and drift of a mine from the point of release may be found from tables listed in the pertinent NavWeps OP's. With this information, the expected point of impact for a given point of release of the mine may be determined.

The maximum altitude which a parachute mine may be planted is limited only by the planting accuracy desired. However, some nonparachute mines planted from high altitudes may be damaged on impact with the water. The minimum recommended planting altitude is 200 feet for all aircraft mines equipped with parachutes. This minimum altitude is governed by the altitude required to insure opening of the parachute and to insure the proper water-entry angle for the mine.

Maximum launching speeds at high altitudes are set to prevent ripping and tearing of parachutes upon launching. Minimum spacing between planting of mines must also be observed to reduce the possibility of the mine's being detonated or made a dud by the explosion of an adjacent mine in the field. Spacing depends on the mine used and the operational requirements.

The useful range of planting depth, which is determined by the effectiveness of the charge, is from 30 to 120 feet, on any type of bottom. However, a mine may be effective against surface craft at depths as great as 180 feet, and may be used against submarines at depths of 500 feet. The maximum effective depth for mines is governed by the crushing strength of the mine case, at which point the firing mechanism becomes inoperative. A minimum depth of about 30 feet of water is required, since mines planted in shallow water may sustain case damage because of impact with the bottom.

The effective depth against surface vessels is generally determined by the sensitivity of the firing mechanism in the mines. The minimum arming depth for current mines is about 16 feet, because the water pressure existing at this depth is required to extend the detonator into the booster and to operate the clock starter.

SERVICE AIRCRAFT MINES

The following brief descriptions of current service aircraft mines are general in nature. Complete descriptions and instructions may be found in the Ordnance Pamphlet or other publication dealing with the mine in question.

Aircraft Mine Mk 25 Mods 0, 1, and 2

Mines Mk 25 Mods 0, 1, and 2 are large parachute-equipped ground mines. They are alike in external appearance, differing mainly in types of firing mechanisms and total weights, and all contain 1,200 pounds of HBX-1. Overall length, including parachute pack, is approximately 87 inches and the diameter is 22 1/2 inches. The case is cylindrical with a tapered tail section. Half the nose is flat while the other half slants aft. A 6-foot parachute is contained in a pack at the tail. Mk 25 Mod 0 mine uses a magnetic-influence induction type firing mechanism and weighs 1,920 pounds. Mk 25 Mod 1 uses an acoustic influence firing mechanism and weighs 1,870 pounds. Mk 25 Mod 2 uses both magnetic induction and pressure type firing mechanisms and weighs 1,930 pounds. All three of the above may or may not have the cylindrical outline of the nose filled out with a thin metal fairing which is torn off when the mine strikes the water.

Aircraft Mine Mk 36 Mods 1, 2, and 3

Mines Mk 36 Mods 1, 2, and 3 have replaced the Mk 26 Mod 1. Mines Mk 36 Mods 1, 2, and 3 are alike in external appearance and differ mainly in firing mechanisms used and total weights. They are approximately 71 inches long and 18 1/2 inches in diameter, cylindrical in shape with a tapered tail section and a half-straight, half-slanted nose. Like the Mk 25 mines, the cylindrical outline of the nose is filled out with a thin metal fairing that is torn off when the mine strikes the water. All three modifications use a 6-foot parachute attached to the tail.

Mk 36 Mod 1 has a magnetic-induction firing mechanism, is loaded with 600 pounds of HBX-1, and weighs 1,040 pounds. Mk 36 Mod 2 has an acoustic influence firing mechanism, weighs 1,020 pounds, and is loaded with 600 pounds of HBX-1. Mk 36 Mod 3 has both magnetic-induction and pressure-type firing mechanisms, weighs 1,065 pounds, and is loaded with 600 pounds of HBX-1.

Aircraft Mine Mk 39 Mod 0

Mine Mk 39 Mod 0 is a large ground mine using a magnetic-induction firing mechanism. It does not have a parachute, but is fin stabilized. The total weight is 1,990 pounds and it is filled with 925 pounds of HBX-1. This mine has an asymmetrical steel flatnose which is covered with a steel fairing. The tail fins are made of steel, and the case is strong enough to withstand water impact despite the lack of a parachute.

Mine Mk 50 Mod 0

This is a 500-pound, aircraft, parachute retarded, underwater bottom mine containing high explosive. The mine has two safety devices, Extender Mk 16 and Hydrostatic Switch Mk 22, for keeping it safe during handling and aircraft loading. The arming wires which are installed in these devices can be rotated 360 degrees for maintaining a direct line between the mine and the aircraft solenoid.

Mines Mk 52 Mods 0 Through 6

This is a family of underwater mines which have a common mine case and are all similar in external appearance. These mines are all parachute retarded, weigh nominally 1,100 pounds, and contain high explosive. The arming device requires a double arming wire to hold the mine safe during handling and loading aboard the aircraft. This arming wire, at the arming device, may be rotated 360 degrees for maintaining a direct line between the mine and the aircraft solenoid. The arming wire in the delayed opening parachute pack must be led up over the parachute pack and direct to the solenoid. Withdrawal of the arming wire from the parachute pack will cause the pack to open with considerable force. Therefore, the arming wire should not be withdrawn except by trained personnel.

Mine Mk 53

This is an aircraft laid, moored mine sweep obstructor designed to sever sweep wires by explosion upon contact of the sweep wire with the mine. This mine weighs nominally 368 pounds and is equipped with a delayed opening parachute pack. Installation in the aircraft requires the installation of one arming wire and the hookup of the weak link delay device which comes attached to the mine. The arming wire in the delayed opening parachute pack must be led up over the parachute pack and direct to the solenoid. Withdrawal of the arming wire from the parachute pack will cause the pack to open with considerable force. Therefore, the arming wire should not be withdrawn except by trained personnel.

Mines Mk 55 Mods 0 Through 6

This is a family of underwater bottom mines which has a common mine case. All the mines are similar in external appearance. These mines are all parachute retarded, weigh nominally 2,000 pounds, and contain high explosives. The arming device requires a double arming wire to hold the mine safe during handling and loading aboard the aircraft. This arming wire, at the arming device, may be rotated 360 degrees for maintaining a direct line between the mine and the aircraft solenoid. The arming wire in the delayed opening parachute pack must be led up over the parachute pack and direct to the solenoid. Withdrawal of the arming wire from the parachute pack will cause the pack to open with considerable force. Therefore, the arming wire should not be withdrawn except by trained personnel.

PRACTICE MINES

Practice Mines Mk 41 Mods 0, 1, and 2 are designed to have the same trajectories as service mines, and are used for training in planting. Practice mines are approximately the same size as standard Army 100-pound demolition bombs, and are handled in the same general manner as bombs, with the same handling equipment.

Externally, Mk 41 practice mines are all the same, however, when different weights are placed inside the case, terminal velocities are varied to simulate those of service mines. The Bomb Signal Mk 4 is installed to indicate by smoke the point of impact. If dropped from a very low altitude, the practice mine may not hit with enough force to fire the bomb signal, in which case only the splash indicates the point of impact. Range and drift from the point of release can be calculated by reference to figures in NOLR 949. NavWeps OD 7334 (Mine, Practice Mk 41 Mods 0, 1, and 2: General Requisites) lists valuable information in regards to practice mine assemblies and their use in lieu of expensive full size mine shapes or actual mines for training.

READYING AND LOADING OF MINES

A mine issued at a depot is assembled for service, except for battery, parachute, arming wires, detonator, hydrophone (if used), sterilizer, and soluble washers. At advanced bases, mine assembly usually includes the installation of batteries and hydrophones.

A mine-warfare crew is responsible for the proper testing and installation of the sensitive influence mechanisms used in firing, and the mineman's preloading overall checks cover these and other operating components. In general, the Aviation Weapons Officer is not concerned with testing or installation of the above units, but is responsible for the following:

1. In some cases, proper installation of the electrically fired detonator in the extender mechanism.
2. Proper installation of arming wires in clock starter and extender. The arming plate or swivel loop of the arming wire is inserted in the arming-wire hook of the rack or shackle, or into the arming control used; the other end of the wire is run through the hole provided in the mechanism, and the correct number of Fahnestock clips are slipped on the wire and run up against the mechanism.
3. Proper installation of the parachute pack on the mine. The moistureproof aluminum foil in which parachute pack containers are wrapped must not be broken or removed until the pack is installed. Care must be taken to protect the parachutes from moisture as they are severely weakened by wetting and may split under the impact of opening.
4. Proper installation of the mine in the rack or shackle, or in the bomb bay. This is accomplished by regular bomb loading methods using the necessary hoist (or hoists) and hoisting band (or sling if used) except for assembling and securing the arming wires and the parachute static line.

Many mines have movable suspension and hoisting lugs which may be located to suspend the mine in the proper position. Others have more than one set of lugs secured to mounting pads which are welded to the case for the same reason. On the latter type, the unused lugs may foul the sway braces of a bomb rack or the shackle release units below the mine station in a bomb bay. In this case the unused lugs should be removed.

Suspension may be 14 or 30 inches, depending on the size of the mine; some mines may use either. In many aircraft, large mines are suspended on steel slings as are torpedoes and large bombs.

The parachute pack is secured to the mine in accordance with the instructions in the Ordnance Pamphlet or other publications dealing with the specific mine. After suspension, the static line which opens the parachute upon release is secured to the aircraft structure; most mine-carrying aircraft have a static line D-ring permanently installed for this purpose.

Arming wires may be installed either before or after mine installation, depending on rack or shackle construction and convenience in performing the operation.

SAFETY PRECAUTIONS FOR MINES

The handling of mines is a very specialized job and unqualified personnel should never attempt disassembly of mines or their components.

Many of the safety precautions which apply to bombs and which have been previously listed also apply to mines and must be observed where applicable.

When a mine is jettisoned safe, the arming wires remain in the clock starter and booster extender, thereby preventing them from operating after the mine is submerged. However, the arming wires may be pulled free of the mine when it strikes the water, hydrostatic pressure or countermining shock may shear the wires, or the wires may corrode and break after extended submergency. Therefore, no mine can be jettisoned safe in water less than 1,300 feet deep with positive assurance that it will not constitute a hazard. Depths greater than 1,300 feet will crush or flood the mine case, rendering the mine inoperative.

Such preflight handling of mines as performed by ordnance personnel should follow the same general handling techniques as for bombs or torpedoes of comparable size.

NUCLEAR WEAPONS

Nuclear weapons are those weapons or warheads which have a nuclear explosion capability. The term nuclear weapons is now being used in lieu of the terms special weapons and atomic weapons.

Following man's initial breakthrough and the ultimate harnessing of atomic energy, succeeding developments have produced a broad new arsenal of nuclear weapons which have been available to large scale military planners and military strategists. Numerous volumes have been written regarding the fundamentals of nuclear physics (for instance, Principles of Guided Missiles and Nuclear Weapons, NavPers 10784) and principles, characteristics, effects, and other aspects of nuclear energy. Therefore, no background coverance of basic nucleonics or nuclear physics is included in this text. Coverage is limited in scope to areas affecting the Aviation Weapons Officer while performing his assigned duties and responsibilities. Due to classification, no specific Mk or Mod numbers of nuclear weapons are used, but rather a generalized coverage of the nuclear weapons field is included. For detailed information on a specific Mk or Mod of a nuclear weapon, refer to the appropriate Special Weapons Ordnance Publication (SWOP).

HISTORY

The history of nuclear weapons is relatively short. However, a half century or more of extensive research was required prior to the dropping of the atomic bomb on Hiroshima. The Aviation Weapons Officer of today is confronted with numerous problems that his predecessor prior to World War II would not have believed possible.

Since the dropping of the atomic bomb, many countries, both allies and enemies, have made extensive research into the development of the atom, both as a source of military and industrial energy. (See fig. 12-6.) The United States has made tremendous strides in harnessing this atomic energy both as a weapon and as a source of energy for industry. The development of the atom as a weapon has altered military thinking and planning, and undoubtedly will continue to do so in the future. It behooves the Aviation Weapons Officer to study the various aspects of nuclear physics.

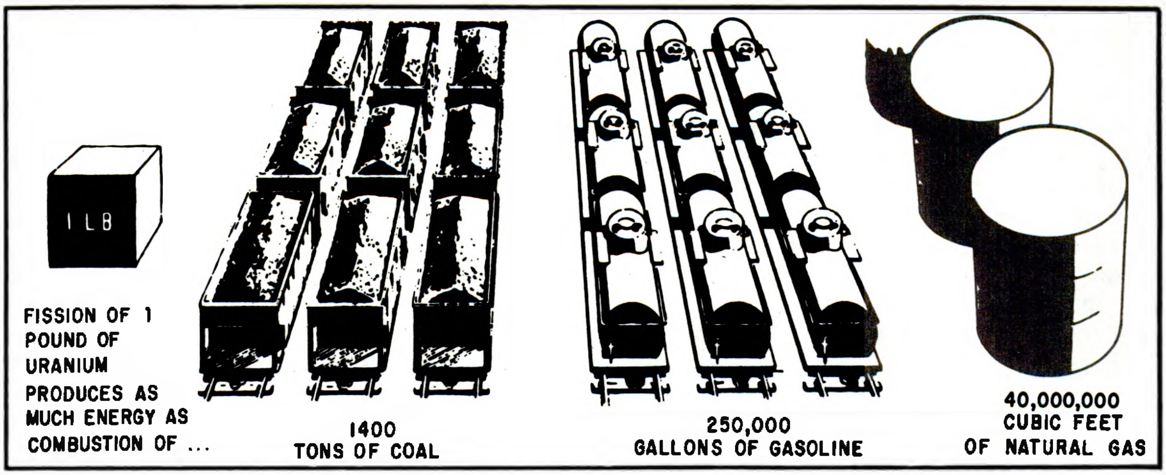


Figure 12-6.—Nuclear energy as compared with chemical energy.

and to become well acquainted with the nuclear weapons now being used in the fleet.

SECURITY

When dealing with nuclear weapons, maximum security measures must be adhered to in regards to nuclear weapons material, publications, and personnel. The Aviation Weapons Officer must be especially vigilant in enforcing all details of the Department of the Navy Security Manual for Classified Matter, OpNav Instruction 5510.1B. Excerpts of this manual are discussed in chapter 3 of this text.

Knowledge or possession of classified information is permitted only to those whose official duties make access to the information necessary, provided they have the proper security clearance.

The responsibility for obtaining the proper security clearance for all personnel within the division/branch, engaged in the handling of nuclear weapons, rests with the Aviation Weapons Officer.

The Aviation Weapons Officer should be thoroughly familiar with the pertinent sections of the Security Manual that apply to his assigned duties. He should also become acquainted with the local requirements and procedures to be used in obtaining security clearances. The various forms required for any desired security clearance are listed in Appendix A of the Security Manual for Classified Information, OpNav Instruction 5510.1B.

HANDLING EQUIPMENT

Handling equipment for nuclear weapons is for the most part identical to handling equipment used for conventional aviation type ammunition. However, in some instances special slings, bands, adapters, shields, and other attachments may be encountered when dealing with specific weapons. In some cases special handling equipment accompanies each particular weapon or group of weapons. However, it may require that specific equipment be special ordered. Each special tool must be used as directed in the basic manuals and no substitute handling equipment should be used unless prior approval has been received from higher authority.

Ample coverage of handling equipment for conventional ammunition is discussed in Volumes 1 and 2, Handling Equipment for Ammunition and Explosives (Mobile and Nonmobile), NavWeps OP 2173. Chapter 15 of this text describes most of the common handling equipment with which the Aviation Weapons Officer should be familiar and is not duplicated here.

CAUTION: Due to the intricate mechanisms used with nuclear weapons, they must always be handled with extreme care. Small dents, bumps, or drops may render the weapon inoperative or require a time consuming disassembly and inspection.

STORAGE

Nuclear weapons storage is divided into two basic parts. These parts are called stockpile storage and operational storage. Stockpile storage is storage of nuclear weapons major assemblies and other components in a disassembled state. The appropriate Navy SWOP (Special Weapons Ordnance Publication) prescribes the stockpile storage configurations for a given nuclear weapon.

Operational storage is any storage configuration occurring in the stockpile-to-target sequence following removal of weapon components from stockpile containers for partial assembly. Operational storage may be further divided into nonready storage, ready storage, assembled storage, completely assembled for ferry (CAF), and completely assembled for strike or launch (CAS/CAL). The Aviation Weapons Officer is mainly concerned with operational storage of nuclear weapons.

SPECIAL WEAPONS CHECK LISTS

NavWeps special weapons check lists are published (by the direction of the Chief of BuWeps) for each model and type of aircraft and each Mk and Mod of nuclear weapon that a particular aircraft is capable of carrying.

Special weapons check lists are actually small pamphlets that contain all the required information to safely perform the following inspections and checks on nuclear weapons.

Alert/Strike Weapon Inspection.
Alert/Strike Aircraft Preparation Check List.
Alert/Strike Loading Check List.
Strike Flight Check List.
Alert/Strike Unloading Check List.
Readiness/Maneuver Weapon Inspection.
Readiness/Maneuver Aircraft Preparation Check List.
Readiness/Maneuver Loading Check List.
Maneuver Flight Check List.
Readiness/Maneuver Unloading Check List.
Logistic Transport Weapon Inspection.
Logistic Transport Aircraft Preparation Check List.
Logistic Transport Loading Check List.
Logistic Transport Flight Check List.
Logistic Transport Unloading Check List.

These check lists also contain information on preferred handling equipment, electrical test equipment, (also alternate equipment if compatible), and other exacting details.

NOTE: The inspections and checks shown above pertain to the A-3 aircraft only. Inspection and check lists used on other aircraft are very similar with certain additions and deletions as required. For the latest information concerning inspection and check lists on a specific aircraft, refer to Special Weapons Check List, Wire Check List, and Supplemental Manual Quarterly Index, NavWeps 01.700.

All steps listed in the special weapons check list are carefully arranged and must be performed in sequence. None of the steps can be omitted and no additional steps are necessary.

No carriage or electrical connection of single, multiple, or mixed loads of nuclear weapons on aircraft is permitted unless authorized by a special weapons check list. Special weapons check lists are mandatory for nuclear weapons system loading of aircraft and are directive in nature. The special weapons check lists must be used with knowledge and understanding in performing each step or function. All other operational procedures performed on nuclear weapons systems must conform to the procedures prescribed in appropriate Navy SWOPS and NavWeps Ordnance Pamphlets.

LOADING TEAMS

The effective completion of a squadron's assigned tasks and missions may depend heavily on the overall efficiency of the nuclear weapons loading team or teams.

It behooves the Aviation Weapons Officer to select (or assist in selecting) members of nuclear weapons loading teams with great care and deliberation. Also, frequently attending loading drills aids in determining the loading teams abilities and weaknesses. These deficiencies can then be corrected by individual instruction or if necessary, replacing certain members of the team.

Personnel assigned to nuclear weapons loading teams must comply with the following standard requirements:

1. Have had a successful National Agency Check (NAC) and be granted a Secret clearance (or granted an interim Secret clearance pending the results of the NAC).
2. Have attended the appropriate nuclear weapons loading school for the actual type of aircraft squadron assigned.

3. Be assigned to a nuclear weapons loading crew by the Aviation Weapons Officer of the station, ship, or squadron to which attached.

A nuclear weapons loading team usually consists of the following personnel:

1. A nuclear weapons loading officer.
2. A nuclear weapons loading crew chief (at present a second class Aviation Ordnanceman or above).
3. Two additional Aviation Ordnancemen (rated or strikers).
4. A petty officer from the electrical or electronic field.
5. Three other members to complete the loading crew which is normally a seven-man crew.

SAFETY PRECAUTIONS

Nuclear weapons are designed with great care to explode only when deliberately armed or fired. Nevertheless, there is always a possibility that, as a result of accidental circumstances, an explosion could take place inadvertently. Although all conceivable precautions are taken to prevent them, such accidents might occur in areas where the weapons are assembled and stored, during the course of loading and transporting on the ground, or when actually in the delivery vehicle, e.g. an aircraft or missile.

In a nuclear weapon, three main classes of components are subject to specific safety precautions. One class is the conventional high explosive that must be used to achieve a supercritical mass of fissionable material. A second class is the complement of mechanical and electrical devices that provide a safe period, an arming cycle, and an initiating impulse. The third class is the nuclear material.

Conventional Explosives

Specific safety precautions for conventional ammunition are summarized in basic OP's dealing with each type. General safety precautions are listed in Ammunition Ashore, Volume 1 of OP 5. Also BuWeps Instructions list applicable safety precautions. These precautions apply in equal measure to nuclear ordnance, and to any separately stowed non-nuclear components that contain explosives.

Electrical and Mechanical Components

The safety delays, arming arrangements, and fuzes used in nuclear ordnance are not radically different from their counterparts in other bomb type and gun type ammunition. Certain refinements have been made, but the underlying principles have not been superseded. For these components, as for conventional explosives, the general and specific safety precautions presently in effect must be known and enforced.

Nuclear Components

All personnel assigned to work with fissionable or fusionable materials must receive special training in the handling, stowage, and accounting methods peculiar to these materials. Fissionable substances are radioactive. Therefore, they constitute a radiation hazard which must be consistently recognized and guarded against.

Special Weapons Ordnance Publications (SWOP's) on specific nuclear weapons supplement the standard Navy safety precautions wherever necessary. Specific safety information on nuclear weapons can be found in the "safety series" of Navy SWOP's. Ordering information for Navy SWOP's is covered in the introductory section of NavWeps OP 0 (Thirty-Third Revision).

CHAPTER 13
PYROTECHNICS

IDENTIFICATION AND USE

Pyrotechnics can best be described as "fireworks adapted to military use." The word pyrotechny means literally "the art of fire"; hence pyrotechnics are those items which produce their effect by burning, and are consumed in the process. Pyrotechnics are used for such purposes as producing a bright light for illumination, or colored lights or smoke for signaling. They may be thought of as fireworks adapted to specific uses.

Aircraft pyrotechnics consist of mixtures of combustible elements and oxidizing agents in containers designed for carrying in aircraft. When the containers are discharged or released, the contents are ignited. The resulting smoke, flame, or flash serves a signaling, marking, or illuminating purpose. Dye or slick markers, though not in conformance with the above definitions, are classed as pyrotechnic ammunition.

Pyrotechnics are used in a large variety of combat and rescue operations. Successful combat operations by aircraft squadrons and by individual aircraft depend heavily upon the reliability and proper functioning of pyrotechnics used for recognition and identification. Target identification and illumination are essential to successful reconnaissance, photography, and attack.

The discovery and recognition of downed airmen, or other personnel in distress, depend largely upon pyrotechnic signals or dye markers. Drift signals aid in determining the drift angle of an aircraft which is used in computing the aircraft's course. Drift signals and float lights are very useful as markers, wind indicators, and reference points.

The effectiveness of most pyrotechnics ammunition depends upon the degree and distance at which its flame, flash, or smoke can be seen (visibility). Visibility, in turn, is affected by the design of the pyrotechnic, the position of the effect relative to the observer, the color and reflective qualities of the background, the degree of natural illumination, and the prevailing atmospheric conditions.

Almost any desired characteristics, such as candlepower, color of light or smoke, and burning time, may be obtained by variation in design. However, most pyrotechnics are designed to perform a specific function.

The earliest pyrotechnic compositions consisted of various mixtures of the constituents of black powder—charcoal, sulfur, and saltpeter. Other materials were added to produce special effects, such as iron filings and coarse charcoal. Many other materials were added or substituted as the art and uses of pyrotechnics progressed.

Pyrotechnic items generally are initiated by means of an ignition train similar to the conventional explosive train. The ignition train may be composed of a primer, a delay element, and a composition or a series of compositions which intensify the heat in order to initiate reliable burning of the pyrotechnic candle.

Pyrotechnic items are identified by the painted color of the packing box or by bands painted on the items. The following information is also included on the packing box: nomenclature, mark and mod numbers, lot numbers, date of manufacture, Interstate Commerce Commission markings or other special markings for dangerous articles required for safety reasons, and name or initials of the manufacturer. The lot number also appears on most items, except on those which are too small. The lot numbers should always be included in various reports on condition, functioning, accidents, or damaged shipments involving pyrotechnic items so that BuWeps may make a suitable investigation of the affected lot.

PYROTECHNICS IN CURRENT USE

A few of the typical pyrotechnics in current use are discussed in this chapter. The Aviation Weapons Officer should be familiar with these current pyrotechnics.

AIRCRAFT PARACHUTE FLARES

Aircraft flares are used to illuminate large areas for the purpose of bombardment, reconnaissance, emergency landing of aircraft, night antisubmarine warfare, blinding of antiaircraft defenses, or any other purpose where a light of high intensity is required. Typical flares in current use in the fleet are discussed in the following paragraphs.

Aircraft Parachute Flare Mk 6 and Mods

The Mk 6 and Mods are high-intensity flares designed to illuminate an area for bombing and reconnaissance. Mk 6 Mods 3 and subsequent are for service use; earlier Mods are unserviceable. The flare can be launched from a bomb rack or shackle, a flare container, or by hand.

The complete flare, as issued ready for release, weighs approximately 30 pounds. The shellac-impregnated chip board case, which contains a time fuze, a parachute, a small auxiliary parachute, and the illuminant candle, is 5 3/8 inches in diameter and 35 3/4 inches long.

The Mk 6 and Mods use a variable time delay fuze to provide a delayed functioning time. The setting is made by turning the lock screw on the metal firing mechanism to the desired delay. The delay is shown on the fuze setting ring, and indicates the vertical distance the flare will drop before igniting. This distance (or delay) can be varied from 300 to 12,000 feet. Thus if the launching aircraft is to fly at 9,000 feet altitude and flare ignition is desired at 2,000 feet altitude, the fuze should be set at "7M" (7,000). The flare will then fall 7,000 feet before igniting.

The Mk 6 Mods 3 and 4 have the older type fuze which requires about 38 pounds of pull to break the snap cord. Mods 5 and later have fuzes which require only about 8 pounds of pull to function, since the snap cord pulls away from the firing lever instead of breaking. The Mods 5 and subsequent also have a safety screw in the fuze body which must be removed after the flare is installed in the aircraft.

The parachute is connected to the illuminant candle by a steel suspension cable. The flare burns approximately 3 minutes and produces a pale yellow light of 1,000,000 candlepower intensity. It falls about 1,500 feet while burning.

Aircraft Parachute Flare Mk 6 and Mods are packed separately in moisture-proof metal containers, four containers in one wooden packing box. The flares should be stowed in their original containers in a location where the temperature will not exceed 100° F. If this temperature is not exceeded, satisfactory performance can be expected for 6 to 10 years after the date of manufacture.

Aircraft Parachute Flare Mk 8 and Mods

Aircraft Parachute Flare Mk 8 Mods 0, 1, and 2 (fig. 13-1) were developed for night antisubmarine warfare. Each flare contains a parachute that opens immediately, but incorporates a 90- or 120-second delay. The flare has two metal steadying bands against which the sway braces of the bomb rack rest.

When the flare is dropped, one end of the firing lanyard is retained by the aircraft. The ripcord unwinds from around the wood reel in the flare. The end of the flare case is torn off, and the wood reel and parachute tube (with the parachute) are pulled out of the flare case. The reel falls away.

The parachute is pulled out of the bottom of the parachute tube by the flare case and the tube falls. When the parachute and shrouds are fully extended, the free release key cord pulls the release key down, allowing the ripcord to slip through the key. When the parachute opens, the illuminant is pulled out of the flare case and the case falls away. Full suspension is 30 to 50 feet below the aircraft. Ninety or 120 seconds after the flare is fully suspended, the first fire of the illuminant is ignited by the delay.

Aircraft Parachute Flare Mk 24 and Mods

The Mk 24 and Mods flare (fig. 13-2) is a delay type flare designed for launching from aircraft. The flare contains two variable delay fuzes—the ejection fuze and ignition fuze. Either fuze can be set for delays from 5 to 30 seconds. The ejection delay fuze

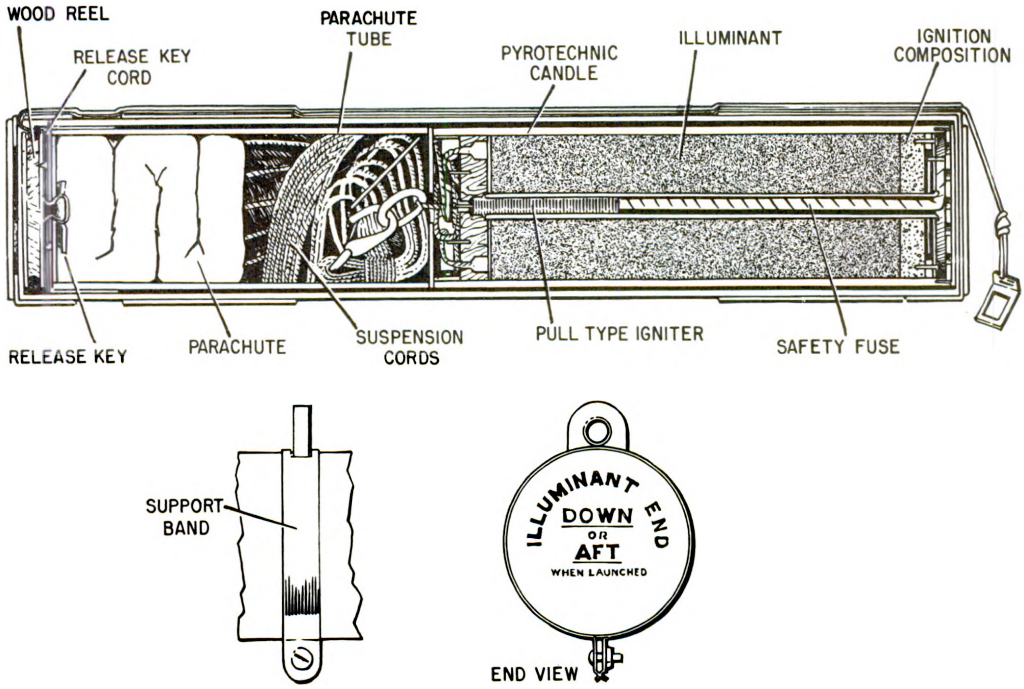


Figure 13-1.—Aircraft Parachute Flare Mk 8 Mod 2, cross section.

allows the flare to fall 25 to 6,634 feet from release to ejection and suspension of the candle. The ignition delay fuze allows the suspended candle to fall 45 to 525 feet before it ignites depending on the fuze settings. The suspended flare can be expected to descend approximately 7.5 fps.

The Mk 24 flare is intended to be used to illuminate an area sufficiently to permit landing of aircraft, reconnoitering, bombing, night antisubmarine warfare, or the blinding of antiaircraft defenses. The flare may be launched from fixed wing aircraft using wing racks or dispensers, or by static line from helicopters.

The Mk 24 Mod 2 flare (fig. 13-3) is similar to the Mod 1 except the plastic fuze block is contained in the outer aluminum container and one "O-ring" has been eliminated in the assembly of the fuze block. The diameter of the fuze block has been reduced to permit insertion into the outer container and is secured by crimping.

The flare has the following two safety features:

1. The ignition system requires movement of the ejection set dial and the ignition set dial to a position other than SAFE to permit the flare to ignite.
2. The ignition system of the flare contains an out-of-line firing train when both fuzes are in the safe position.

The flare is approximately 36 inches in length, 4.9 inches in diameter, and 24 pounds in weight. The Mk 24 Mod 1 flare has an aluminum outer container, closed and sealed at one end with an aluminum end cap and O-ring. The other end is closed and sealed with the ejection fuze assembly and sealed with two O-rings. In the cavity of the ejection fuze assembly are the ejection set dial, the ignition set dial, thumbscrew, and the lanyard. The ejection fuze assembly is covered with a weather cap, sealed in place with a sealing tape. The ejection fuze assembly contains the ejection

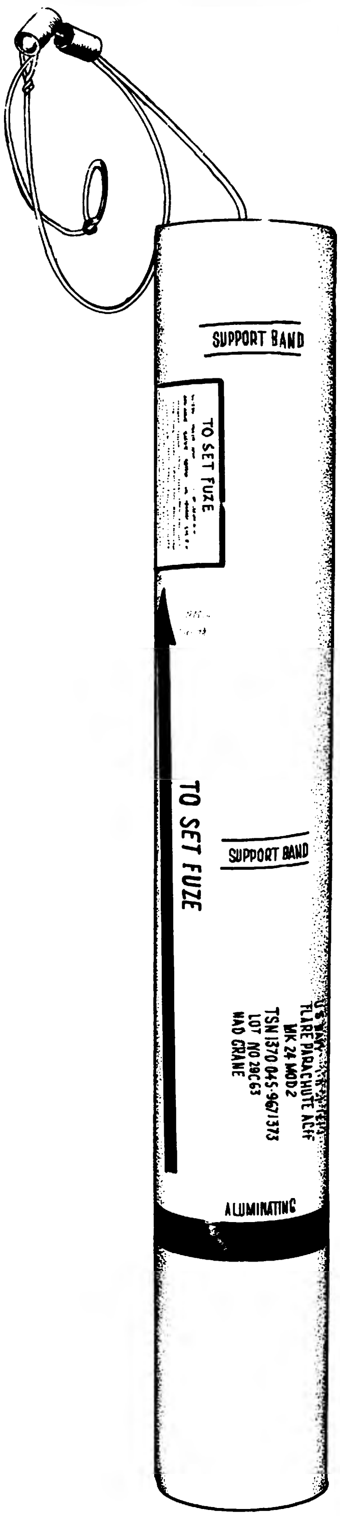


Figure 13-2.—Aircraft Parachute Flare Mk 24 Mod 2.

plunger and housing assembly, a delay fuze and the ejection composition assembly.

Below the ejection fuze assembly, in the outer container, is the candle and ignition fuze assembly which consists of the candle assembly, cable assembly, and ignition fuze assembly. The candle assembly consists of the candle tube and illuminant composition. The ignition fuze assembly contains the base, ignition fuze, ignition time delay fuze, and ignition fuze canister assembly. The parachute assembly is attached to the cable assembly that is folded in a split container. Between the parachute assembly and the end cap is a compression pad.

The flare functions as follows: When released the flare falls causing a pull on the lanyard, which activates the ejection fuze assembly. The lanyard separates from the flare when pulled with a force of 50 pounds. The flare reaches a terminal velocity of 200 fps within 12 to 13 seconds. After an elapse of the time set on the ejection fuze, the ejection time delay fuse ignites an ejection disk. The ejection disk then initiates the ignition fuze and expels the ignition fuze, candle assembly, and the parachute assembly from the outer container.

Upon clearing the outer tube, the split container falls away allowing the parachute to open and suspend the ignition fuze and candle assembly. During the 5 to 30 seconds, depending on the ignition fuze setting, the suspended ignition fuze and candle assembly descends at a rate of 15 fps. After the preset time of the ignition fuze, the ignition time delay fuse activates a transfer disk which initiates an ignition disk that ignites the candle and causes the separation of the ignition fuze assembly from the candle assembly.

The flare burns for a minimum of 2 minutes and produces a minimum average candlepower of 1,650,000.

MK 24 FLARE SAFETY PRECAUTIONS.—The weather cap covering the ejection fuze assembly of the flare, must remain in place at all times in handling, shipping, and storage. The weather cap retains the lanyard which if pulled could cause the flare to become nonfunctional when used.

The ejection delay dial must be set on SAFE at all times during handling, shipping, and storage. If the ejection delay dial is not set on SAFE, the flare will eject the contents if a minimum pull of 12 pounds is exerted on the lanyard. However, the candle will not ignite.

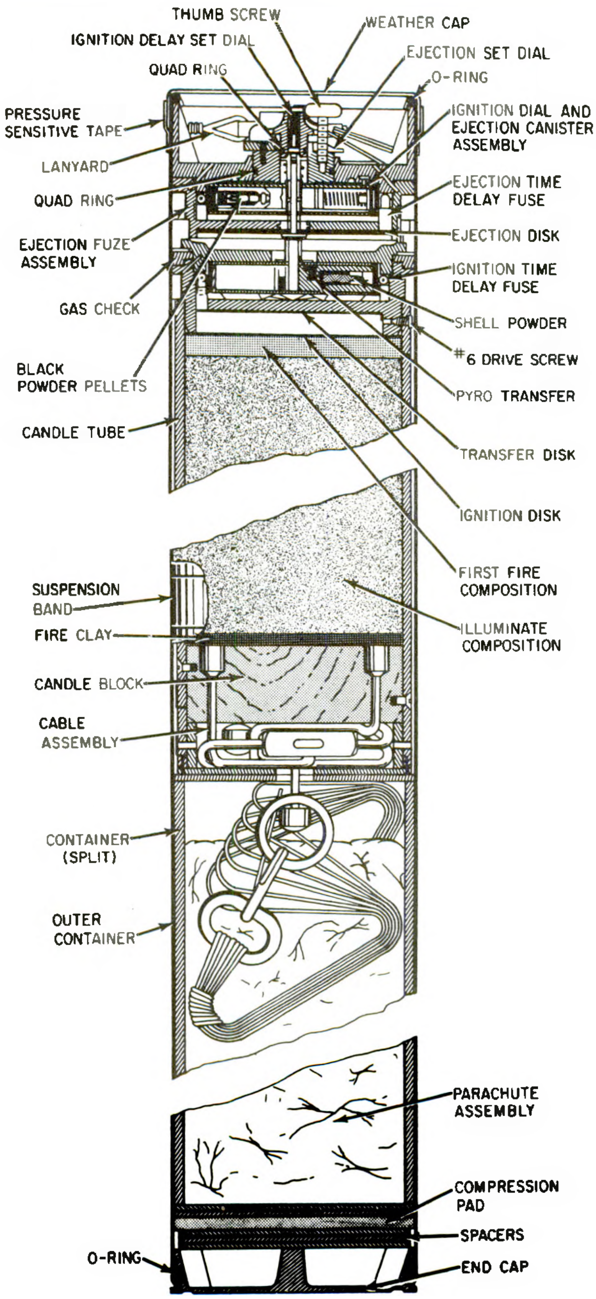


Figure 13-3.—Aircraft Parachute Flare Mk 24 Mod 2, cutaway view.

If the ejection delay dial is set on SAFE and a minimum pull of 12 pounds is exerted on the lanyard, the ejection delay plunger will fire and cause the flare to be nonfunctional.

FLARE HANDLING AND LAUNCHING PROCEDURES.—The Mk 24 and Mods flares can be launched from certain models of ASW stores ejectors and from all 14-inch suspension wing racks. This flare should be handled and stored in accordance with specific procedures listed in OP 4 and OP 5, and in general the same as other aircraft parachute flares. The Mk 24 and Mods flares are packed two to a wooden box for handling, shipping, and storage. Each flare is a sealed unit. Also, installation instructions are included in each wooden packing box. Defective flares must be disposed of in accordance with current BuWeps Instructions.

A flare is very likely to ignite combustible material unless it is entirely burned out and cool when striking the ground. Minimum release distances are controlled by such factors as burning time, rate of descent, actual fuze settings, and drift.

Prior to using the Mk 24 flare, responsible personnel should consult the basic NavWeps OP for pertinent launching data.

For a detailed coverage of the Mk 24 and Mods flare including minimum launch height tables, refer to the publication, Aircraft Parachute Flare Mk 24 Mods 1 and 2, NavWeps OP 3018, latest revision.

NOTE: The tables listed in this publication do not solve for drift.

AIRCRAFT PHOTOFLASH AMMUNITION

Photoflash Bombs M120 and M120A1

Photoflash Bombs M120 and M120A1 have been developed for night photographic missions at altitudes up to 30,000 feet. They develop a peak intensity of approximately 3 billion candlepower in 0.004 second. If the bomb is assembled with Fin Assembly M125A1, it is called Photoflash Bomb M120; if it is assembled with Fin Assembly M127, it is called Photoflash Bomb M120A1. (See fig. 13-4.)

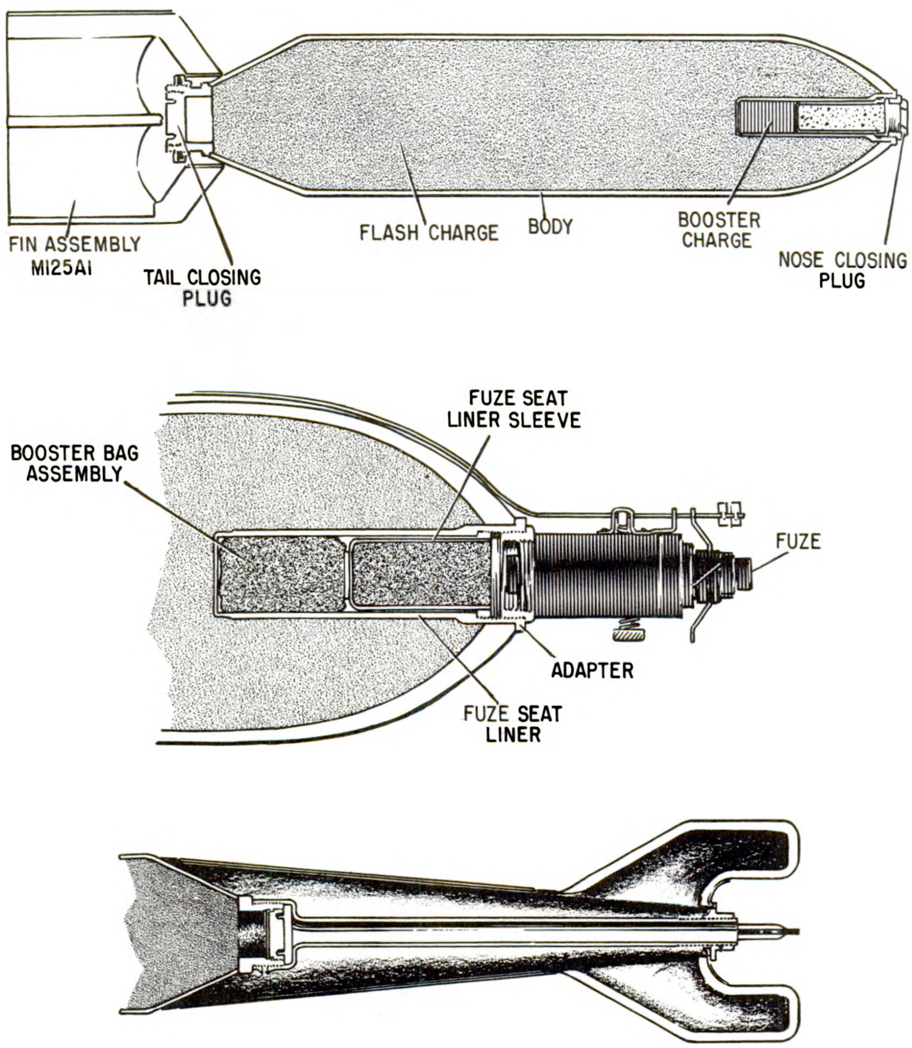


Figure 13-4.—Photoflash Bombs M120 and M120A1.

Photoflash Bomb M120 is cylindrical, 39.7 inches long exclusive of fin and fuze, and 8.0 inches in diameter. The average wall thickness of the case is 0.19 inch. As shipped, the loaded bomb weighs 155 pounds and contains 69 pounds of photoflash powder. A booster bag of 0.25 pound of black powder is assembled within a steel housing assembly in the nose cavity.

The choice of fin assembly to be used with the bomb is dependent upon such considerations as altitude of release, speed of aircraft, desired trail angle, and height of burst. Fin Assembly M125A1 is a modified AN-M103A1 box type fin assembly. The modification, which consists of three holes on each side of the fin box, is provided to permit assembly of a trail plate or trail angles. Trail Plate Kit M42A1, or Trail Angle Kit M43, is usually required with this fin assembly.

Fin Assembly M127 is a conical type fin assembly. It consists of a coupling tube with setscrews, a cone assembly, and a fin locknut with setscrews.

Information on assembly and disassembly of the M120 and M120A1 photoflash bombs may be found in OP 2213, Pyrotechnics and Miscellaneous Explosive Items.

The M120 and M120A1 can be released only from bomb racks or shackles. If the bomb is released safe, it may function on impact and for this reason should never be jettisoned over friendly territory. When released armed, it functions as follows:

As the bomb falls away, the arming wire is withdrawn, allowing the arming vane to rotate and the arming pin to be ejected. When the set time has elapsed, the fuze functions, igniting in turn the black powder booster and the main charge of flash powder.

In preparing the bomb for loading, the AN-M146 nose fuze should be screwed into the fuze adapter handtight and then set for the desired time delay. The arming wire, which is shipped with the bomb, should be run through the forward suspension lug, the arming pin, and the arming wire guide and vane lock. No Fahnestock clip is used, as the spring loaded arming pin holds the arming wire firmly in place until armed release. After the arming wire is installed, the safety cotter pin is removed from the arming pin and the seal wire removed from the vane lock.

Photoflash Bomb M122

The Photoflash Bomb M122 (fig. 13-5) is used for night photographic missions at altitudes up to 20,000 feet and develops 45 million candlepower during the optimum 0.004-second interval of flash duration.

The bomb is cylindrical in shape and approximately 38 inches long exclusive of the tail fin and fuze. It weighs approximately 103 pounds and has a burster well the entire length of the bomb. When issued, the bomb is equipped with a single branch arming wire. The use of a safety Fahnestock clip is optional when the bomb is carried internally in aircraft with a rated cruising speed of 300 knots or less. If the bomb is carried externally on a bomb rack, or internally in aircraft with a rated cruising speed in excess of 300 knots, one clip must be used on the arming wire. The operation and safety precautions for this bomb are the same as those previously discussed with the exception of the type of fuze used.

Photoflash Bomb Fuzes

Photoflash bombs use mechanical time fuzes which are either identical to or closely resemble the fuzes used in aircraft bombs. Fuzes currently used by the Navy are the AN-M146A1, AN-M147, and the AN-M147A1. Since the AN-M146A1 was discussed in chapter 11 of this text, only the major differences between the three fuzes are discussed.

Fuzes AN-M147 and AN-M147A1 differ from the mechanical time fuze AN-M146A1 in that they have booster leads of high explosive instead of boosters filled with black powder. The AN-M147A1 differs from the AN-M147 in that the AN-M147A1 has a protective finish and a reworked clock movement that makes it more suitable for low temperature operation. These fuzes are detonator safe.

Aircraft Photoflash Cartridges

Aircraft photoflash cartridges are used for low aerial photographic reconnaissance missions at altitudes of 100 to 5,000 feet. The cartridges produce a flash of high-intensity light.

A photoflash cartridge consists of a rimmed aluminum case with an electric primer, covered by a shunt cap, at the rimmed end of the case.

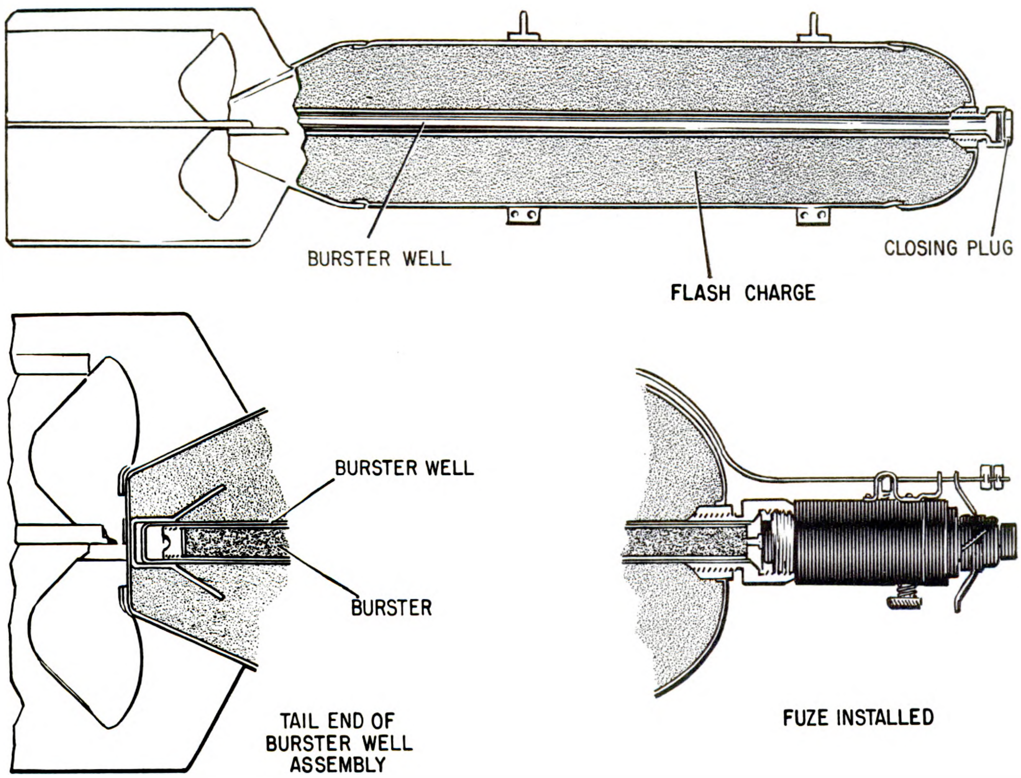


Figure 13-5. —Photoflash Bomb M122.

The opposite end of the case is closed by a steel cap. Inside the case, and next to the primer, is the propelling charge. The rest of the space in the cartridge is occupied by the inner case, which contains black powder delay pellets and the charge of flashlight powder.

Photoflash cartridges are electrically fired from a multibarreled ejector whose firing circuit includes an intervalometer in the circuit which fires the cartridges at the desired time intervals of one-half second or more. When the primer fires, the propelling charge is ignited, the inner case is projected, and at the same time the delay pellet is ignited. After a delay the flashlight powder is ignited and explodes, producing a brilliant flash of light for a short period of time.

The cartridges are marked with the nomenclature, length of delay, lot number, manufacturer, and date of manufacture.

CARTRIDGE M112.—The three types of Photoflash Cartridge M112 differ from each other only in the amount of delay. Refer to the table on page 121 of NavWeps OP 2213 (Pyrotechnics and Miscellaneous Explosive Items) for this information. This delay time is plainly marked on each cartridge.

These cartridges are provided for use in connection with aerial photography at low altitudes, 100 to 5,000 feet, and high speeds, up to Mach 0.95, during reconnaissance missions. They are fired from a 9A ejector (which is discussed in chapter 16 of this text).

CARTRIDGE M123.—The three types of Photoflash Cartridge M123 differ from each other only in the amount of delay. (Refer to the table mentioned above.) This delay time is clearly marked on each cartridge. This cartridge is used in the 9B ejector.

The various components of the M123 photoflash cartridge are shown in the cross section view in figure 13-6.

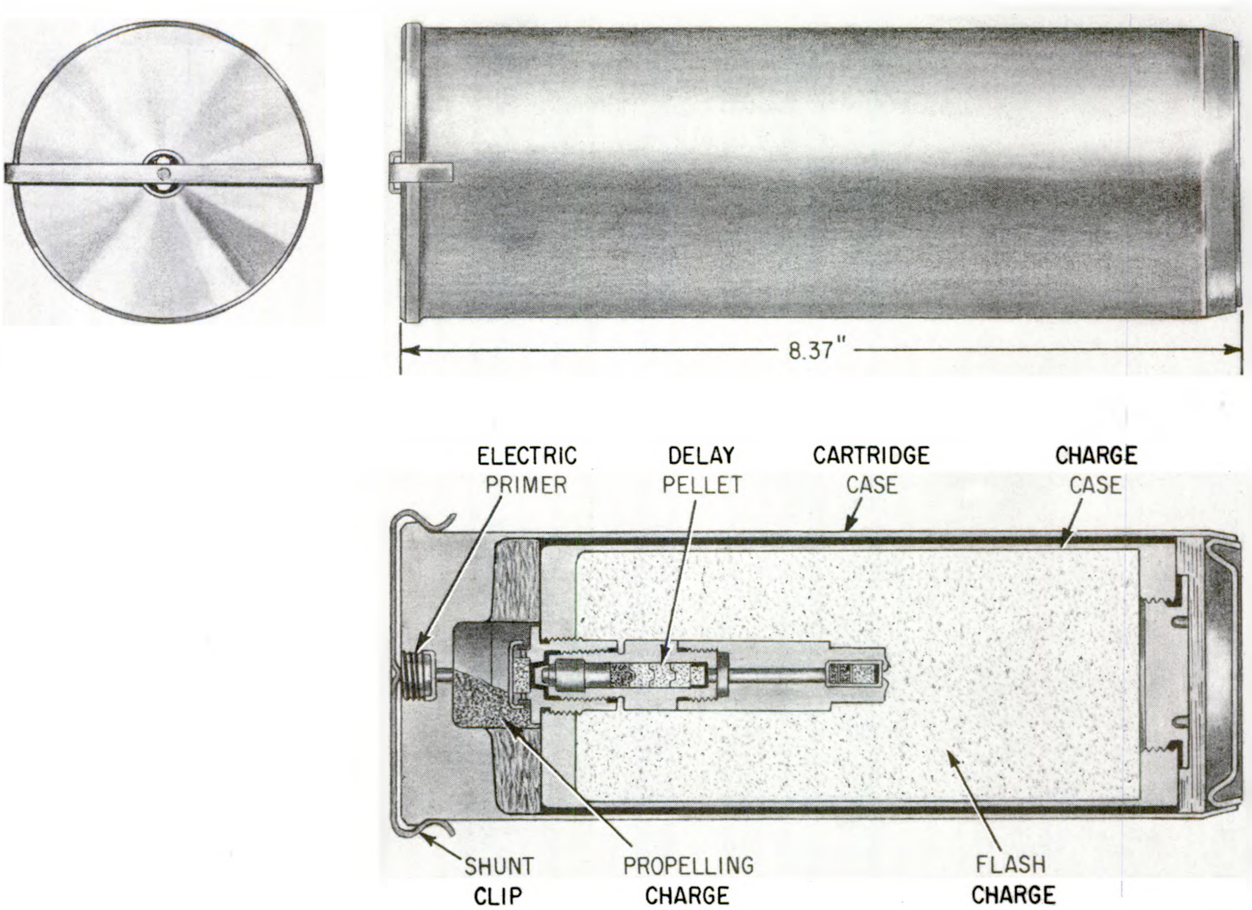


Figure 13-6. —Photoflash Cartridge M123, external view and cross section.

RECOGNITION AND DISTRESS SIGNALS

Pyrotechnic signals are used for communication or identification between surface craft, surface craft and aircraft, or submarine and either surface craft or aircraft. Weather conditions are an important factor in the use of pyrotechnic signals because rain, snow, fog, clouds, and other conditions affect visibility.

Most signals are little larger than shotgun shells, and all are small enough to be stowed easily in small surface craft or submarines. Distress signals are often stowed in pockets of lifejackets or in liferafts.

Signals produce a variety of effects. Smoke is visible by day; and flame or burning stars, candles, or tracers are visible by night or day.

Aircraft Signal Cartridges

Signal cartridges are fired in the Pyrotechnic Pistol AN-M8 as a method of identification for and communication between aircraft and surface vessels. These signals can be seen during the day or night. An example of the correct nomenclature for a cartridge-type identification signal used by the Navy is the Signal, Illuminating, Aircraft, AN-M39A1 Green-Green Star.

Aircraft signals project one or two free stars of the same or different colors; colors in current use are red, yellow, and green. All aircraft signal cartridges weigh from 4 to 6 ounces, are approximately 1 1/2 inches in diameter, and between 3 and 3 7/8 inches in length. Table 13-1 shows aircraft signals in current service use.

Table 13-1. —Aircraft signal cartridges.

Designation	Double or single star	Color combination
AN-M37A1	Double . . .	Red-red.
AN-M38A1	Double . . .	Yellow-yellow.
AN-M39A1	Double . . .	Green-green.
AN-M40A1	Double . . .	Red-yellow.
AN-M41A1	Double . . .	Red-green.
AN-M42A1	Double . . .	Green-yellow.
AN-M43A1	Single . . .	Red.
AN-M44A1	Single . . .	Yellow.
AN-M45A1	Single . . .	Green.
AN-M53A1	Double . . .	Yellow tracer, red-yellow star.
AN-M54A1	Double . . .	Green tracer, red-red star.
AN-M55A1	Double . . .	Green tracer, green-red star.
AN-M56A1	Double . . .	Red tracer, green-green star.
AN-M57A1	Double . . .	Red tracer, red-red star.
AN-M58A1	Double . . .	Red tracer, green-red star.

The standard signal cartridge consists of a one-piece extruded aluminum case with extracting rim, a percussion primer, a propellent charge of black powder, a steel closing cap, and the illuminant star or stars, together with suitable cushioning wads. Double-star signals have two star charges, each in an aluminum case and tied together with quickmatch. Single-star signals have only one charge. The empty space in the cartridge case is maintained with spacers. Tracer-double-star rounds differ in having both star charges contained in one inner container which is closed at one end by the tracer composition. This inner container also contains a bursting charge of black powder to expel and separate the stars from the inner container at the proper time. A typical double-star signal cartridge is shown in figure 13-7.

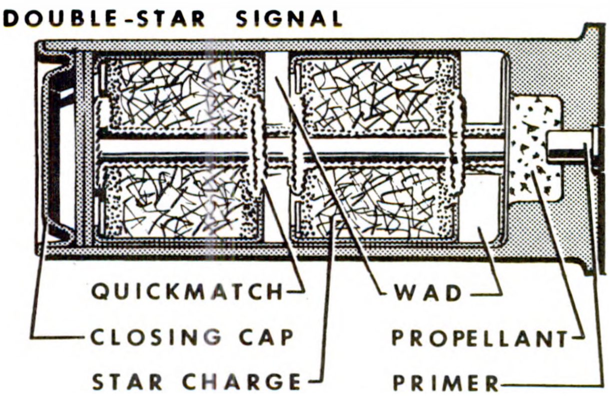


Figure 13-7.—Signal, Illuminating Aircraft, AN-M37A1 series, cutaway view.

Earlier types of aircraft signals have a shotgun type cartridge case of paper assembled to a brass head. These earlier types do not have the "A1" suffix in their designation, whereas all the metal-case signals are designated "A1."

Colors of the star or stars in both types are indicated by one or two colored bands on the forward end of the case. Double-star signals have two 1/4-inch bands, matching the color of the stars. Single-star signals have one 1/2-inch wide band, while tracer-double-star signals have one 1/4-inch band in the color of the tracer and two 1/2-inch bands representing the star colors. The designation of the round and other information are stenciled on the case in black.

All signal cartridges which do not contain tracers function as follows:

When the firing pin strikes the primer, the primer ignites the black powder propellent charge. As the star or stars are propelled from the case, the quickmatch is ignited by the burning gases and, in turn, ignites the first-fire compositions and stars. The stars reach full brilliance after traveling about 40 to 50 feet; and when fired from the ground, reach a height of approximately 250 feet. The stars burn about 7 seconds and can be distinguished for 5 miles at night and from 2 to 3 miles in daylight.

Signal cartridges containing tracers function in a slightly different manner as follows:

When the black powder propellent charge burns, it ignites the tracer in the inner container and expels the entire inner container, holding the two stars and the tracer, from the case. The tracer becomes visible after traveling about 20 feet. As the signal approaches the highest point of its trajectory (about 250 feet), the quickmatch connecting the two stars and the bursting charge are ignited by the tracer by means of a black powder relay charge. The two-star assemblies are ignited as they are expelled and separated from the inner container by the bursting charge.

The tracer burns about 4 seconds and the stars for about 4 1/2 seconds. In effect, the tracer appears as a single star and rises to a height of 250 feet, when the star separates into two stars which fall separately. The tracer and stars can be seen for 5 miles at night and 2 to 3 miles in daylight.

Aircraft signal cartridges are packed 12 cartridges to a carton, 12 cartons to a box. They must be stowed in magazines at temperatures of less than 100° F or rapid deterioration will occur.

Pyrotechnic Pistol AN-M8 and Mount M1

With or without mount, the "pyro pistol," as it is often called, is standard equipment for naval aircraft, including training aircraft, and is used to fire the aircraft signals just described. (See fig. 13-8.)

The Mount M1 (fig. 13-8) attaches the pistol to the aircraft so that it may be fired through an opening in the fuselage. The pistol may also be detached from the mount and fired from the hand.

Pyrotechnic Pistol AN-M8 is a breechloading double-action signal pistol. The barrel, hinged to the frame, is held in firing position by the breechlock. The plastic grips, backplate, and cover plate fasten to the aluminum frame and act as a housing for the firing mechanism. To load the pistol, lift up on the breechlock. This unlocks the breech and swings the breech up. Insert the round and close the breech.

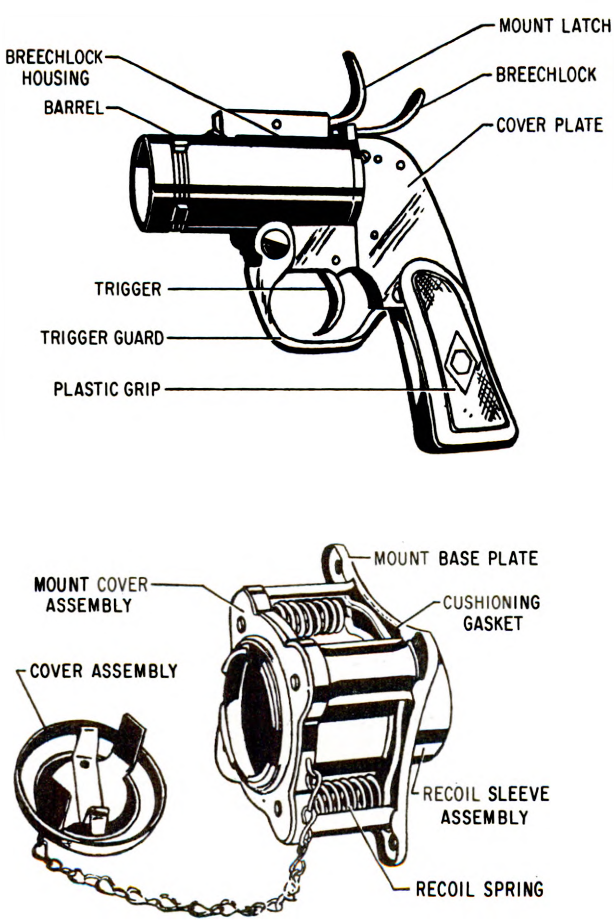


Figure 13-8.—Pyrotechnic Pistol AN-M8 and Mount M1

CAUTION: When loading and firing, care should be taken never to point the pistol toward other personnel or ships. The star charges can inflict severe burns or start fires. When firing the pistol by hand, it should be held with the elbow slightly bent to absorb the shock of recoil.

The pistol must be kept in serviceable condition at all times. After each firing, it should be cleaned thoroughly and all principal parts wiped down with an oily cloth. When assembled, the exposed parts should be wiped off with a dry cloth. To remove powder residue, the bore should be swabbed out with a cloth dampened with an approved bore cleaning solvent. Other pyrotechnic pistols used by the Navy are the Mk 1 Mod 0 and the Mk 5 Mod 0.

Signal, Illumination, Aircraft, Mk 6 Mod 0 Emergency Identification

The Mk 6 Mod 0 signals are used as a means of night identification for aircraft. The signals produce red, white, or green stars which are parachute suspended. The signal consists of an aluminum cylindrical case, with a grenade type firing mechanism screwed into one end and the other end closed by a metal cap. Inside the case are the ejection charge, the pyrotechnic star charge, and a parachute which is made of silk, rayon, or paper. (See fig. 13-9.)

After selecting the star color to be used, the signal is launched by being grasped in one hand with the safety lever held firmly against the body of the signal. The safety ring, attached to the safety cotter pin, is pulled with the other hand, or may be pulled by catching it on a stationary hook located inside the aircraft. The signal is then thrown overboard.

When the safety lever is released, it is thrown off by the spring loaded striker which rotates and

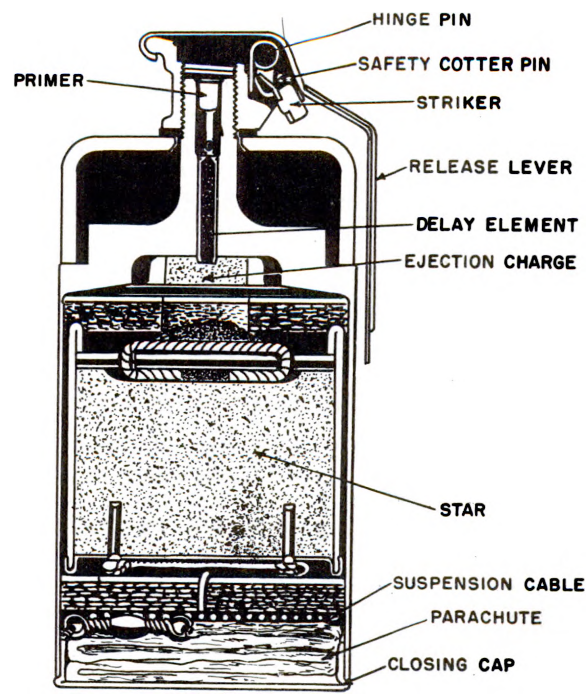


Figure 13-9.—Signal, Illumination, Aircraft, MK 6 Mod 0.

strikes the primer. The delay element is ignited by the primer and, in turn, the ejection charge is ignited. Expanding gases eject the parachute and pyrotechnic star by pushing off the closing cap. The star is ignited by quickmatch which is ignited by the ejection charge. The parachute opens and suspends the burning star.

The closing cap has a raised pattern to aid in night identification of the star color. The red-star signal has a dot, the white-star has a short, straight line, while the green-star signal has a wide V in the middle of the cap. All three have a raised curved line, 1 inch in length near the edge of the cap. The outer surface of the signal is stenciled to indicate the color of the star, the Mk and Mod, manufacturer, lot, and the date of manufacture.

Signal, Smoke, Aircraft, Mk 7
Mod 0, Emergency Identification

This signal, used as a method of identification for aircraft, produces red, green, yellow, or black smoke while being suspended by a parachute. The case of the signal is an aluminum cylinder with a grenade-firing mechanism screwed into one end of the case, while the other end is closed by a metal cap. Inside the case is an ejection charge, pyrotechnic smoke charge, and a parachute. The parachute is made of silk, rayon, or paper.

Operation of the Mk 7 Mod 0 is similar to that of the Mk 6 Mod 0. The signals are identified as to color by the closing caps which are painted the same color as the smoke produced by the signal.

Signal, Smoke and Illumination,
Marine, Mk 13 Mod 0, Day and Night

The Mk 13 Mod 0 is a combination distress signal for either day or night use. Because of its small size and weight, it can be carried in the pockets of lifevests or flight suits and on liferafts. The signal is especially adapted for use by aircraft personnel downed at sea.

The signal consists of a metal cylindrical outer case with each end closed by a soldered cap; each cap has an attached pull ring large enough for the insertion of the index finger. The signal has two inner cans—one containing an orange smoke pyrotechnic, and the other a flare pyrotechnic. A brass pull wire is attached to the bottom of each cap through an ignition cap. Both ends of the signal are covered by paper caps to prevent the metal caps from being pulled off accidentally. (See fig. 13-10.)

Instructions for using the signal are printed on the cylindrical outer case. The flare end of

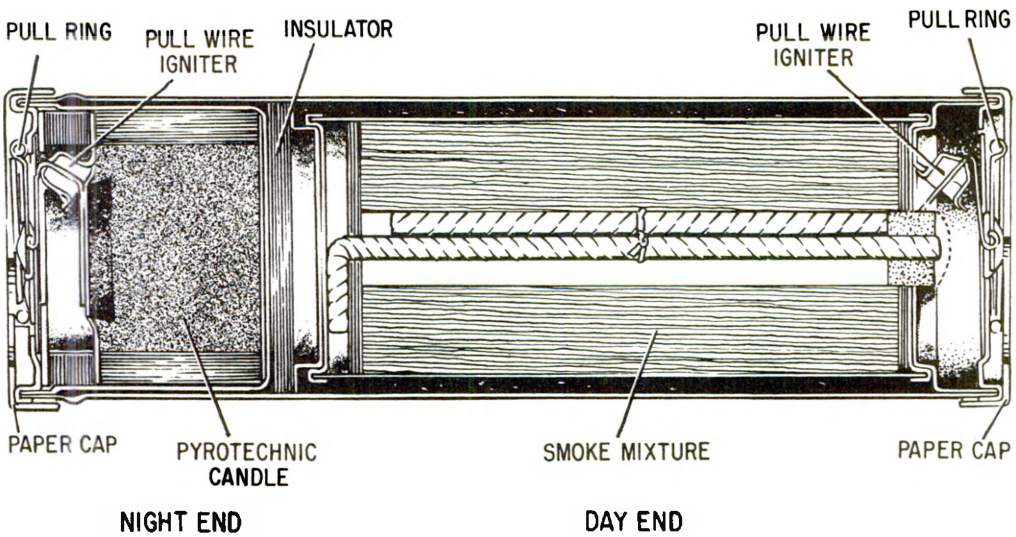


Figure 13-10.—Signal, Smoke and Illumination, Marine, Mk 13 Mod 0 Day and Night, cross section.

the signal (for night use) has raised projections extending around the body about one-fourth of an inch from the cap. These serve as an identification so that the signal can be correctly operated, even in total darkness.

When the "day" end is used, orange smoke is emitted; and when the "night" end is used, a pyrotechnic candle is lighted. Each section of the signal is designed to be held comfortably in the bare hand while it is functioning.

To operate the signal, proceed as follows:

1. Determine which end of the signal is to be used. Remove the paper cap which is glued to the signal body.
2. Point the signal away from the face and give a quick pull on the pull ring, removing the cap and igniting the composition. To break the seal, it may be necessary to bring the pull ring down over the rim of the can and twist it.
3. Submerge the signal in water immediately after use in order to cool the metal parts. The signal should then be retained for use of the opposite end, if required.

Special safety precautions applicable to the operation of this signal are as follows:

1. Never attempt to ignite both ends of the signal at the same time.
2. Do not handle the signal roughly.
3. Hold the signal properly to prevent drippings from hitting the hand.

Signal, Illumination,
Marine, AN-M75, Distress

This is a night, hand-held distress signal for use by aircraft personnel when forced down over water. It is small enough to be carried in the pockets of flight suits, life-jackets, and liferafts. The case has a length of 5 inches, a diameter of 1 1/8 inches, and the signal weighs 5 1/2 ounces.

To operate the signal, remove the screw type cap and hold the signal in one hand with the igniter end pointed upward. Before attempting to fire the signal, unfold and fully extend the double-wire loops attached to the notched retainer fork. A twist of the assembly or a sharp pull at right angles to the case releases the spring loaded firing pin, activating the signal. After a delay of 2 to 4 seconds, the first star is ejected to a height of about 125 feet. Following a further delay of 2 to 4 seconds, the second star is ejected to the same height. The burning time of each star is from 4 to 6 seconds at a minimum intensity of 8,000 candlepower.

Figure 13-11.—Marker, Location, Marine, Mk 25 and Mods assembled with Adaptor Kit, Mk 34 Mod 0.

CAUTION: The ignition end of the signal should be aimed upward, to leeward, and away from the face and body. Do not look into the top of the signal. When the retainer fork is disengaged from the striker, the primer is ignited and this throws the igniter assembly about 10 feet away from the signal.

Signals AN-M75 are packed 5 to a metal can, 16 metal cans in a wooden shipping box. Stowage requirements are the same as for other pyrotechnic items.

MARKERS AND DRIFT SIGNALS

Marking pyrotechnics are used over water to provide a stationary reference point on the surface. They are used as aids to navigation by enabling a determination of drift to be made, to mark the point of initial contact with a submarine, to determine wind direction before landing, or to mark the location of the surface for emergency night landing. One type of marker produces a slick on the water while the other type burns, producing smoke and flame.

Marker, Location, Marine, Mk 25 and Mods

The Marker, Location, Marine, Mk 25 Mods 0, 1, and 2 (fig. 13-11), are approximately 18.5 inches maximum in length by 3.080 inches maximum in diameter and weigh approximately 4 pounds.

The Marker, Location, Marine, Mk 25 Mods 0, 1, and 2 are identical in external configuration and appearance with the exception that the Mod 0 has an instruction tag. The difference between the markers are as follows:

1. The Marker Mod 0 contains the Battery, Water Activated Mk 72 Mod 0 while the Mods 1 and 2 contain the Battery, Water Activated Mk 72 Mod 1.
2. The Mod 2 has an improved designed starter container.
3. The Mods 1 and 2 do not have an instruction tag; instructions are marked on the outer tube.

These markers are intended for ASW use to mark surface locations by producing a yellow flame and white smoke for a minimum period of 15 minutes within 15 seconds after striking the water. Markers may be launched from Pneumatic Retro Marine Marker Ejector Aero 1A or 1B, gravity dropped (with the adaptor kit (fig. 13-11)) from the S-2D aircraft stores dispenser, or may be launched by hand. The markers are designed primarily for use with antisubmarine warfare aircraft and will function when dropped

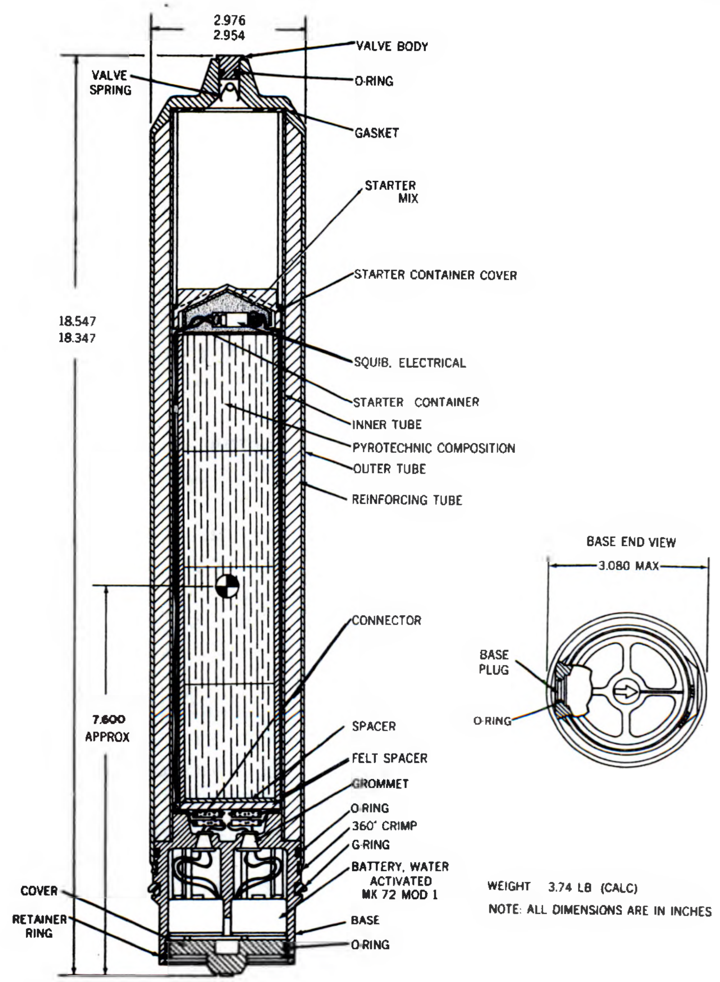


Figure 13-12.—Marker, Location, Marine, Mk 25 and Mods cross section.

from altitudes of 25 to 1,000 feet at speeds up to 200 knots.

The marker (fig. 13-12) consists of an aluminum outer tube closed at the nose end with a valve assembly and at the other end with the inner tube assembly. The inner tube assembly consists of a pyrotechnic candle contained in the inner tube that is attached to the base which contains two sea water activated batteries, two base plugs, a cover with arming indicator, and a retaining ring. A G-ring fits on the base. The base of the inner tube assembly is secured to the outer tube by a 360° crimp. The outer tube encloses all components of the marker except for the cover, base plugs and G-ring portion of the base, and the valve assembly.

The active contents of the marker are the pyrotechnic candle which contains approximately 2 pounds of a red phosphorus, manganese dioxide, zinc oxide and magnesium powder mixture and a starter mixture consisting of approximately 26 1/2 grams of lead peroxide, powdered silicon and cupric oxide, two squibs, and two batteries.

The markers prior to launching must be set on ARMED and the two base plugs must be pushed in for hand or gravity launching. When the marker is launched from the ejector the base plugs are pushed in by the ejector firing pressure. The marker, after being launched into sea water, floats on the surface. While floating, water enters the base plug holes in the base. The sea water acts as an electrolyte thus permitting the two batteries to produce sufficient electrical energy to initiate the electric squibs. The squibs ignite the starter mixture which activates the pyrotechnic composition. The burning of the starter mixture and pyrotechnic composition produces gases which build sufficient pressure to release the valve assembly, thus activating the marker.

The marker has the following two safety features:

1. The cover has safety stops which prevent accidental dislodging of the base plugs when the cover is set on SAFE. When the cover is set on ARMED, it is possible to push the base plugs in, thereby allowing water entry into the marker which would activate the batteries.
2. The marker is considered to be nonsusceptible to radiofrequency energy.

ADAPTOR KIT, MARINE MARKER MK 34 MOD 0.—The Adaptor Kit, Marine Marker Mk 34 Mod 0 is a cylindrical retainer which is used with the marker when gravity dropped from the S-2D aircraft stores dispenser. The adaptor provides a means of sealing the markers while in the dispenser.

The Mk 34 Mod 0 kit is used to make the Marker, Location, Marine Mk 25 and Mods compatible for use with the S-2D aircraft store dispenser by providing a method of sealing the markers while being retained in the dispenser. The adaptor is approximately 3 inches in diameter by 2.3 inches in length. The adaptor weighs approximately 0.3 pounds.

The adaptor kit (fig. 13-11) consists of a steel cylindrical retainer with a coil spring secured to the bottom. A leaf spring with rubber seal plugs at each end is attached to the coil spring by a small wire lanyard. A U-pin which is used to secure the adaptor to the marker is positioned at the top end of the retainer.

The base plugs of the marker must be pushed in prior to assembly of the adaptor kit on the marker. The marker with the adaptor kit is released from the S-2D aircraft stores dispenser. The coil spring provides energy necessary to separate the retainer from the marker. The leaf spring straightens out and opens the base plug holes completing the separation. The adaptor kit falls as one unit, the lanyard keeping the parts from separating. The marker will function as described earlier in this chapter.

SAFETY PRECAUTIONS.—The following precautions should be observed while handling or using the Marker, Location, Marine Mk 25 and Mods.

The markers are sea water activated pyrotechnic devices that do not contain a safety feature after the base plugs are pushed in and therefore can be hazardous to inexperienced personnel.

The markers contain a pressed red phosphorous mix composition which while burning produces a smoke that can be moderately severe when inhaled. The composition can also be a caustic irritant to skin and mucous membranes.

The valve body in the nose of the marker is expelled with considerable velocity after ignition of the markers and is a missile hazard; therefore the marker should be handled so personnel are not in line with the nose.

Markers must be set on SAFE until ready for use. This prevents the base plugs from being pushed in. When the base plugs are pushed in it is possible for water to enter the marker.

After removal from the ejector, markers must be set on SAFE by rotating the cover counterclockwise from the ARMED position to extreme SAFE position or have adaptor kits installed. Markers set on SAFE or with adaptor kits which are not dented or otherwise damaged may be returned to storage.

The G-ring must be present and not damaged. The G-ring prevents the marker from passing beyond the detents of ejector and from collapsing due to buildup of high pressure air against the outer tube.

Pneumatic launching of the marker should be only with the Aero 1A or 1B Pneumatic Retro Marine Marker Ejectors. Marker compatibility with other ejectors has not been proven.

Markers that show signs of damage or leakage, or are otherwise unserviceable must be disposed of in accordance with current regulations for disposition of pyrotechnic materials.

For more information on the handling and operation of the Marker, Location, Marine Mk 25 and Mods, refer to Marker, Location, Marine Mk 25 and Mods, Handling and Operating Instructions, NavWeps OP 2969 (latest revision).

Signal, Smoke and Illumination,
Aircraft, AN-Mk 5 and Mods,
Drift, Night

Drift signals and float lights float on the surface while burning and give a light and smoke which are visible to an observer in the aircraft from which launched. The AN-Mk 5 and Mods (fig. 13-13) is one of the most commonly used pyrotechnic items in naval aviation; it is used to determine the drift of the aircraft, to mark the location of an object on the water, or to provide a reference point for any purpose.

The Signal Mk 5 and Mods weighs approximately 4 pounds. The body is of wood, 3 inches in diameter and 19 inches in overall length. A flat diecast nose contains a water-impact fuze at one end, and at the other, a sheet-metal tail fin assembly is mounted.

The pyrotechnic mixture is composed of 3 pellets end-to-end, each pellet being 4 inches long and 1 1/4 inches in diameter, with a 0.22-inch hole through the center, through which passes a length of safety fuse. The pellets are enclosed in a metal pyrotechnic tube to keep the hygroscopic mixture from absorbing moisture through the wooden body. The signal burns from 12 to 15 minutes and the flame can be seen at night for a distance of 6 or 7 miles.

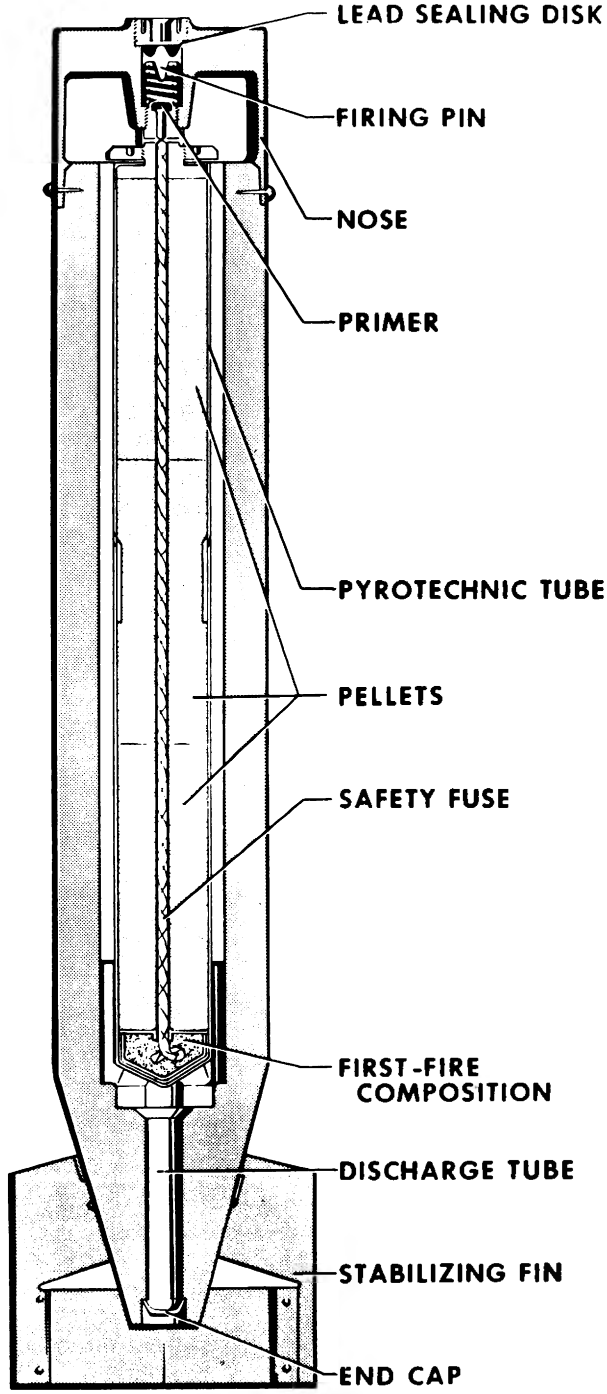


Figure 13-13.—Signal, Smoke and Illumination, Aircraft, AN-Mk 5 and Mods.

The white smoke is readily seen in daylight on clear days, but under hazy conditions, observation is difficult.

The AN-Mk 5 Mod 4 has a sensitized fuze which will function when dropped on the water from an altitude of 50 feet at 0 knots speed, or from any altitude if the release speed is 125 knots or greater. Earlier Mods function satisfactorily if released at speeds above 100 knots and altitude above 50 feet.

When launched from aircraft, the signal falls nose downward and on impact with the surface, the water breaks the lead sealing disk and drives the firing pin back against the primer. Flame from the primer ignites the safety fuse, which burns about 9 seconds, giving the signal time to return to the surface and right itself.

The safety fuse ignites a length of quickmatch which in turn ignites the first-fire composition. The first-fire composition produces enough heat to ignite the pellet, and gases generated break open the pyrotechnic tube and force out the cap which seals the end of the discharge tube. A flame 12 to 15 inches high and a white smoke are produced.

Drift signals are packed in individual corrugated boxes wrapped in a moisture-vapor-proof material, 25 such boxes to a wooden shipping box. They should be stowed in the containers in which they are supplied, in temperatures no greater than 100° F. Aboard ship they should be stowed in pyrotechnic lockers above decks, because burning drift signals produce large quantities of smoke, making firefighting difficult.

Signal, Smoke and Illumination, Aircraft, Mk 6 and Mods

The Signal Mk 6 and Mods (fig. 13-14) provides a long-burning surface marker for day or night use. It consists of a wooden body 5 1/8 inches square and is 20 1/4 inches long and weighs 16 pounds. The body contains four Night Drift Signal Mk 5 and Mods pyrotechnic candles, which burn successively for a total of 40 to 60 minutes. A flat die-cast metal nosepiece is attached to the forward end of the body, which causes the signal to fall nose down and to remain in an upright position, nose downward, while in the water. No tail stabilizing fins are used.

In the tail end of the body are a pull type igniter and the outlet holes for the four discharge tubes. Each hole is closed with a metal cap and sealed with a square of adhesive tape. This tape must not be removed prior to launching the float light. A safety fuse provides continuity between the igniter and the top of the first candle, and between the bottom of one candle and the top of the next. Normally there is no delay in transferring the flame from one candle to another but a delay of 12 to 60 seconds occurs between actuation of the igniter and ignition of the first candle. This is to give the float light time to return to the surface of the water and become stabilized. The Mk 6 Mod 2 may be launched from aircraft at any altitude up to 5,000 feet.

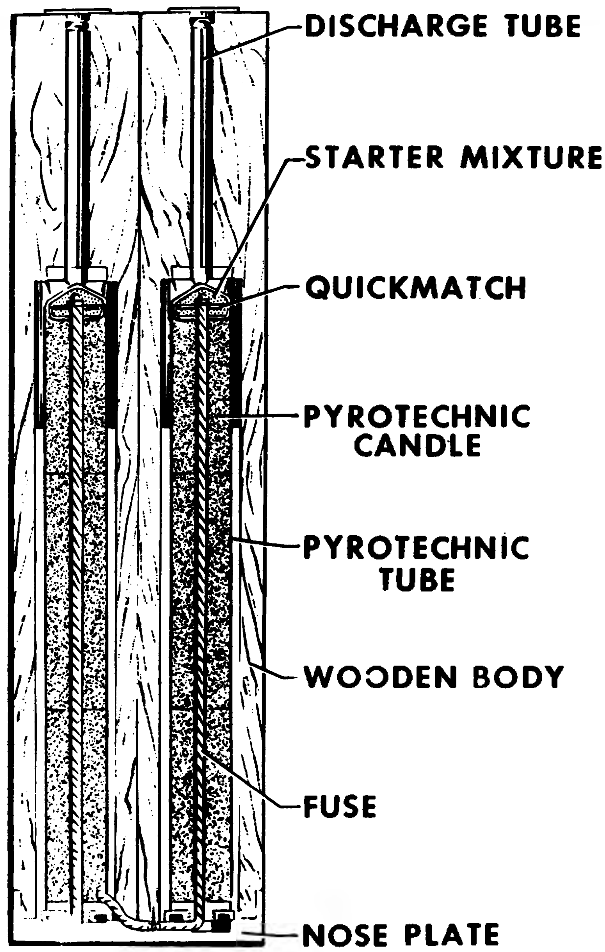


Figure 13-14.—Signal, Smoke and Illumination, Aircraft, Mk 6 and Mods.

The pull type igniter is actuated when the flare is launched by sharply pulling on the ring attached to the friction wire, either by hand or by a lanyard attached to the aircraft structure. The float light must be launched immediately after the igniter has been actuated. The igniter ignites the safety fuse which runs through the center of the body, and the fuse burns 12 to 60 seconds and then ignites the quickmatch and starter mixture at the top of the first candle. The gases generated by the burning candle break open the pyrotechnic tube which seals the candle from moisture, force out the end cap, and break the adhesive tape seal, allowing the gases to escape and burn. As each candle burns down to its end, a fuse is ignited which burns to the top of the next candle and ignites it, and this process is repeated until all four candles have burned. A flame 10 to 12 inches high and a white smoke are produced.

The Signal Mk 6 and Mods is packed individually in moisture-vapor-proof containers, six containers to a wooden shipping box. Aboard ship they should be stowed in pyrotechnic lockers above decks. Stowage temperatures should not exceed 100° F.

Signal, Smoke and Illumination, Aircraft, Mk 7 Mod 2

The Mk 7 Mod 2 signal produces light and smoke and is used as a reference marker. It consists of a die-cast metal nose and a wooden body tapered at the tail end. The nose houses the pressure-activated firing pin and primer. The cylindrical wooden body contains the pyrotechnic candle and the delay fuse in a round hole through the center. A hole extends through to the tail where it is covered by a metal cap. The delay fuse relays ignition from the primer, through a hole in the center of the candle, to the ignition composition at the tail end of the candle. (See fig. 13-15.)

The marker is launched from the Pneumatic Retro Marine Marker Ejector Aero 1A or 1B. The marker is ignited during ejection. The airblast during ejection exerts sufficient force to break the sealing disk and drive the firing pin against the primer. The delay fuse burns through the center of the candle, allowing the marker sufficient time to come to the surface with the tail out of the water. When the ignition composition begins to burn, expanding gases force out the cap, and the candle begins to burn with smoke and flame.

Practice Bomb Signals

Practice Bomb Signals Mk 4 Mods 3 and 4 (fig. 13-16) are essentially 10-gage shotgun shells of extra length. They contain an expelling charge of smokeless powder and are primed with a commercial primer.

The marker load of the Practice Bomb Signal Mk 4 Mod 3 is stabilized red phosphorus, and produces some flash, which could ignite areas adjacent to bombing ranges; whereas the Practice Bomb Signal Mk 4 Mod 4 has an inert load of zinc oxide.

The pyrotechnic or inert marker load is separated from the expelling charge by a disk and cardboard gun-wad. The end of the shell is closed by felt gun-wads which are secured by a cemented cover.

The signals are used either in the miniature or the larger practice bombs. Installed in the miniature practice bombs, the signals do not consistently produce a visible signal on impact with water or soft earth when dropped from an altitude of 10,000 feet or higher. The bomb, when dropped from that height, enters the water or earth so quickly that the signal frequently does not have time to function.

When the practice bomb in which the signal is installed strikes water or the earth, impact causes the firing pin in the nose of the bomb to impinge upon the primer of the signal. The primer ignites the expelling charge, forcing

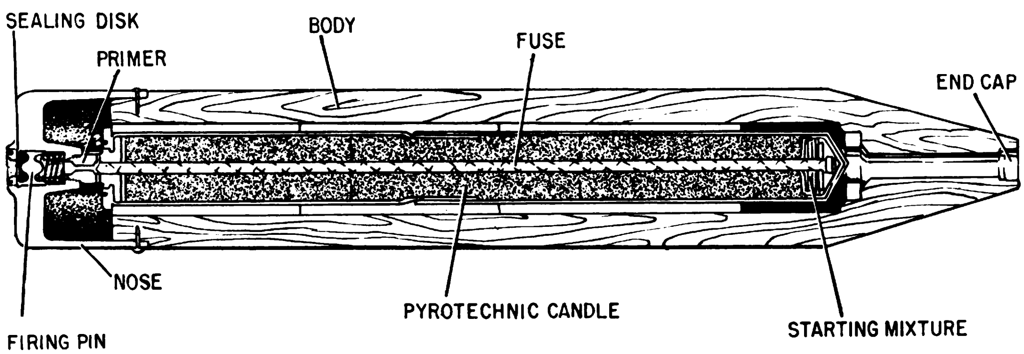


Figure 13-15.—Signal, Smoke and Illumination, Aircraft, Mk 7 Mod 2, cross section.

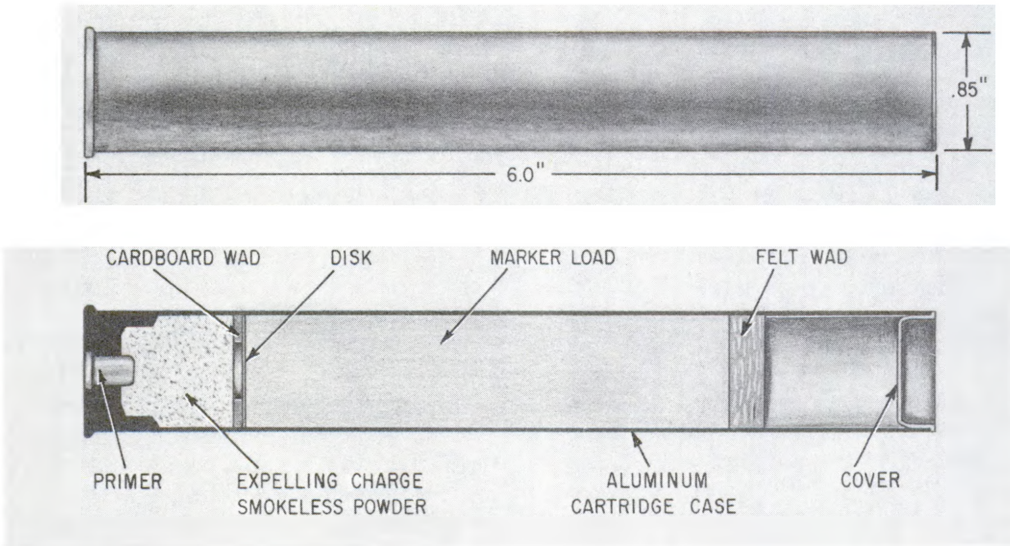


Figure 13-16. –Practice Bomb Signals Mk 4 Mods 3 and 4.

the marker load out through an opening in the bomb. The resulting flash and puff of white smoke permits observation as to bombing accuracy.

During loading operations, the signal is placed in position in the bomb. The firing-pin assembly then is inserted with the firing pin facing toward the signal. A cotter or plain pin is inserted in the nose of the bomb to prevent the firing-pin assembly and the signal from falling out.

The Mk 4 Mod 4 signal is similar to the Mk 4 Mod 3 with the exception of an inert marker load. In both mods the cover and cartridge case are cemented together.

Practice Bomb Signals Mk 4 and Mods are packed 50 to a cardboard carton, and 25 cartons to a wooden shipping box.

Rough handling may cause immediate functioning of the signal or may damage it so that it will not function properly.

Signals must not be unpacked in advance of requirements. If unpacked and not used, return them to their original packing.

Swollen or deformed signals are not to be used. The primer must be flush with or slightly below the base of the signal. Defective signals must be set aside and disposed of according to current instructions.

Under no circumstances should a signal case be opened, tampered with, or forced into the bomb recess.

MISCELLANEOUS PYROTECHNICS

The discussion of pyrotechnics included in this chapter is in no way intended to be conclusive or complete. Other items with which the Aviation Weapons Officer may have contact are: Drill mine signals, missile tracking flares, missile flash signals, and jet engine starter cartridges.

Although it is deemed impractical to discuss these items in detail, their function is included.

Drill mine signals are signals which are attached to airborne mines to provide visual indications of the mine's location in the water. They are used for training and in evaluation or testing work.

Missile tracking flares are test devices used as a visual and photographic aid to track the path of a missile during flight.

Missile flash signals are used to produce a flash which may be observed visually from the ground and evaluate the operation of the missile or circuits contained in the missile.

Jet engine starter cartridges are devices which are attached to certain aircraft engines which provide a flame to ignite the engine should normal means fail during a flameout.

LAUNCHING PROCEDURES

Pyrotechnic ammunition is one of the most widely used types of ammunition in naval aviation. Pyrotechnics of one type or another are carried in almost every Navy aircraft, including unarmed transport and training aircraft.

Pyrotechnics are composed of sensitive elements, such as fuzes, friction compositions, and primers, in addition to the pyrotechnic compositions which are hazardous in themselves.

Because of the hazards inherent in pyrotechnics, provisions are usually made in naval aircraft for stowing, launching, or releasing pyrotechnic ammunition. Pyrotechnics should be launched or released only from the devices provided in naval aircraft for this purpose. They should not be launched, released, or fired through ports, windows, or hatches because of the danger of a fire hazard that could result from a mishap.

Personnel engaged in launching of the various types of pyrotechnics should be familiar with the pyrotechnics in use and the associated launching equipment. Due to the enormous amounts of pyrotechnics used, the Aviation Weapons Officer should be constantly on the alert to insure that personnel engaged in using pyrotechnics are using standard procedures and equipment, and adhering to prescribed safety precautions.

SAFETY PRECAUTIONS

Pyrotechnics contain material of an extremely dangerous nature. Special precautions for certain pyrotechnics are prescribed in the section relating to the specific item. The following general precautions should be observed at all times.

Pyrotechnics should be handled carefully. Rough handling may cause immediate functioning, or may damage the item so it will not function properly at the time desired. Some pyrotechnic ammunition is more dangerous than other types of service ammunition, and its proper functioning is equally important.

Whenever possible, pyrotechnics should be stowed in the boxes or watertight containers in which they are supplied, and should be separated according to type, color, and lot number.

Functioning of pyrotechnics is affected by moisture, so they should be stowed in a dry, well-ventilated place. Most pyrotechnics are packed in moisture-proof containers; the seal of such packings should not be broken until just before the item is to be used. Pyrotechnics exposed to moisture should be segregated until an examination has proved they are safe and serviceable.

Pyrotechnics should not be stowed where the direct rays of the sun can strike them, and they should be protected from excessive and variable temperatures. The temperature in stowage spaces should be below 100°F. The main reason for this temperature limitation is that many pyrotechnic items incorporate commercial percussion type primers containing fulminate of mercury which deteriorates rapidly at temperatures exceeding 100°F.

Aboard ship, smoke-producing pyrotechnics should be stowed above deck if possible, because it is difficult to combat fire in these materials when they are stowed where the smoke produced is not blown away. Water-activated items should be stowed separately. If water is used to fight a fire, the water may spread the fire by activating the pyrotechnics.

Smoking or carrying lighted cigarettes, cigars, or pipes is not permitted in the vicinity of pyrotechnics. Matches and other flame or spark-producing articles should not be carried near places where pyrotechnics are stowed.

When a cartridge type pyrotechnic misfires, make at least two more attempts to fire it. If it still fails to fire, the pistol or projector may be unloaded after waiting a minimum of 30 seconds. Because of the possibility of hang fire, this rule should never be disregarded.

Because of the nature of pyrotechnics, most types deteriorate in a shorter period of time than other types of service ammunition. The oldest serviceable pyrotechnics available should be issued first to insure the continuing availability of a fresh stock.

Pyrotechnic ammunition aboard aircraft must be stowed securely. For example, a loose flare may ignite and cause a serious accident if the ripcord or arming plate fouls on other gear or on some projection.

Flares are more dangerous as a fire hazard than many types of ammunition because they are so easily activated and because of the great heat developed by the burning illuminant candle. Extreme care is necessary in stowage, use, and handling. Flares exposed to excessive moisture or mechanically damaged by rough handling must be returned to ammunition depots, dumped overboard, or burned. Flares should never be disassembled and parachutes or other components removed, nor should they be left in aircraft indefinitely grounded.

When directed by the Bureau of Naval Weapons, defective and obsolete items of pyrotechnics may be disposed of by either dumping overboard or burning. Dumping must be done at least 10 miles offshore and in water more than 500 fathoms deep. Dumping is preferred to burning because it involves less preparation and hazard. Full instructions for dumping or burning pyrotechnics may be found in OP 5, Volume 1, Ammunition Ashore. Specific instructions have been issued to cover the disposition of photoflash bombs and certain other items not mentioned in OP 5.

Photoflash bombs are extremely dangerous and must be handled with great care. They detonate with a high-order explosion. Duds should be handled with extreme caution, particularly if they have distorted or ruptured cases. The slightest friction may set off the loose photoflash powder with which these bombs are loaded and unfuzing duds of this class of bombs does not render them safe to handle.

If possible, such duds should be destroyed in place, using two 1/2-pound blocks of TNT. Such work should be undertaken only by qualified explosive ordnance disposal personnel. Removal of duds is extremely hazardous and should be performed only in emergencies.

CHAPTER 14

NONCOMPUTING SIGHTS AND BORESIGHTING

A great deal of time, effort, design engineering, money, and experimentation have gone into the production and installation of the ordnance and armament materials that equip our current operational aircraft. The armament equipment installed and the ordnance load carried are there for one major purpose–that of destroying any enemy whom we may be forced to engage in combat.

Aircraft weapons systems and fixed armament equipment installed in the aircraft need to function properly under varying conditions with the weapons carried in order to complete an assigned mission. This is accomplished only when there is a working harmonization or alinement with the equipment installed in the aircraft and the payload being delivered against the enemy target.

This chapter presents a brief coverage of the development of the various aircraft sighting methods, alinement procedures, and usage of noncomputing sights in current naval aircraft.

Also included in this chapter is a discussion on aircraft boresighting, including terminology, equipment used, procedures, and boresighting safety precautions.

GUNSIGHTS

As early as World War I, it was recognized that a faster more accurate sighting method must be devised for aiming guns from aircraft. The necessity for increased speed of alinement became more apparent as the aircraft's capability of carrying a variety of weapons and the speed of the aircraft increased.

The development of methods of sighting from the "seaman's eye" system to the present methods has kept pace with the development of aircraft from the "flying Jenny" to the supersonic jet.

Complicated computing gunsights and complex fire control systems have replaced the ring and bead sight and noncomputing gunsights in high speed aircraft in many instances. However, ring and bead sights and noncomputing gunsights are used in some current aircraft models and therefore are covered in the following paragraphs.

NOTE: The term gunsight, is a holdover from pre-World War II days at which time guns were the fighter aircraft's main armament. Actually, present day gunsights are general purpose sights which can be used for firing guns, rockets, and missiles, or for dropping bombs, torpedoes, mines, etc.

RING AND BEAD SIGHT

Currently, the ring and bead sight is used mainly in one operational aircraft type, the S-2D. In the S-2D aircraft the ring and bead rocket sight is used by the pilot to aim the aircraft toward a target when firing rockets. The ring sight is stenciled on the inside of the pilot's windshield (using a special tool for alinement). The bead sight is mounted in the outer skin panel in front of the pilot's windshield. The bead sight is a tapered post with a spherical bead at one end. The other end is threaded and is screwed into a support fitting located in front of the left windshield at approximately station 66. The bead sight is secured with a capnut and O-ring assembly that fits over the bead sight and is screwed onto the support assembly. The bead sight is adjustable by loosening the capnut and rotating the bead sight until the proper height and angle is achieved.

ILLUMINATED SIGHT MK 8 MOD 8

The Illuminated Sight Mk 8 Mod 8 (fig. 14-1) is a fixed, pilot-operated, general purpose

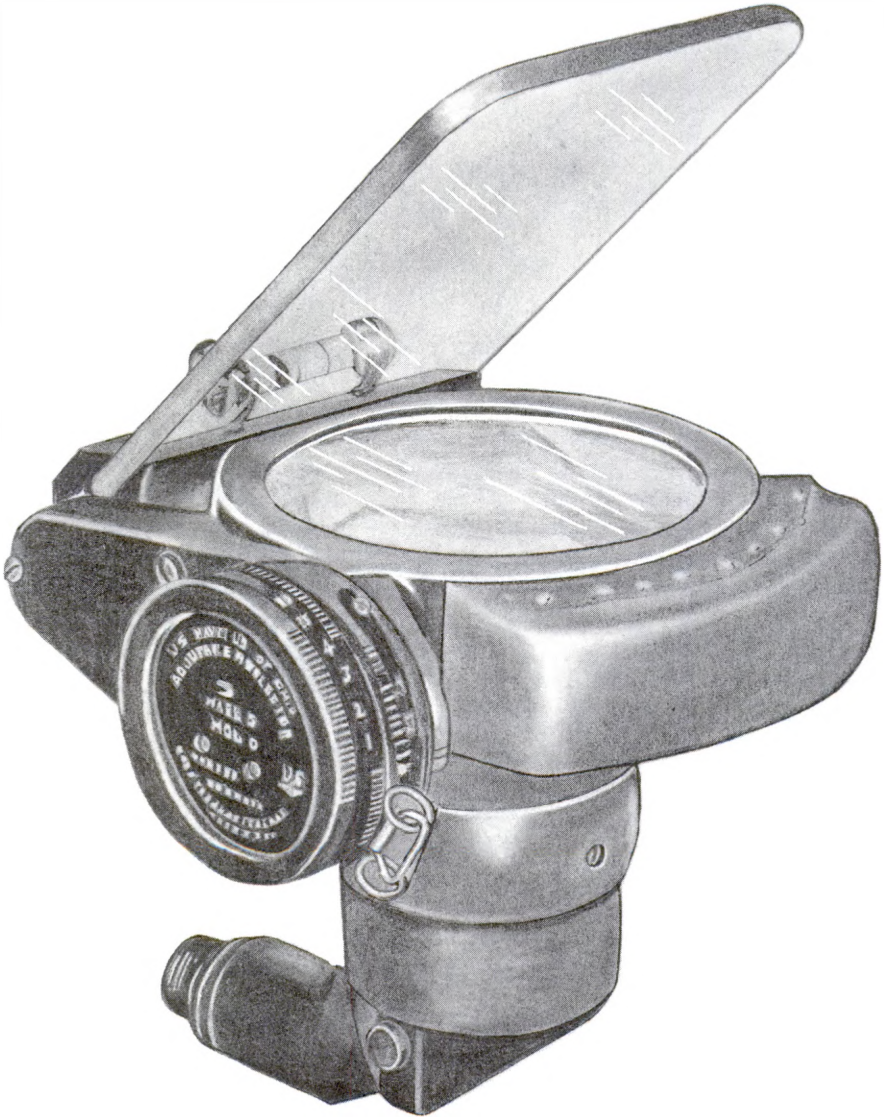


Figure 14-1.—Illuminated Sight Mk 8 Mod 8.

sight currently used for firing rockets in patrol type aircraft. The sight has an adjustable reflector plate allowing the pilot to set in a wide variety of lead or lag target angles. The sight is mounted in the inverted position forward of the pilot and can be removed and stowed when not in use.

The sight is constructed on the same principle as the illuminated reticle system shown in figure 14-2. It consists of a light source, a reticle disk, collimating lenses, and a reflector plate. Rays from the light source pass through a color filter and then through a reticle which establishes the desired pattern. Next, they pass into a lens system which enlarges the pattern and collimates (makes parallel) the rays. Finally, the rays pass to a reflector plate or the windshield where the pattern is viewed by the pilot.

The sight is constructed in two parts: The lamp housing, and the sight body, upon which

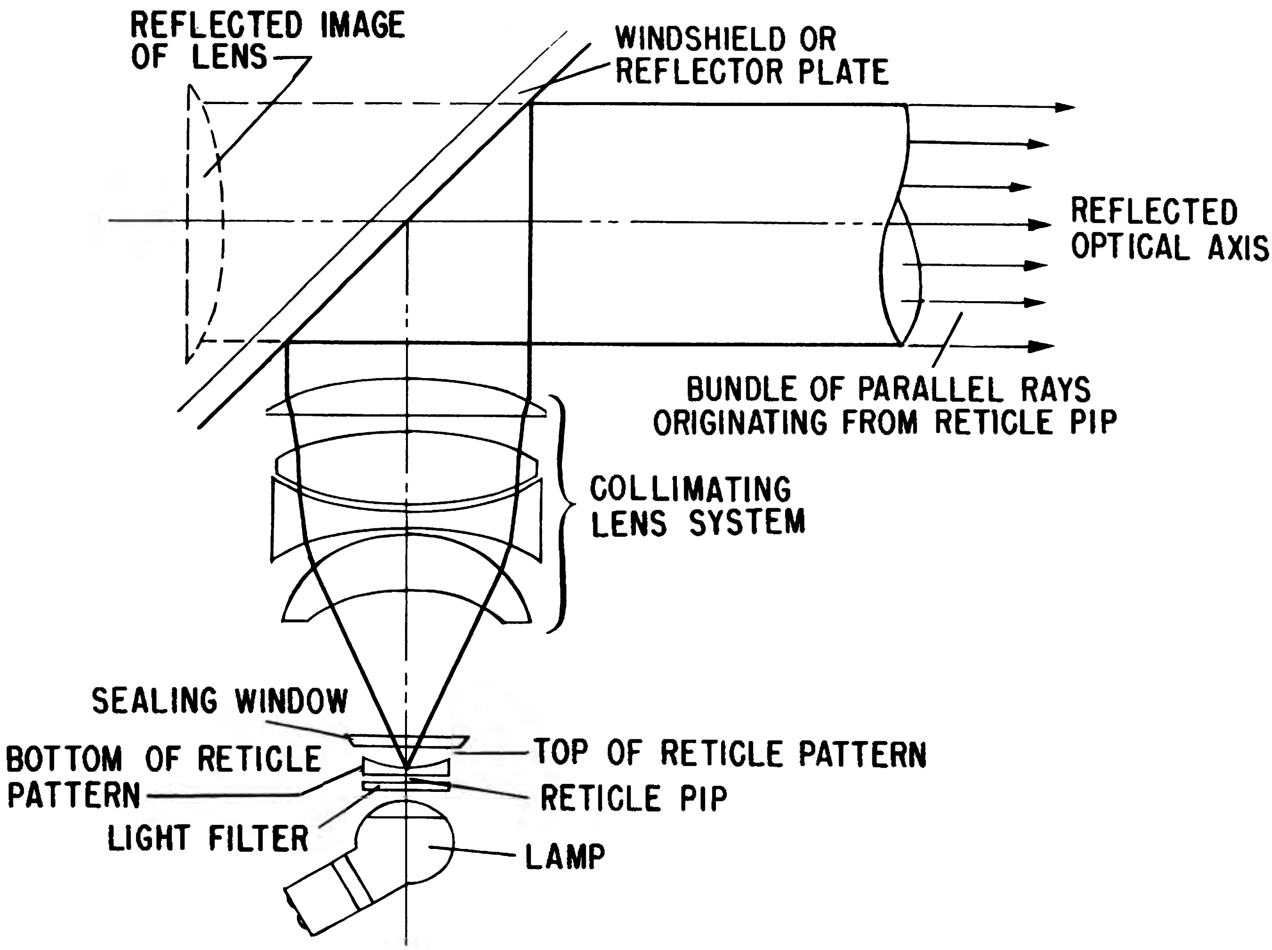


Figure 14-2.—Optical diagram of illuminated sight system

are mounted the reflector plate and the sun filter. An inclinometer, which is simply a spirit level to tell the pilot whether the aircraft is sliding or skidding during a firing run, is attached to the reflector plate mount. A soft rubber crash or buffer pad is cemented to sights which are mounted directly in front of the pilot's head to prevent injury from sudden stops. A rheostat switch is mounted on the pilot's instrument panel and is used to brighten or dim the lamp according to the light conditions existing at the time of attack. A filament selector switch, also panel mounted, enables the pilot to select the alternate filament in the sight lamp. Operating current for the Mk 8 sight is 24 to 29 volts d.c. supplied from the aircraft armament bus. The 21-candlepower, two-filament lamp is connected to the power source through a dimmer rheostat and a filament selector switch.

Operation of the sight is accomplished by turning on the sight switch and adjusting the rheostat for proper illumination. A mounting bracket is provided for mounting the sight to the aircraft and alining the sight vertically and horizontally. The mounting bracket consists of a sleeve which is clamped to the spherical surface of the sight body and a bracket on which the sleeve is adjustable, supported by three spring-loaded mounting screws. The screws are used to make boresighting adjustments. Three captive nuts in the bottom of the sleeve are used to hold three wedge screws between the spherical surface of the sight body and the inner surface of the sleeve. The wedging action of the screws clamps the sight body to the sleeve.

In the P-3A aircraft, the rocket sight light receives its power from the sight light circuit breaker on the forward lighting bus at the forward load center. The brilliance of the light is controlled by the sight rheostat located on the flight station left outboard overhead panel.

PILOT SIGHT ASSEMBLY

Another type of illuminated sight, the pilot sight assembly (fig. 14-3), is utilized in the A-4E type aircraft. This sight provides an adjustable, illuminated reticle image that is made visible in the pilot's field of view by a reflector plate. This permits the pilot to aline his aircraft relative to the target in azimuth and elevation, with a minimum amount of interference with his field vision.

This sight assembly consists primarily of a hermetically sealed elbow housing which contains the objective lens, two small lenses, and a mirror; an illuminated knob assembly which contains the condenser lens and reticle; a lamp assembly; a lever arm assembly; an inclinometer; and a counterbalance.

The illuminated knob assembly is located on the left-hand side of the elbow housing. The reflector plate assembly is above the objective

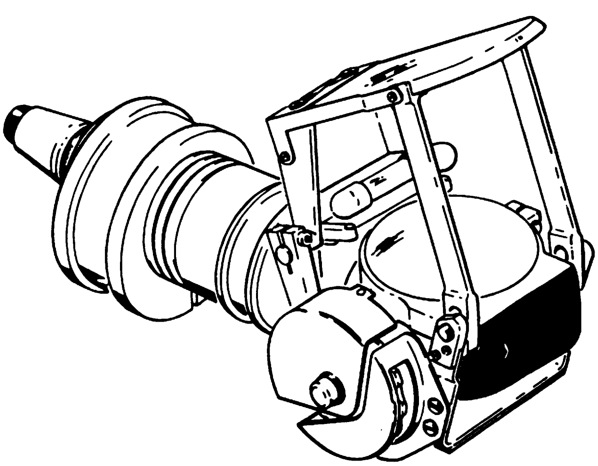


Figure 14-3.–Pilot sight assembly.

lens and is mounted on two struts and the follower assembly. The two struts are attached to the elbow housing and to the lever arm assembly; the follower assembly is connected to the cam in the knob assembly.

The lower housing, containing the condenser lens and reticle, is attached to the lower end of the elbow housing. The lamp assembly is attached to the end of the lower housing with bayonet type fittings for accessibility. A counterbalance is clamped to the exterior of the lower housing assembly. The inclinometer is mounted on an adjustable adapter under the lower end of the reflector plate assembly, so that it may be seen while sighting through the reflector plate. A crash pad is cemented to the sighting end of the elbow housing for the protection of the pilot.

The reticle is illuminated by light from a remote-controlled lamp and its reflector through a condenser lens. The reticle is located at the focal plane of an optical system consisting of two achromatic doublet lenses and a mirror. This optical system produces an image of the reticle which is reflected by a beam-splitting reflector plate in such a manner that when a target is viewed through the reflector plate the reticle appears superimposed on the target.

Adjustment of the position of the reticle image in elevation is controlled by the knob assembly. The follower assembly, which is pivoted on the same shaft as the reflector plate, has rollers that ride on the cams of the knob assembly. As the knob is rotated, the follower is moved, changing the angle of the reflector plate relative to the pilot's sight axis.

The pilot selects the desired mil angle by rotating the knob assembly, which is graduated in mils from 0 to 270.

Once the desired mil setting is selected, it can be locked in this position by pushing the lever arm assembly down until it bottoms. The lever arm assembly must be in the full up position before any knob adjustments can be made. A shield attached to the lever arm assembly prevents an inadvertent attempt to force the knob to turn while it is in the locked position.

Complete service and overhaul instructions with parts breakdowns of the pilot sight assembly are covered in NW 11-10C-21.

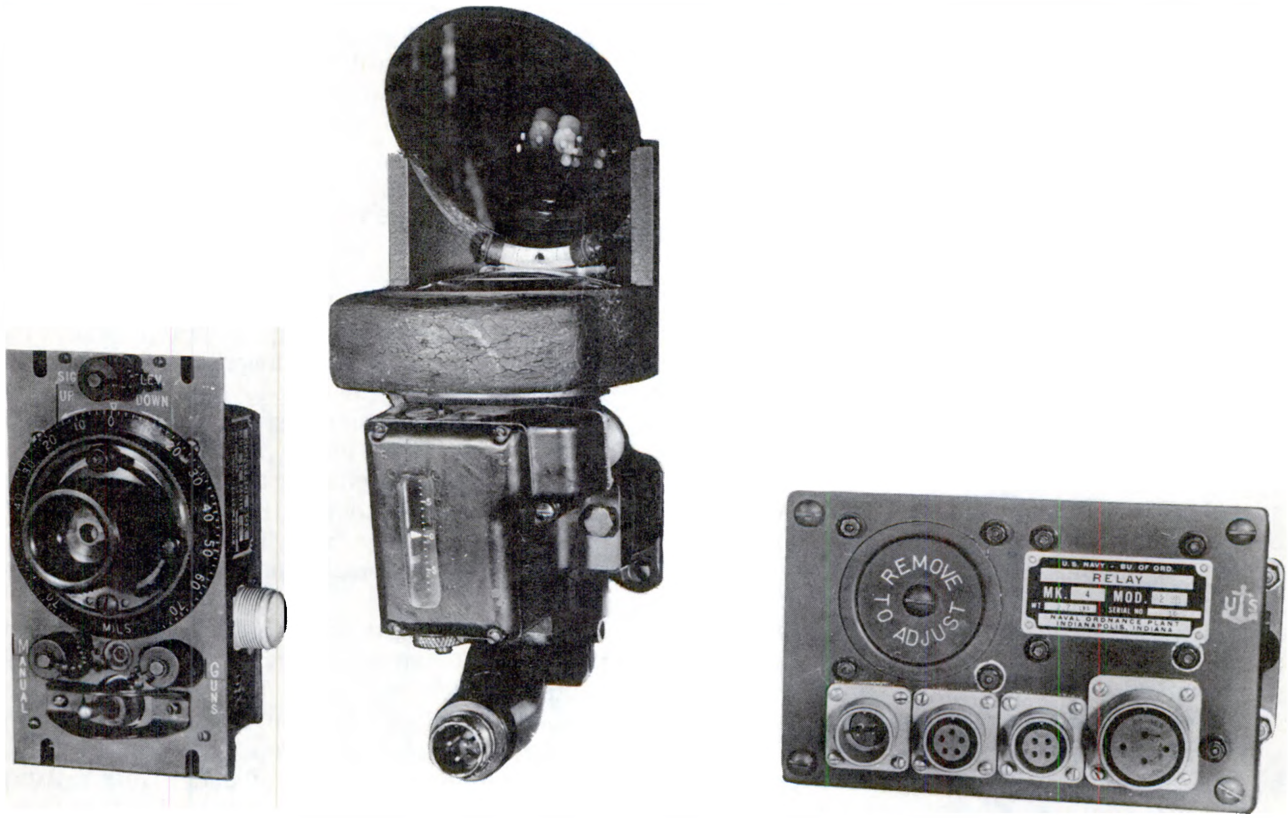


Figure 14-4.—Aircraft Sight System Mk 1 Mod 1.

AIRCRAFT SIGHT SYSTEM MK 1 AND MODS

The Aircraft Sight System Mk 1 Mod 1 (fig. 14-4) is an assembly of components designed as a general purpose sight system for use in aiming the aircraft during air-to-air gunnery or in air-to-surface operations. The system provides the pilot with a reticle pattern similar to that furnished by the Illuminated Sight Mk 8, except that the Mk 1 is adjustable in elevation. The adjustment is made by a servomotor which is, in turn, controlled by a dial on a control box that is readily accessible to the pilot.

The system enables the pilot to shift rapidly and accurately from gun to bomb position during air-to-surface fixed gun strafing, rocket firing, and bombing operations. It also provides a zero sight line for aiming the aircraft's fixed guns when needed for air-to-air gunnery.

Due to the current limited use of the Aircraft Sight System Mk 1 and Mods (used in A-1 type aircraft), minimum coverage has been afforded in this text. For more detailed information on this system, the Aviation Weapons Officer should refer to the publication, Aircraft Sight System Mk 1 Mods 0, 1, 2, and 3, NA 11-70GCA-501.

AIRCRAFT BORESIGHTING

The purpose of boresighting aircraft armament is to establish a relationship between the flight attitude of the aircraft, the bore axes of the armament, and the axis along which the sighting is projected. The theory of boresighting involves analyzing pertinent ballistics and mechanical data in establishing the relationship between the sight line of the aiming device (sight) and the trajectory of the projectile being fired or launched in order to predict the mean point of impact at predetermined ranges. No sighting device can do its job accurately unless it is properly alined with the armament with which it is used. Thus, the sight and armament must be made to function together. The technique of making them function together is called boresighting.

Aircraft guns are boresighted so that their axes of fire either converge or remain parallel throughout the trajectory. There are tactical advantages to be gained in both of these boresight methods. When the guns are boresighted to converge at some point along the axis, a more concentrated fire will exist at this point, thereby producing a more deadly fire when the target is at the point of convergence. When the guns are boresighted so that they are parallel to each other, their concentration is the same throughout the entire range of the guns. Thus, the "lethal density" of the concentration is the same at all points within the range of the guns.

Modern high performance aircraft have their guns mounted in the wing roots or the fuselage. Installations in which the guns are mounted in the fuselage normally use parallel boresighting. However, the final decision as to how they are to be boresighted is controlled to a great extent by their intended tactical employment and by the needs and desires of the operating activity.

BORESIGHTING TERMINOLOGY

To facilitate understanding of the theory and practice of boresighting, the terms used in connection with boresighting are defined below:

1. Armament datum line–A longitudinal line established on or within the aircraft by the manufacturer, having a fixed relationship to the angle of attack of the aircraft.
2. Datum point–A definite point on the boresight screen or target where the line of sight through the boresight alinement sight will strike when the aircraft is properly alined with the boresight screen or target. Its position with regard to the centerline is given in the Maintenance Instructions Manual for each specific aircraft.
3. Boresight datum line–An imaginary line through the boresight fixture to the datum point on the target screen. The boresight datum line may or may not be parallel to the armament datum line, depending on the model of aircraft.
4. Angle of attack–The angle of attack and the boresight datum line of the aircraft are intimately associated. When the aircraft has been set up or positioned so that the datum line (or the datum line sight, depending on the specific model of aircraft) is horizontal, the aircraft may be said to have assumed its proper angle of attack for boresighting. This is true only because the manufacturer has previously computed the angle of attack with the aircraft under a definite set of conditions. These conditions are deemed to be the optimum for a particular flight condition (combat condition). When the aircraft is leveled and boresighted, its boresight datum line and the angle of attack are in such relationship to each other that projectiles strike the target at the specified range under the conditions mentioned. If the conditions of altitude, gross weight, angle of dive, acceleration of gravity, and airspeed are changed to values other than those set up as the optimum, corrections will have to be made. In most operational aircraft, these corrections are made automatically in the fire control system.
5. Flight attitude–This is the position of the aircraft while airborne in normal unaccelerated flight. Normal flight is the condition that exists when the aircraft is in level flight, is at its critical altitude, is flying at V max (average combat speed), is under full military power, and has a full military load and one-half its total fuel capacity.
6. Flight line–This is the line in space along which the aircraft is moving.
7. Zero sight line–The sight line through the fixed pipper of the sight which is parallel to the armament datum line.
8. Line of sight–The straight line from the eye to the object observed.
9. Sight angle–The angle between the zero sight line and the line of sight at the instant of firing or releasing. For a zero sight angle, the line of sight is through the fixed pipper of the sight. Sight angle may be positive or negative. It is positive when the zero sight line is above (beyond) the impact point, and negative when the zero sight line is below (short of) the impact point.
10. Sight axis–The straight line from the pilot's eye through the fixed pipper which extends out into space.
11. Impact point–The point at which the projectiles or missiles strike the target in a correctly solved fire control problem.
12. Bore axis–A straight line through the center of the bore of the gun (from chamber through muzzle) which extends out into space.

13. Bore line–The line in space along which the bore axis of a gun is projected. This line is established by the boresighting procedure.

14. Mean point impact (M.P.I.)–The average point of projectile impact from a gun where the heaviest density is registered.

15. Point of convergence–The point at which the bore axes of two or more guns intersect or converge. It also may be the point at which the sight line and the bore axis intersect.

16. Dispersion–The spread of projectiles from each gun due to muzzle whip and other ballistic factors.

17. Lethal density–The concentration of projectile impact density within a given area.

18. Trajectory–The actual path transcribed by the center of gravity of the missile or projectile in free flight through space.

19. Bullet drop–That portion of the trajectory attributed to time of flight factors of a projectile.

20. Launcher line–The longitudinal axis of the rocket or missile while fixed in the launcher.

21. Parallax–The apparent displacement of the position of an object caused by a shift in the point of observation.

22. Allowance for parallax–A correction to the sight made by adjusting the mount to change the sight angle to compensate for the fact that the sight is above the gun, rocket, and missile launcher, or bomb station.

23. Target screen–A fixture having separate aiming points for sights, individual guns, camera, and datum sights. It may be designed for use at any given distance in front of the aircraft. These screens may be painted on plywood, fiberboard, screen, hangar doors, or bulkheads. They are normally designed for use at distances of 10 to 300 yards.

24. Parallel boresighting–Alinement of all the armament of an aircraft and its gunsight so that the bore axes and the line of sight are parallel–parallax not considered.

25. Convergence boresighting–Alinement of all armament of an aircraft and its gunsight so that the bore axes and the line of sight converge at some predetermined range or ranges–parallax not considered. (NOTE: Combinations of parallel and convergence boresighting may be used. For example, the bore axis of each gun may converge in the horizontal plane but may be parallel to the sight axis in the vertical plane.)

26. Point boresighting–The point on the zero sight line to which the guns are boresighted. This type of boresighting is covered by instructions provided in the Maintenance Instructions Manual for the aircraft involved.

27. Mil–An angle whose tangent is 1/1,000, or an angle of 1 mil subtends 1 inch at a distance of 1,000 inches.

28. Datum sights (also called boresight brackets and target alinement sights)–These alinement sights may be ring and post, telescope, or ring and peep sights. When installed in the aircraft they are used to establish the correct line of sight (in relation to the armament datum line) between the aircraft and the boresight target. Some of these sights are adjustable, thus allowing for armament boresighting at different degrees of depression or elevation. In some installations the adjustment may be used to aline the boresight target with the lateral attitude of the aircraft, making leveling of the aircraft unnecessary.

29. Leveling lugs–Lugs or blocks built into the aircraft by the manufacturer and designed to be used with a spirit level or quadrant when leveling the aircraft for boresighting.

30. Leveling datum plate–A plate having lateral and longitudinal reference marks for use in leveling the aircraft with a plumb bob.

31. Plumb bob bracket–A bracket to which the plumb bob line is attached.

32. Projectile clearance gage–A tool for checking for sufficient clearance between the projectile path and the aircraft structure to insure that the projectiles do not strike the aircraft.

TYPES OF BORESIGHTING

The two standard types of boresighting are convergence and parallel. Each type is discussed in the following paragraphs.

Convergence Boresighting

For such tactical employment as ground strafing, it may be more effective to boresight the guns to converge at some point in range, thus giving more spread of gunfire at points in front of the point of convergence. In convergence boresighting, all guns are alined to fire to a certain point along the sight axis. This may be whatever distance is established by doctrine. The lethal density at this point in the trajectory is greatly magnified.

Each individual gun has its own dispersion due to muzzle whip or jump. This jump or whip is due to several factors–among which are the lack of rigidity of the long barrel, lack of rigidity of the gun mounts, and the fact that the barrel tends to elevate itself when the gun fires. Guns that are boresighted parallel have greater total dispersion than those which are boresighted to converge at a point. The effects of dispersion are less conspicuous in the guns which are boresighted to converge. Also, if one of the guns is not in proper boresight, the loss of its effectiveness is not as great for convergence boresighting.

Parallel Boresighting

Parallel boresighting (infinity boresighting) is used on installations where the guns are closely grouped in the fuselage. This type of boresighting produces a highly effective lethal density along the entire trajectory up to the maximum range of the guns.

NONCONFORMITY OF BORESIGHT FIXTURES

Each aircraft manufacturer furnishes the necessary dimensional data (in the Maintenance Instructions Manual) and boresight fixtures to properly aline the aircraft with a boresight screen or target. This equipment may vary considerably with the aircraft type. Types of fixtures may include a telescope with mounting posts, ring and peep sights, and T-slots. Regardless of the type of equipment sent with the aircraft by the manufacturer, its single purpose is to properly aline the aircraft with the boresight target prior to boresighting.

EQUIPMENT USED IN BORESIGHTING

Boresighting kits are usually composed of only the necessary equipment and accessories to perform a particular task of the boresighting process. The kits may be roughly divided into two distinct classes–kits for a specific equipment (20-mm guns, cameras, etc.) and kits for different model aircraft. The latter may contain datum sights, mount tools, projectile clearance tools, and other items necessary for use in conjunction with equipment kits to boresight aircraft.

Close quarters boresight kits may be obtained for some models of aircraft where a space limiting factor is involved. These kits are used in much the same manner as templates; and when used with extreme care, will allow accurate boresighting. These kits are designed for use in close quarters and should be used only when screen boresighting fire-in procedures are impractical.

Boresighting Kit Mk 3 Mod 0

Boresighting Kit Mk 3 Mod 0 is used for boresighting 20-mm aircraft guns in present gun installations. The principle of operation of the kit is based upon forming a telescope by inserting the breech and muzzle fixtures in a gun barrel. A telescope is formed with the barrel of the gun acting as the tube of the telescope. The telescope thus formed utilizes the last few inches of the barrel's muzzle end, making extremely accurate boresighting possible.

The focal length of the boresighting kit is dependent upon the length of the gun barrel and the adjustment of the eyepiece; consequently, guns with short barrels cannot be boresighted with the Mk 3 Mod 0 kit.

Detailed procedures for boresighting guns installed on aircraft are outlined in the appropriate Maintenance Instructions Manual prepared by the Bureau of Naval Weapons for the specific aircraft. These instructions include armament harmonization and necessary boresighting measurements for local manufacture of target screen and the relative locations of the target screen and the aircraft.

The boresighting kit contains the following items:

1. Breech end assembly.
2. Breech adapter.
3. Muzzle end assembly and warning flag.
4. Installation tool and tool extension.
5. Carrying case.

The carrying case and contents are shown in figure 14-5.

For detailed information on the use and maintenance of the Boresighting Kit Mk 3 Mod 0, refer to OP 2228 (current revision).

Camera Boresighting Equipment

Two basic types of gun camera boresights are in wide use at the present time. They are the film magazine type (fig. 14-6), which is inserted into the camera in place of the film magazine, and the camera type (fig. 14-7),

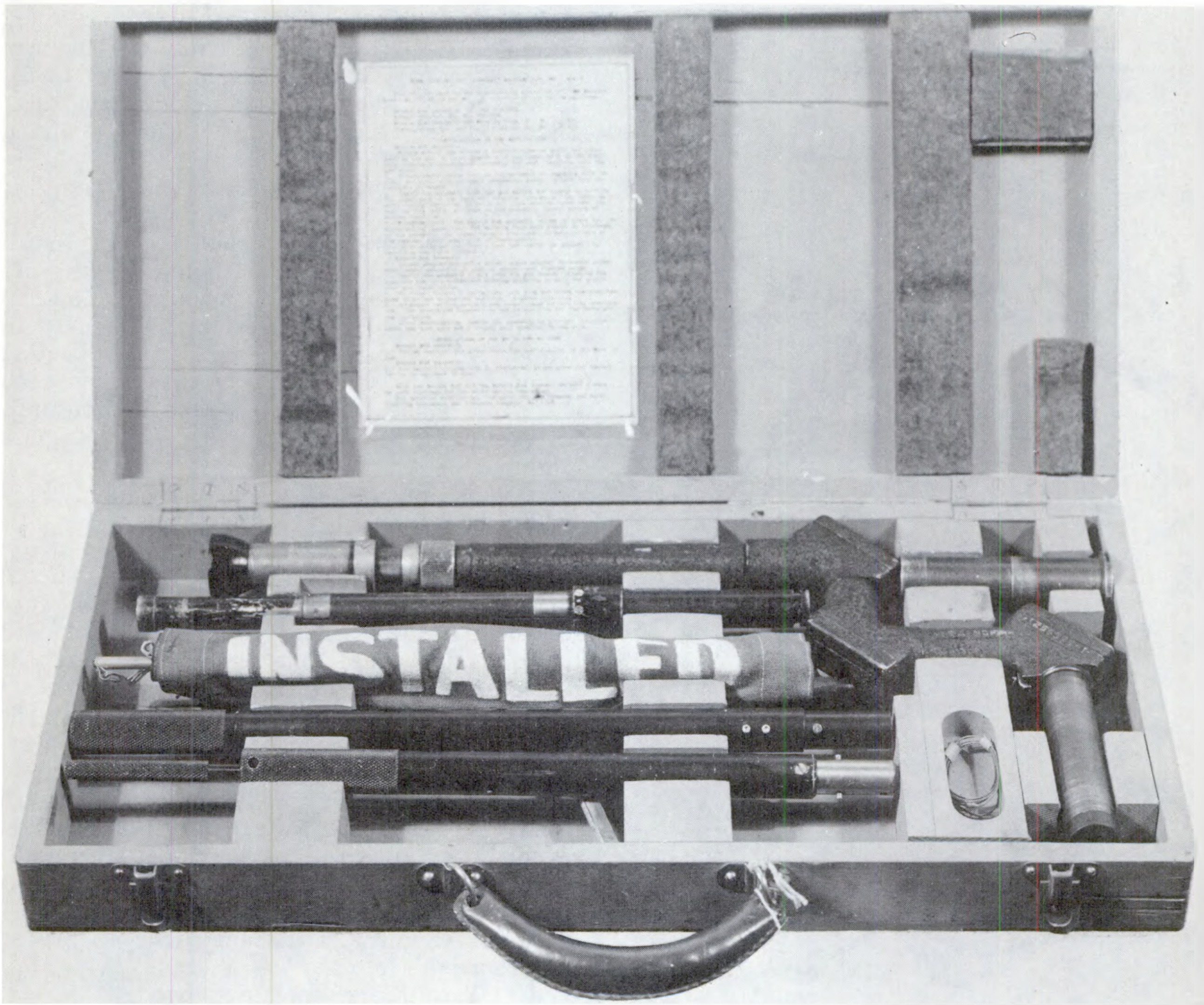


Figure 14-5.—Boresighting Kit Mk 3 Mod 0 and carrying case.

which actually replaces the camera on the mount adapter. The latter type is used where a camera adapter plate is bolted to the mount, providing for quick detachment and installation of the camera.

A gun camera boresight is a precision optical instrument and extreme care must be exercised in its assembly, disassembly, and use. It should be kept in its case when not in use. The optics in some boresights are made of optical plastic and demand special care in handling and cleaning. Use only authorized materials for cleaning of all optical equipment.

Although camera boresighting kits are issued with both straight and angle optical systems, it may be necessary in some camera installations to use special adapters which are furnished by the manufacturer of the specific model aircraft involved.

Launcher Boresighting Equipment

In some installations it is not possible to aline launchers, while on others the alinement of the pylons and launchers is required. On aircraft requiring alinement of launchers, a drawing or part numbers for the necessary

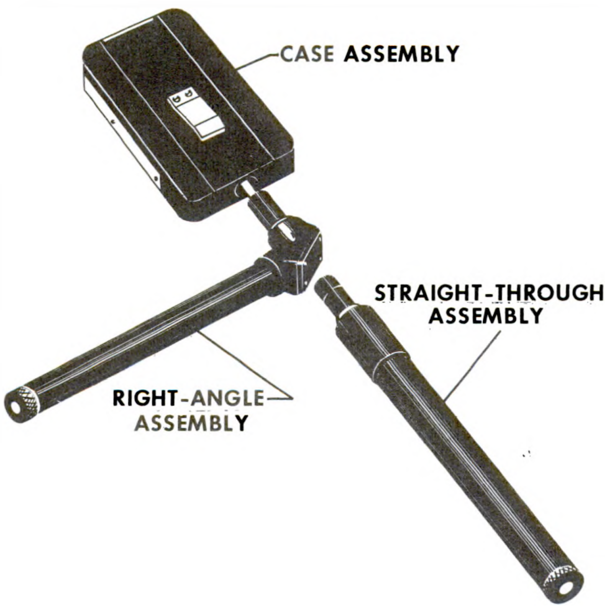


Figure 14-6.-AN-1 gun camera boresight.

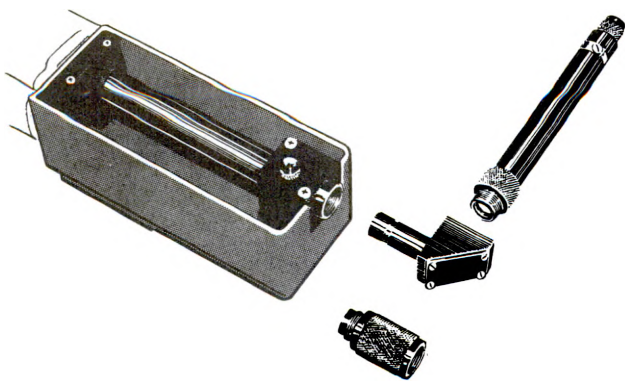


Figure 14-7.-Boresight Camera KB9A.

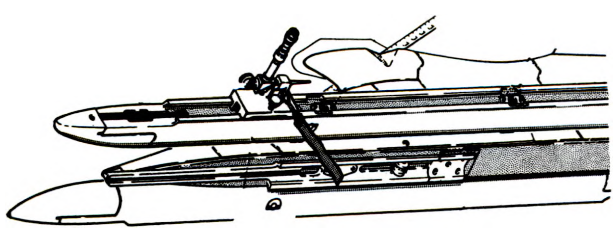


Figure 14-8.-Sidewinder launcher track boresight fixture assembly.

equipment are given in the armament section of the Maintenance Instructions Manual; for example, F-4B lists the Sidewinder launcher track boresight fixture assembly (fig. 14-8). This assembly may be used to boresight Sidewinder launchers in any installation requiring alinement.

In the majority of installations, launcher adjustments are limited to adjustments in the vertical plane which are normally accomplished by shimming under the launcher or mount. Horizontal corrections are usually confined to calibration, where the system is checked to determine if the launcher is alined within acceptable tolerance. In any case, reference should be made to the applicable Maintenance Instructions Manual before alinement is attempted.

Boresight Screens

Boresight screens or targets for operational aircraft are considerably more complex than for the aircraft of a few years ago. In addition to points for guns, sights, cameras, and the datum line, points for radar antennas, rocket launchers, and missile launchers may be required on the screen or target. The Maintenance Instructions Manual (Armament Section) for each type of aircraft gives a pattern and usually an alternate pattern for the boresight target board required for that type of aircraft.

There are many basic factors to be considered prior to the actual construction of a boresight screen for a particular aircraft. These factors are as follows:

1. Type of armament employed.
2. Type of sighting device used.
3. Range of the guns installed.
4. Range of the rockets and other armament installed.
5. Whether the guns are to be boresighted to converge or to be parallel.
6. At what range or ranges they are to converge.
7. The type and construction of the screen itself, as well as the materials from which it is to be constructed.
8. Gravity or bullet drop for range to which guns are boresighted.

The dimensions of a boresight screen should be such that all boresight points of the armament fall well within the sides, as well as have sufficient space in which to plot the vertical and horizontal reference lines. Therefore, the

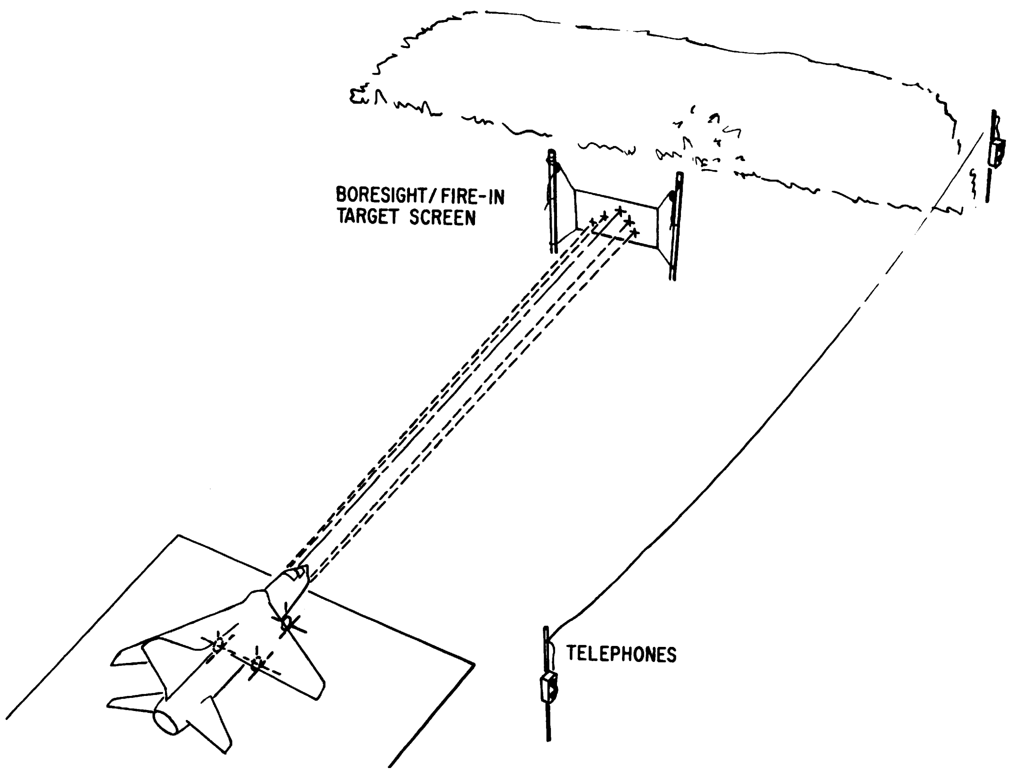


Figure 14-9.—Boresighted/fire-in range.

overall dimensions of the screen must be based on the distance the screen is to be used from the aircraft and the locations of the boresight points of the guns and other armament to be boresighted.

The boresight target or screen may be constructed of any suitable material. Where the guns cannot be fired-in, the targets are usually of rigid material, such as plywood or hard board. They may either have legs or be attached to a workstand or some other structure. These targets or screens may be reused for aircraft of the same type and model.

Where fire-in is possible, a screen made of banner target material or heavy paper material may be used. The screen may be attached to a light wood frame, much the same as target backing material is secured to frames on a rifle range. In the case of the target banner material, no frame is necessary. This nonrigid type screen may be used to boresight, and then fire-in the aircraft in certain situations. When used for boresighting and firing-in, the screen is usually mounted in the butts between two posts, which have rigging and tackle for raising, leveling, and securing the screen between them. (See fig. 14-9.) Provisions must be made for securing boresight screens of all types to insure that they remain in the same position until boresighting is completed.

Construction of boresight/fire-in screens is simple. The basic problem is one of making a stencil or template of heavy paper or any other suitable material. First, the target pattern, taken from the Maintenance Instructions Manual (or computed if the boresight pattern is to be nonstandard), is laid out on the chosen stenciled material. After the layout is completed, the points for the guns, launchers, sight, cameras, datum point, and reference lines are cut out of the stencil, usually in the shape of crosses or circles; the reference lines are cut in the shape of dash lines leaving sufficient material to insure that the stencil will not become distorted. The stencil may then be laid over the target screen material, and a spray gun or Aerosol can containing any suitable paint may be used to reproduce the pattern on the boresight screen material. With care, the stencil may be used to lay out many boresight screens. It can be cleaned and put away for future use.

BORESIGHTING PROCEDURES

In addition to the equipment already mentioned, many other items are required to boresight an aircraft. A source of power (a.c. and d.c.) and high pressure air, jacks, jackpads, level, tiedowns, and a kit of standard handtools are necessary to complete the routine boresighting of an aircraft.

An aircraft operating activity will normally have short slack periods in which there will be an opportunity to perform general armament maintenance and may include the boresighting of armament equipment. The Aviation Weapons Officer, working closely with the leading ordnanceman of their respective activity, will have to anticipate such periods and schedule the necessary work. (Past experience has shown that there is little actual time in which the aircraft is available for the important boresighting task.) All possible arrangements should be made in advance of actual boresighting, so that the job may be carried out in the minimum length of time and with the least confusion. Different boresighting equipment and gear may be needed for each type of aircraft. This fact should be taken into consideration when accumulating the necessary equipment. Since rockets and other types of missiles are widely used on modern combat aircraft, provisions must be made for proper boresighting of the launchers when necessary.

Whenever possible, guns should be fired-in after they are boresighted. This requires that the boresighting be carried out at the butts, which is the most desired arrangement, or after boresighting, the aircraft must be moved to the butts, alined, and securely tied down. Where boresighting can be carried out in the butts, the use of a boresight screen made of target banner material may be used to boresight and then test fire the guns. By using a different color of bullet tipping paint for each gun, an accurate and permanent record of the pattern fired by each individual gun is established. The only disadvantage of this method is that a boresight fire-in screen may be used for only one aircraft. However, the simplicity of construction of the screens (given previously in this chapter) makes it one of the most desirable methods of boresighting.

Unless the aircraft is boresighted at the butts, fire-in requires alinement of the aircraft, so that the guns will fire into the butts. Only practice ammunition may be used for test firing at the butts. This excludes all ammunition of pryotechnic and explosive classification.

All safety precautions must be observed at all times with particular emphasis on the handling of ammunition and the actual firing of the guns.

There will be a variety of circumstances, other than the above, which demand additional or different types of boresighting equipment. It is the duty of those in charge of the ordnance phases of work in the unit to anticipate the needs of the unit, and see to it that all is in readiness for the relatively short periods of time in which boresighting and general ordnance maintenance work may be accomplished.

Due to the many problems involved in boresighting present types of aircraft, shipboard boresighting should only be performed on aircraft that have close quarters kits (previously mentioned) provided, or in an emergency. Any emergency boresighting carried out aboard ship will have its own specific problems, which must be worked out as the situation dictates.

Planning the Operation

The Aviation Weapons Officer should be familiar with the various aspects of boresighting an aircraft.

A general plan for boresighting the aircraft of an activity may be as follows:

1. Plan the operation.
2. Set into motion the boresighting crews previously organized.
3. Prepare the screens, if not already prepared.
4. Schedule the boresighting.
5. Check the equipment to be used for availability and condition. Do not overlook the condition of the safety features incorporated.

6. Move the gear to the boresighting area.
7. Move the aircraft to the boresighting area.
8. Carefully position the aircraft the prescribed distance from the target screen, and elevate to boresighting position.
9. Check the aircraft's guns to see that they are clear (not loaded). Remove all ordnance from the aircraft (bombs, rockets, missiles, etc.).
10. Boresight the gunsight (this job is sometimes done by Fire Control Technicians).
11. Boresight the gun camera(s).
12. Boresight the guns.
13. Boresight all other armament (pods and launchers, etc.).
14. Have Fire Control Technicians boresight the fire control equipment (antennas).
15. Recheck all boresighting and alinement of the aircraft with the screen.
16. Safety wire or otherwise secure the armament.
17. Observe all range safety precautions. Be sure that all boresighting equipment and tools have been removed from the aircraft and accounted for. Insure that the aircraft is removed from the jacks prior to firing, so that it will not vibrate off during firing. Only authorized personnel should fire the guns.
18. Fire-in wherever possible.

As an Aviation Weapons Officer, you will undoubtedly be called on to teach and supervise the work of aviation ordnance personnel in any phase of ordnance and armament work in your unit. In addition, you may be called on to lecture to pilots on certain aspects of aviation ordnance. It is therefore expedient that your procedures and schedules be worked out to the best possible point in order that your time may be utilized most advantageously.

SAFETY PRECAUTIONS FOR BORESIGHTING

There is danger associated with all phases of ordnance work. Boresighting is by no means an exception. Boresighting may be conducted safely only when those participating in the work are able to recognize and understand the causes and effects of all the real and incipient dangers associated with this work, and are thereby able to avoid and prevent their occurrence. Listed below are some of the precautions which should invariably be taken in connection with boresighting. It is the responsibility of the Aviation Weapons Officer to insure that these safety precautions are observed. Some of these may seem inconsequential, but are generally found to be more far-reaching than at first supposed:

1. One of the primary precautions is to insure that all personnel concerned have a complete understanding of the operation of boresighting. This does not necessarily mean that the man whose only job is driving the tractor should know how to boresight all the guns on an aircraft. However, it does mean that those whose job it is to boresight the guns should know all of the procedures and safety precautions therewith associated.
2. Remove all external loads such as bombs, rockets, and internal stores in the bomb bays.
3. Use only tractor drivers who are thoroughly checked out, and use the proper towing gear in each instance.
4. Make use of elevated platforms or other types of check stands so that boresighting personnel may avoid clambering over the aircraft during boresighting.
5. Check the output voltage of the external power units.
6. Stay clear of the line of fire at all times. Even when boresighting from the muzzle with the bolt group removed, this practice should be enforced.
7. The boresighting crewmember in charge should personally check to insure that the feed mechanisms are disconnected and that chambers are empty each time before allowing the breechblock assembly to go forward into battery.
8. Never mechanically block or electrically "jump" the disabling switch. This device is placed in the gunfiring circuit for making the guns safe whenever the landing gear is lowered, either in the air or on the ground.
9. The breechblock assembly should be in its aft position in all guns being boresighted.
10. Insure that the jacking and hoisting equipment to be used in boresighting is of sufficient capacity (plus a safety margin) for the job at hand.
11. Always use the safety locks on the hoists and jacks once the aircraft is in the proper boresighting position.
12. While jacking an aircraft, check the jack feet to insure that the load weight is being evenly distributed and that the jacks do not become off balance.

13. The jack pads should be checked during the jacking process to insure that no slippage or shifting of weight occurs.

14. When an aircraft with tailwheel type landing gear is being boresighted, its center of gravity tends to rotate around the main landing gear as the tail is elevated. As the longitudinal axis of the aircraft approaches the horizontal, a nosing over moment may be experienced. Sandbags placed across the fuselage and on the horizontal stabilizer roots, preventer lines around the fuselage at the tail and anchored to a pad eye in the apron, or other suitable means must be employed to prevent possible upset.

15. When using a tail jack and two wing jacks, elevate the three at the same rate so as not to unbalance the aircraft.

16. Always handle the boresighting kit carefully as it is precision made optical equipment, and therefore very delicate.

17. If test firing is to be conducted to check boresighting, have sound powered communication equipment installed in the butts and at the aircraft site to expedite operations and serve as a safety measure.

18. When an aircraft is being boresighted or its guns being test fired while on a ramp, serviceable chocks have to be carefully fitted in place about the wheels and the aircraft properly secured.

19. Before boresighting or test firing the guns, check the gun mounts for worn components, security, and proper installation. Also check to insure that the guns are actually locked into the mounts.

20. Before firing-in, make proper projectile clearance checks, and repeat these checks each time any adjustment is made on a gun prior to firing.

21. In organizing the crews to boresight aircraft armament, limit the personnel only to those essential in the actual boresighting work and those who must observe for training purposes.

22. After boresighting has been completed, safety wire all adjustable elements or otherwise secure them to specifications, and check the aircraft compartments for tools and equipment that may have gone adrift during the work.

23. Always check to insure that all the boresight elements are back in the boresighting kit after boresighting is completed. Instances have occurred in which the boresight adapter and muzzle elements have been left in the gun muzzles with fatal results to personnel.

It is hard to find time and incentive to lay proper emphasis on safety precautions due to the commitments of daily routine operation and other distractions, yet accidents occur daily while carrying out these same routine operations. The obvious remedy to correct for such a condition to the greatest possible extent is to find time and impress on each person involved the seriousness of knowing, understanding, and complying with all pertinent safety precautions.

CHAPTER 15

ORDNANCE HANDLING EQUIPMENT

The handling of aviation ammunition from its arrival, into stowage, through assembly, and to the expending aircraft will vary considerably, depending upon the time, place, situation, and equipment available. The mechanical equipment used to handle ammunition afloat and ashore is often identical. On the other hand, differences in stowage accommodations, fixed installations, working areas, and space allowances sometimes require ammunition handling equipment and techniques specially designed for the job.

Handling ammunition is a difficult task for all personnel concerned, usually requiring a large number of personnel for many hours at a time. Moreover, the nature of the material demands that prescribed safety precautions be rigidly observed at all times regardless of the familiarity and monotony of the work. To ease the burden and reduce the danger of the ammunition handler's task, many items of handling equipment for ammunition and explosives have been designed. The number of such items is extremely large; however, the equipment covered in this chapter meets the primary requirements of most operating units, ashore and afloat.

The contents of this chapter are based primarily on the publications Handling Equipment for Ammunition and Explosives, Mobile Equipment (Volume 1, NavWeps OP 2173) and Handling Equipment for Ammunition and Explosives, Nonmobile Equipment (Volume 2, NavWeps OP 2173). For clarity and ease of discussion in this chapter, handling equipment has been divided into two sections—nonmobile and mobile.

NONMOBILE EQUIPMENT

Nonmobile equipment may be defined as equipment that has runners, legs, stationary support, or points of attachment to support other items and may merely adapt another piece of equipment to do a new and different handling job.

PALLETS

A pallet is a wood or metal platform upon which material can be stacked. Wood pallets consist of a top decking and a bottom decking, both of hardwood, separated by three equally spaced softwood stringers or spacers. The space between the top and bottom decking must allow the entry of forks of materials handling equipment. Wood pallets are being replaced by metal pallets for the handling of live ammunition. Metal pallets generally have a main deck or platform made of lengths of heavy steel wire welded to form a grid of 2-inch squares. The deck is welded to and supported by vertical supports and a number of parallel, heavy steel wire deck supports. The vertical supports are welded to the deck and to three steelplate base runners. These runners extend along the length of the bottom of the pallet. The complete pallet is thoroughly galvanized. Metal pallets are more durable than wood pallets, are not subject to warping, and do not present a fire hazard.

Pallet Mk 1 Mod 1

Pallet Mk 1 Mod 1 is a wood platform 48 x 48 inches square and 5 3/8 inches or more high. The bottom deck consists of four hardwood boards 5 5/8 to 6 inches wide. Two boards are placed near the center of the pallet and spaced 1 to 1 1/2 inches apart; the other two are placed at the ends of the pallet.

The pallet is a general purpose pallet used in conjunction with forklift or pallet trucks.

Pallet Mk 3 Mod 0

Pallet Mk 3 Mod 0 (fig. 15-1) is a steel wire weldment 40 x 48 x 4 3/4 inches. The pallet consists of a deck, deck supports, and steel bearing plates. The deck is composed of steel wire, formed into a grid pattern of 2-inch squares, and is welded to the deck supports. The bearing plates run fore and aft beneath the deck, with one plate on each side and one in the center of the pallet. Nine steel deck supports are welded to the bearing plates and to the deck. This pallet is called a four-way pallet, since it can be approached and raised with a forklift or pallet truck on all four sides.

The pallet is a general purpose pallet used in conjunction with forklift or pallet trucks to move and stack loads which are assembled on the deck of the pallet. (Refer to OP 2140 for specific palletizing and carloading instructions for handling ammunition with this pallet.) It is also suitable for the palletization of Fleet Issue Unit Loads, where specified, and for hoisting by a Pallet Hoisting Sling Mk 70 Mod 0.

Pallet Mk 7 Mod 0

Pallet Mk 7 Mod 0 is an all-metal pallet consisting of a deck, supports, and runners. The deck, 35 x 45 1/2 inches in size, is a weldment of steel bars and steel rods, positioned perpendicular to each other and forming a grid pattern. Three steel runners are positioned parallel to each other and to the longer dimension of the pallet. One runner, 6 inches wide, is placed at the center of the pallet; the other two, 3 inches wide, are placed at the outer edges. The deck is supported above the three runners by nine U-shaped steel supports—three supports for each runner. The supports are welded to the deck and the runners. This pallet permits four-way entry of pallet trucks and eight-way entry of forklift trucks. The pallet weighs 56 pounds. The space required to ship this item is approximately 5 1/2 cubic feet.

This pallet is designed to replace the Mk 2 type metal pallets in service. It can be used to support those sectionalized unit loads of ammunition which, when palletized, are 35 x 45 1/2 inches in size. This pallet is also suitable for hoisting by a Pallet Hoisting Sling Mk 70 Mod 0. (Refer to OP 2140 for specific palletizing and carloading instructions for handling ammunition with this pallet.) This pallet is suitable for palletization of Fleet Issue Unit Loads when specified.

Materials Handling
Pallet Mk 12 Mod 0

Materials Handling Pallet Mk 12 Mod 0 (fig. 15-2) is a steel wire and formed sheet steel weldment 35 x 45 1/2 x 5 1/8 inches. The pallet consists of a deck, supports, and runners. The deck is steel wire which is bent, assembled in a grid pattern of 2 1/2-inch

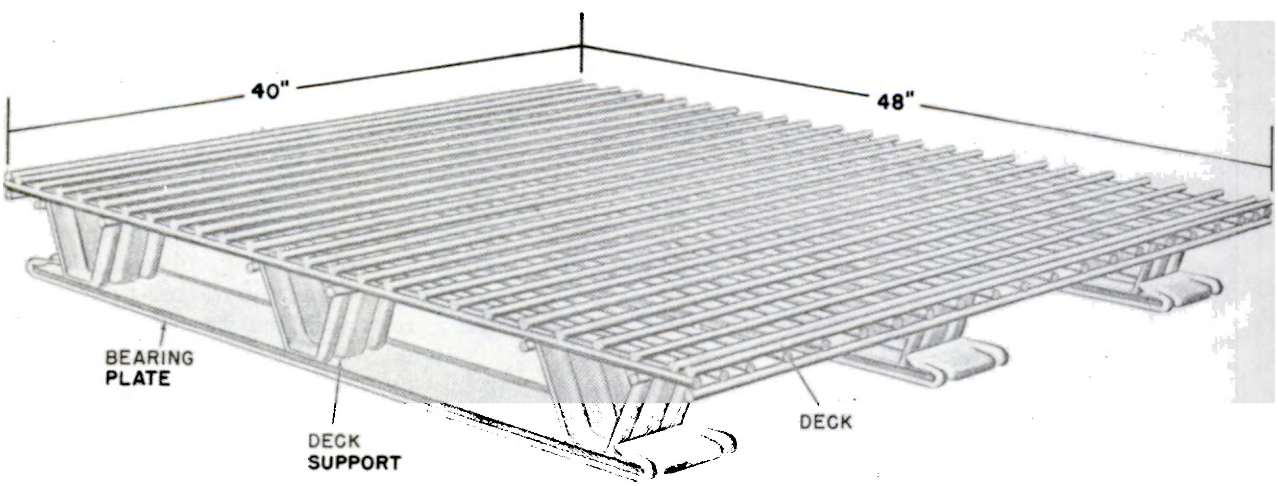


Figure 15-1.–Pallet Mk 3 Mod 0.

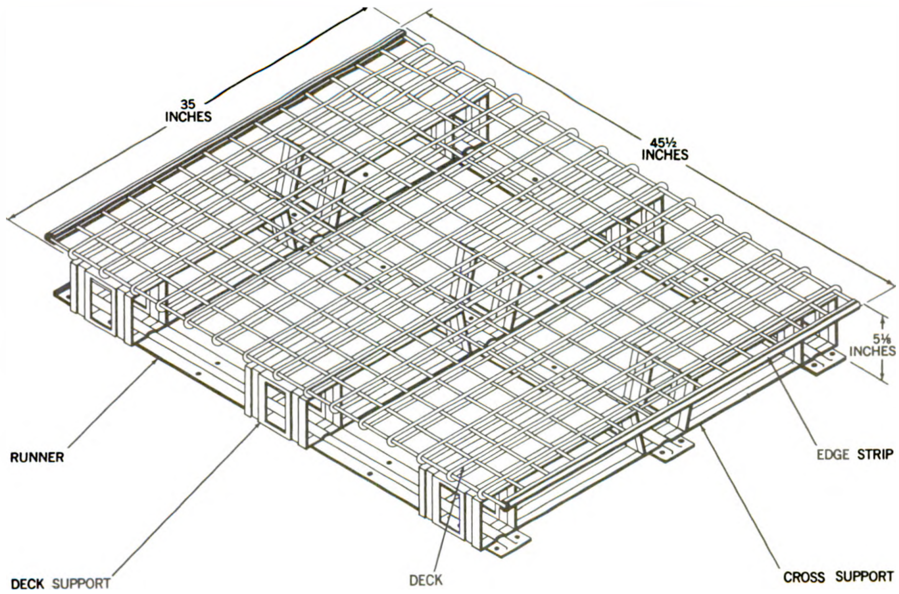


Figure 15-2.—Materials Handling Pallet Mk 12 Mod 0.

squares, and welded to the supports. Steel edge strips protect wire endings. Three formed sheet steel runners extend fore and aft beneath the deck, one running under each side and one under the center of the deck. The nine deck supports are integral with cross support members which extend laterally just under the deck and between the runners to make up a strong base for the pallet. This pallet is called "four-way" since it can be approached and raised with a forklift or pallet truck on all four sides. It weighs 110 pounds, and the shipping space required is approximately 5 1/2 cubic feet.

Materials Handling Pallet Mk 12 Mod 0 is used in the palletization of weapon components and containers for storage, handling, shipping, and transfer-at-sea. It is an improved version of Pallets Mk 2 Mod 3 and Mk 7 Mod 0. The base of the pallet is designed to permit hoisting with a bar type pallet sling in two directions. The capacity of this pallet is 4,000 pounds.

BOMB CARRIERS

Bomb carriers provide a quick and safe means of attaching a crane cable or other hoisting devices to a bomb for conveyance from one area to another. They may also be used in lifting bombs from skids for loading on the aircraft. Some carriers are designed for horizontal lifting, some for vertical lifting, and others may be used for both horizontal and vertical lifting.

The lifting lug type of bomb carrier consists of a steel beam with two carrying hooks. The hooks are spaced either 14 inches or 30 inches apart to coincide with the suspension lug spacing on an uncrated bomb. One of the carrying hooks has a spring-actuated safety latch for locking the carrier to the bomb. The beam of the carrier is also equipped with one or two lifting eyes to which a hoisting hook is attached.

Generally, the bomb carrier is used in conjunction with chain falls or overhead hoists in lifting and handling bombs. In a very few instances, two bomb carriers may be used together in handling the same bomb. For example, Bomb Carriers Mk 30 Mod 0 and Mk 25 Mod 0 are used in conjunction with each other on low-drag bombs.

When selecting a bomb carrier for a particular bomb handling situation, several important factors should be considered. The weight of load which the bomb carrier has to support must not exceed the bomb carrier's capacity. The method of bomb carrier attachment of the load must be such that the bomb carrier can be properly and securely assembled to the load. The type of lifting position desired must be determined, and also whether the bomb carrier is capable of lifting in that position.

Bomb Carrier Mk 4

Bomb Carrier Mk 4 (fig. 15-3) is used to lift and carry uncrated bombs weighing up to 2,000 pounds. The center lifting eye is bolted between a pair of sideplates, having a rigid hook at each end. These hooks, spaced 14 inches center to center, slide into the suspension lugs of the bomb. A spring-loaded latch prevents one hook from slipping out of the bomb lug, and holds the bomb in place until pressure on the upper extension releases the latch. A pin is also provided to prevent the latch from being accidentally opened.

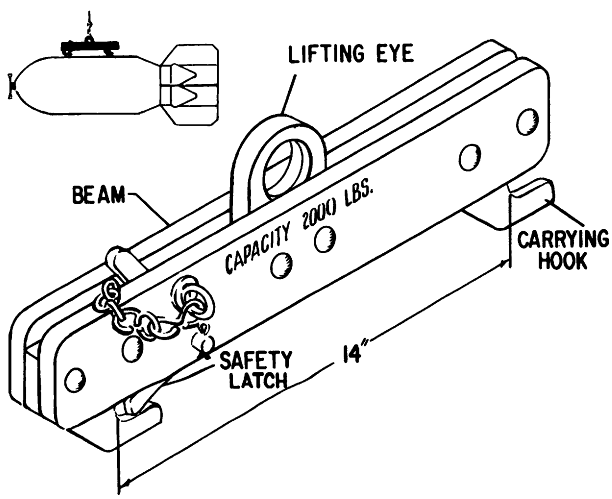


Figure 15-3.–Bomb Carrier Mk 4.

Bomb Carrier Mk 9

Bomb Carrier Mk 9 (fig. 15-4) is used to lift and carry uncrated bombs equipped with suspension lugs spaced 14 inches between centers. It has a capacity of 1,600 pounds. The Mk 9 is similar to the Mk 4 but is arched in the center. This provides clearance in the middle of the beam for installing a hoisting band while the carrier is in place on the bomb. A spring-retained latch and safety pin are provided as on other rigid hook carriers.

Bomb Carrier Mk 10 Mod 0

Bomb Carrier Mk 10 Mod 0 (fig. 15-5), which has a weight limit of 2,000 pounds, is a long beam type carrier. The beam consists of two steel channel plates riveted together.

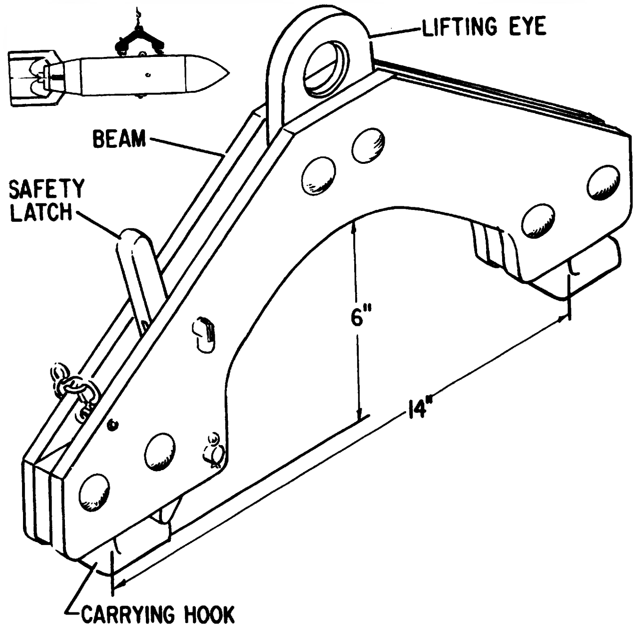


Figure 15-4.–Bomb Carrier Mk 9.

At the center of the beam is a sway brace which strengthens the beam at that point and prevents swaying of the bomb when lifted. One end of the beam is bent approximately 30 degrees to fit the contour of the bomb.

The carrier has two lifting eyes, one of which is used for vertical-position handling, the other for horizontal-position handling. Two pairs of carrying hooks are spaced 14 inches or 30 inches apart to fit the suspension lugs of the bombs. One hook of each pair of carrying hooks has a spring-retained safety latch which secures the carrier in place until the safety latch is released by pressure on its upper extension.

Bomb Carrier Mk 12 Mod 0

Bomb Carrier Mk 12 Mod 0 consists of a beam with a lifting eye in the center and a rigid carrying hook on each end. This carrier also has a retaining safety latch on one of the carrying hooks. The carrier has a capacity of 2,000 pounds and is used to carry uncrated bombs with suspension lugs spaced 30 inches apart.

Bomb Carrier Mk 21 Mod 0

Bomb Carrier Mk 21 Mod 0 (fig. 15-6) consists of a steel center plate, to which are

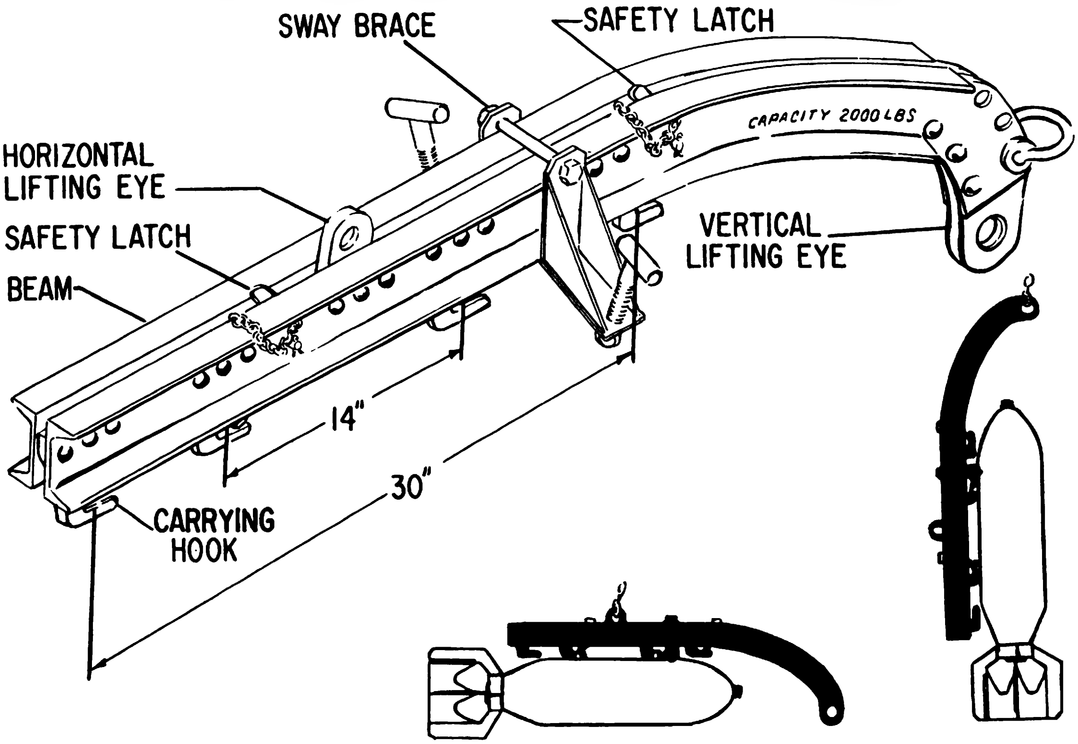


Figure 15-5.—Bomb Carrier Mk 10 Mod 0.

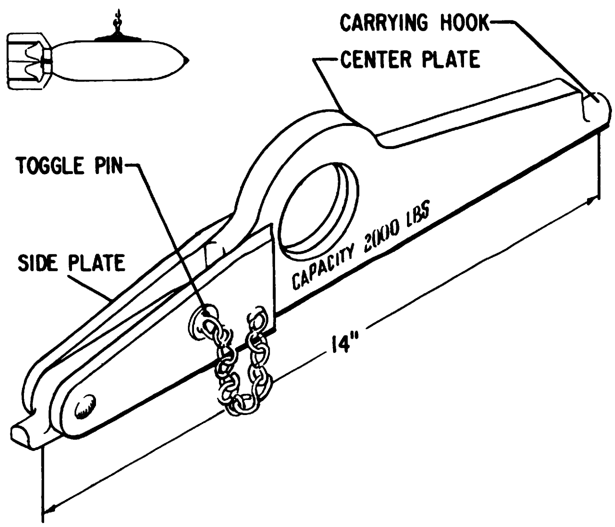


Figure 15-6.—Bomb Carrier Mk 21 Mod 0.

welded two steel sideplates. The center plate has a fixed carrying hook at one end and a lifting eye near the end. A movable carrying hook is hinged between the sideplates. A toggle pin, which passes through the carrying hook and two sideplates, secures the carrying hook against movement when the carrier is assembled on the bomb.

This carrier is used in conjunction with chain falls or overhead hoists in lifting and handling bombs up to 2,000 pounds in weight and has suspension lugs spaced 14 inches apart. The special function of this carrier is to provide means for attaching the hoist hook within 2 inches of the bomb so that the bomb may be lifted as high as possible for stowing in bomb magazines of aircraft carriers having low overheads.

Bomb Carrier Mk 30 Mod 0

Bomb Carrier Mk 30 Mod 0 (fig. 15-7) is designed for lifting low-drag bombs in a horizontal or an inclined position. This carrier may be used in conjunction with vertical low-drag bomb carriers when both horizontal and vertical handling are required.

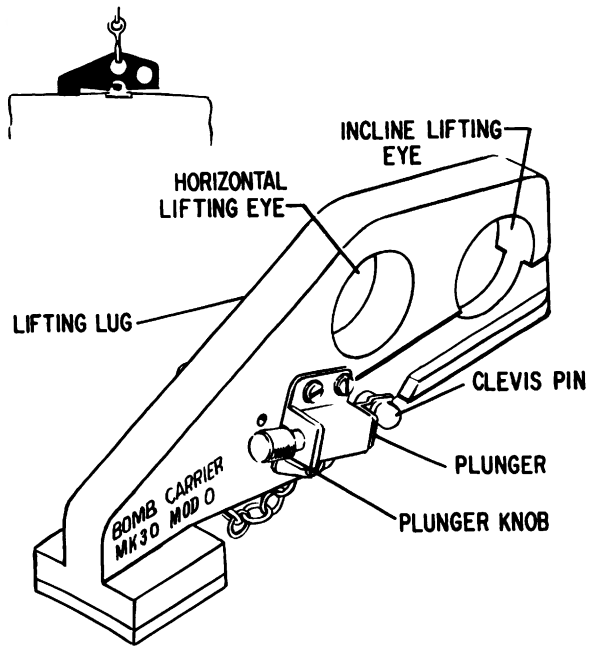


Figure 15-7. –Bomb Carrier Mk 30 Mod 0.

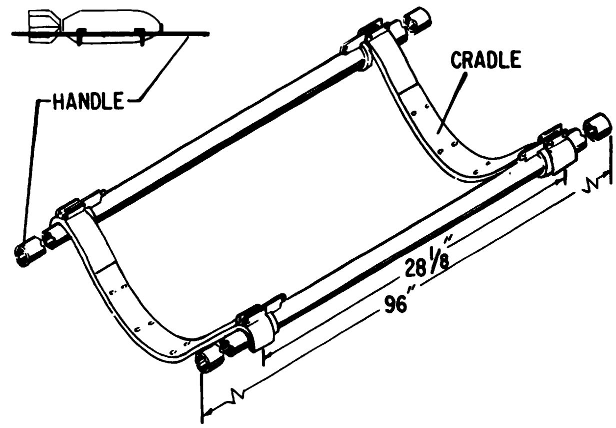


Figure 15-8. –Bomb Carrier Mk 14 Mod 0.

The Mk 30 Mod 0 bomb carrier consists of a lifting lug which is designed to engage the hoisting lug of the bomb. The lifting lug connects with the hoisting lug of the bomb and is locked in this position by a clevis pin which passes through the bomb hoisting lug eye and the hole in the lifting lug. The clevis pin is held in position by a plunger and plunger spring. The lifting eyes on the lifting lug are used for hoisting the bomb in a horizontal or an inclined position.

Bomb Carrier Mk 14 Mod 0

Bomb Carrier Mk 14 Mod 0 (fig. 15-8), which has a capacity of 500 pounds, may be used for lifting bombs from bomb skids or trucks for manual loading of bombs on the store stations of an aircraft. It is composed of two tubular steel handles, parallel to each other, between which are attached two semicircular steel cradles. A bomb is carried in the saddle formed by the two semicircular cradles.

Bomb Carrier Mk 19 Mod 0

Bomb Carrier Mk 19 Mod 0 (fig. 15-9) consists of a long steel tube with a lifting hook bolted at the center. The hook of the carrier is placed into the lug of a bomb. Two carriers are used for manual handling of 500-pound bombs. This bomb carrier is primarily used for transferring bombs from one bomb skid to another or in the stowage of bombs.

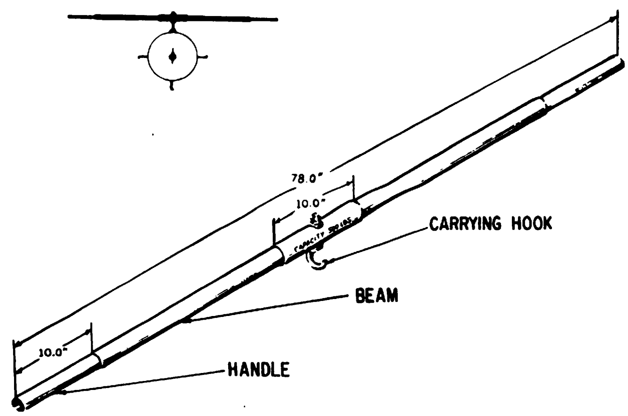


Figure 15-9. –Bomb Carrier Mk 19 Mod 0.

BOMB HOISTS

A hoist is a device used to raise or lower a load such as a bomb, mine, torpedo, or special weapon during aircraft rearming operations aboard aircraft carriers and at shore establishments. Usually, hoists are manually operated but can also be electrically operated.

Bomb Hoist Aero 14B

Bomb Hoist Aero 14B (fig. 15-10) is a crank-operated, single-cable device for hoisting loads. It is the current replacement for obsolescent hoists. It consists of a gear train, drum and cable, brake mechanism, fishpole type extension tube, and two handcranks—a ratchet crank and a brake crank. The cranks turn in the oppostie direction from drum rotation. The ratchet crank is used only to help lift the load and may be disengaged from the gear train by latching a ratchet pawl with a ratchet pawl latch. The brake crank is used to lift the load and to control the position of the load. Overhand motion of the cranks lifts the load. After the load is lifted, a clutch type brake holds the gear train fast. Backing off the brake crank lowers the load, but only as long as the brake crank is turned backward. A spring-loaded roller, riding on the top of the cable drum, and a cable guide, inside the extension tube, keep the cable laying firmly in its groove even when no load is applied to the hoist. A swiveling clevis for hook suspension at the end of the extension tube couples the hoist to the bomb rack and permits the hoist to be operated from different points on the ground. The tube clamp permits the housing to be rotated to any position with respect to the extension tube.

The hoist is approximately 58 3/16 inches long, 18 inches wide, and 21 1/8 inches high. This hoist has a 2,240-pound capacity with a 28-foot lift height and weighs 57 pounds.

Bomb Hoist Mk 8

Bomb Hoist Mk 8 is similar to the Aero 14B except that it is limited to a maximum lift

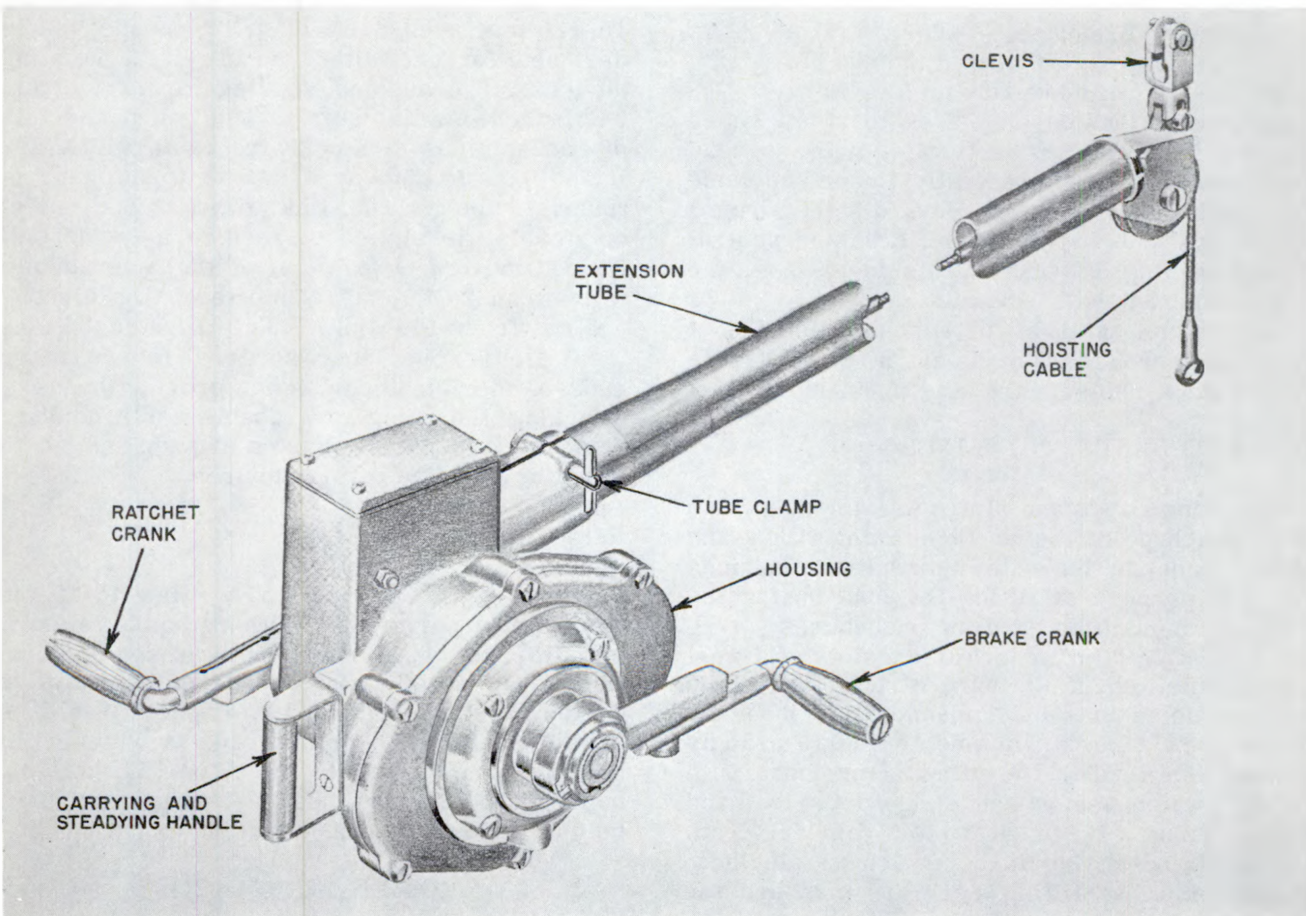


Figure 15-10.—Bomb Hoist Aero 14B.

height of 10 feet. The Mk 8 hoist is currently obsolescent; however, the Aviation Weapons Officer will undoubtedly come in contact with this versatile piece of equipment.

Safety Precautions for Bomb Hoists

When approaching the "two-blocked" position (all the way up), take care that the cable terminal does not ride up onto the pulley. If this happens, the cable terminal will damage the cable at the point where it enters the terminal, thus causing cable failure.

Never cock the pulley at such an angle that the hoist cable is caught between the pulley guide and pulley. If this occurs, the pulley housing, cable, and pulley may be damaged and the cable may be broken.

When a bomb is "two-blocked" into position, never crank even a small part of an extra turn. This will cause the stress on the cable assembly to be greatly increased, causing weakening or breakage.

Never stand (or allow others to stand) under a load while hoisting or lowering.

Maintain tension on the cable at all times when paying out or reeling in with no load attached. (This is especially important since the cable may kink or ride off the drum.)

Always put the left-hand crank in neutral when lowering a load. If this is not done, the left-hand crank will windmill.

Watch the cable at all times to see that it is seating properly on the drum and that there is no slack cable behind the pressure roller.

HOISTING BANDS AND SLINGS

Hoisting bands and slings are devices which are attached to bomb type ammunition and used in conjunction with other hoisting devices for the purpose of lifting the load during the various ammunition handling procedures.

A hoisting sling generally consists of a steel wire cable, chain, or wire strap. The strap is assembled in such a manner that it forms a circle of a certain diameter and fits snugly around the load. The sling is provided with fittings which secure the sling to the load and allow quick attachment to or removal from the load. Hoisting fittings such as clevises, clevis pins, or lifting eyes are provided for attachment of hoisting device cables.

A hoisting band, which is basically similar to a hoisting sling, generally consists of a steel band or strap. Some hoisting bands consist of two steel bands or straps which are spaced apart by a yoke type assembly so that they harness the load. These harness type hoisting bands usually serve a dual purpose—they may be used to hoist the load as well as to suspend the load from the aircraft.

When selecting a hoisting sling or band for a specific hoisting operation, several factors must be considered. The weight of the load to be lifted (capacity of sling or band) and the diameter of the load are of prime importance. The number of hoisting fittings—single, double, or combination single and double—provided on the sling or band is also a factor to be considered.

A representative hoisting sling and band are briefly discussed in the following paragraphs.

Bomb Hoisting Sling Mk 16 Mod 0

Bomb Hoisting Sling Mk 16 Mod 0 (fig. 15-11) has a capacity of 4,000 pounds and is designed for use with a double-cable hoisting device. The assembled sling forms a circle 34 inches in diameter. The sling consists of two sections of steel wire cable which are joined end to end by a link to form one continuous cable. The link, fixed to one end of one cable, is slotted to receive a swage ball fitting, located on one end of the other cable, which can be quickly connected to or disconnected from the link. Two lifting clevises with clevis pins are secured to the loose ends of the joined cables and provide means of attaching the sling to a double-cable hoisting device. Two cable spacers are assembled to the sling near the lifting clevises.

Hoisting Band Aero 61A

Hoisting Band Aero 61A (fig. 15-12) is designed to permit use with all bombs, mines, missiles, or weapons currently in service use. There are no publications currently available on the hoisting band; however, they should be available in the near future. A number of operational failures to the Aero 61A hoisting band have required design changes and have held up production quantities.

MOBILE EQUIPMENT

Mobile equipment may be defined as equipment mounted on wheels, rollers, or tracks.

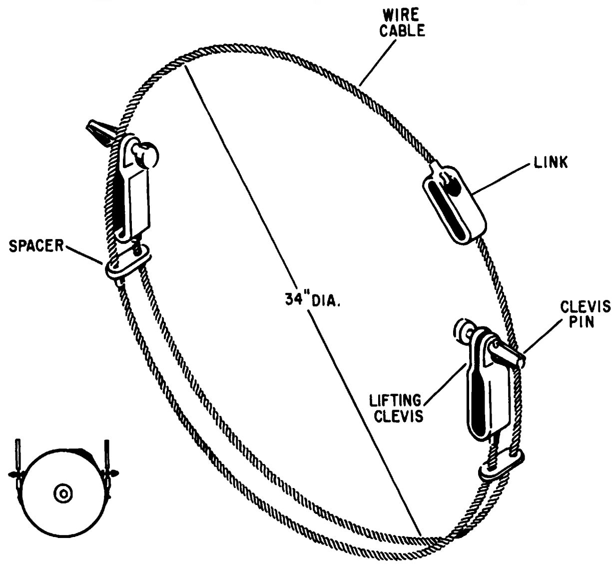


Figure 15-11. –Bomb Hoisting Sling Mk 16 Mod 0.

In this chapter mobile equipment has been divided into seven categories.

BOMB SKIDS AND ADAPTERS

A skid is a device which is designed to support a load of certain weight and to facilitate handling of the load. It consists essentially of a cradlelike metal frame weldment which is usually mounted on two, three, or four rubber-tired wheels. Some skids have track-laying wheels instead of conventional wheels in order to increase the skid's effective operation over soft, muddy, icy, or rough terrain. There are skids which are simply platforms mounted on legs and which have no wheels.

The skid is not self-propelled and, consequently, requires either manpower or powered equipment for its movement from one place to another. Some skids are equipped with lift angles which provide a means of lifting the entire skid by a suitable lifting device. In this case, the skid is moved from place to place in pickaback fashion and is raised to a desired height for unloading by lifting equipment.

Skids mounted on wheels are generally equipped with braking mechanisms to prevent inadvertent movement of the skid when it is unattended. Devices to secure the load to the skid are provided on all skids. Handles are attached to all skids to provide a means of imparting movement to the skid and controlling the skid's movement.

Most skids can be made adaptable to support various types of loads through the use of devices called skid adapters. The skid adapter generally consists of a frame weldment with a specific configuration to accommodate a particular load, such as a quantity of bomb type ammunition, rockets, or miscellaneous ammunition components. The skid adapter is mounted on and secured to the skid frame.

The important factors to consider in selecting a skid or skid adapter for a particular handling situation are the type of load to be handled, the capacity of the skid or skid adapter, the compatibility of the skid and skid adapter, the type of terrain or surface over which the skid is to be used, and the type of wheels on the skid.

Skid adapters (nonmobile equipment) are mentioned in this section of the chapter because

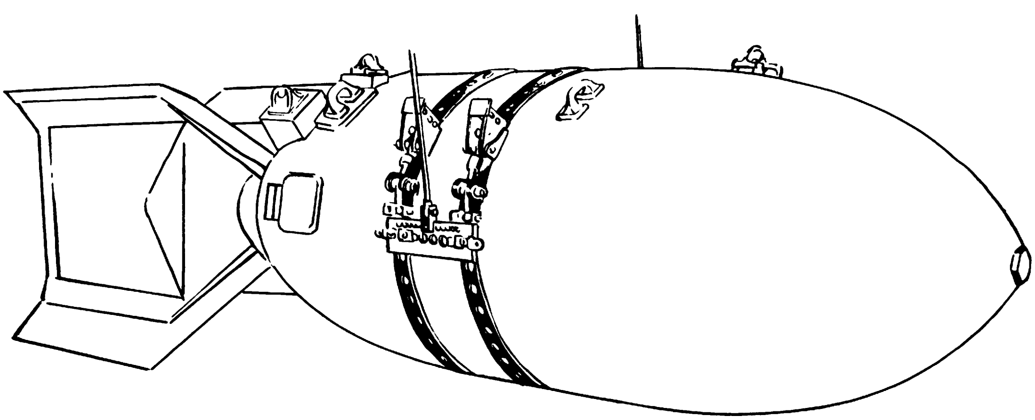


Figure 15-12. –Hoisting Band Aero 61A.

the relationship of the skid and its load is directly dependent on the type of adapter used to accommodate the load.

Bomb Skid Aero 12B

Bomb Skid Aero 12B (fig. 15-13)is a wheelbarrow type of skid which consists of a cast aluminum cradle type frame mounted on two 14-inch diameter rubber-tired wheels and two supporting legs. The skid is provided with two pairs of steel tubular handles. The shorter pair of handles is used for handling bombs, while the longer pair must be used for most missile handling. The rubber-tired wheels are nondirectional. Regardless of the angle at which the bomb skid wheels hit an arresting gear cable, or similar deck obstacle, they ride over with ease. The skid is also equipped with brakes which are applied when the aft end of the skid makes contact with the deck.

All operating parts of the bomb skid such as wheels, brake mechanism, handles, chocks, and holddowns are completely interchangeable. Handles may be latched on either end of the skid, the latch control being located at the operator's end of the handles. Thus the operator, after loading the skid on the ship's bomb elevator, does not have to enter the elevator to unlatch and release the handles. The skid is capable of transporting any store up to 1,250 pounds, from the ammunition magazines, up through any combination of upper and lower stage elevators, on any aircraft carrier. A description of the associated adapters for the Aero 12B follows.

AERO 8B/C BOMB SKID ADAPTER.—This adapter is a frame upon which are mounted adjustable supporting stumps designed to handle six of any type rocket from 2.75 to 5 inches in diameter. No loose or interchangeable parts are required to accommodate the various diameter rockets.

AERO 9B BOMB SKID ADAPTER.—This adapter is a collapsible box, the sides and ends of which are attached to the base of the adapter with piano type hinges. When assembled and ready for transporting stores and miscellaneous equipment, the sides and ends of the adapter are held in position with four simple bolts. The adapter is capable of transporting practice rockets, rocket heads, rocket motors, belted ammunition, ammunition cans, and any packaged pyrotechnics up to its 1,250-pound capacity. In its collapsed position, the adapter can be hung on a bulkhead or stacked on the deck.

AERO 18A BOMB SKID ADAPTER.—This adapter is a cast aluminum alloy cradle with two troughs. It is secured to the Bomb Skid Aero 12B by two securing pins which are held by quick-disconnect locking pins. The holddown straps of the bomb skid are used to secure the load.

This adapter has a capacity of 750 pounds and is capable of transporting three 250-pound bombs.

Bomb and Torpedo Skid Mk 8 Mod 0

Bomb and Torpedo Skid Mk 8 Mod 0 (fig. 15-14) is a wheelbarrow type skid. It consists of a welded steel frame which is cradle shaped at the ends. The frame is mounted on two 14-inch diameter wheels which are solid rubber capped. A traylike center member is located in the well of the skid.

A movable center bolster is attached to the center member to provide a third support for large bombs and torpedoes or to provide an end support for small bombs, such as 100-pound bombs, which are too short to be supported across the ends of the skid.

The skid is braked by means of two brake shoes, both of which are applied to their respective wheels when the floor brake legs are lowered to and make contact with the deck. The force for the braking action is derived automatically from the weight of the skid and its load, through the floor brake legs. In addition to the automatic braking action, a cam-locking parking brake is provided to insure positive braking action independent of the brake legs.

Two tubular, demountable handles, which can be attached to either end of the skid, are used to maneuver the skid. Cam-locking chain holddowns are attached to the frame of the skid and are used to secure the various loads.

The skid weighs approximately 303 pounds and is designed for use on hard surfaces, primarily aprons or runways at shore stations and on aircraft carriers, and for handling stores up to 2,500 pounds in weight. Although only one large store can be loaded on the skid at a time, several stores of smaller size may be loaded on the skid in various ways, as long as they can be properly secured and the total weight does not exceed the capacity of the skid.

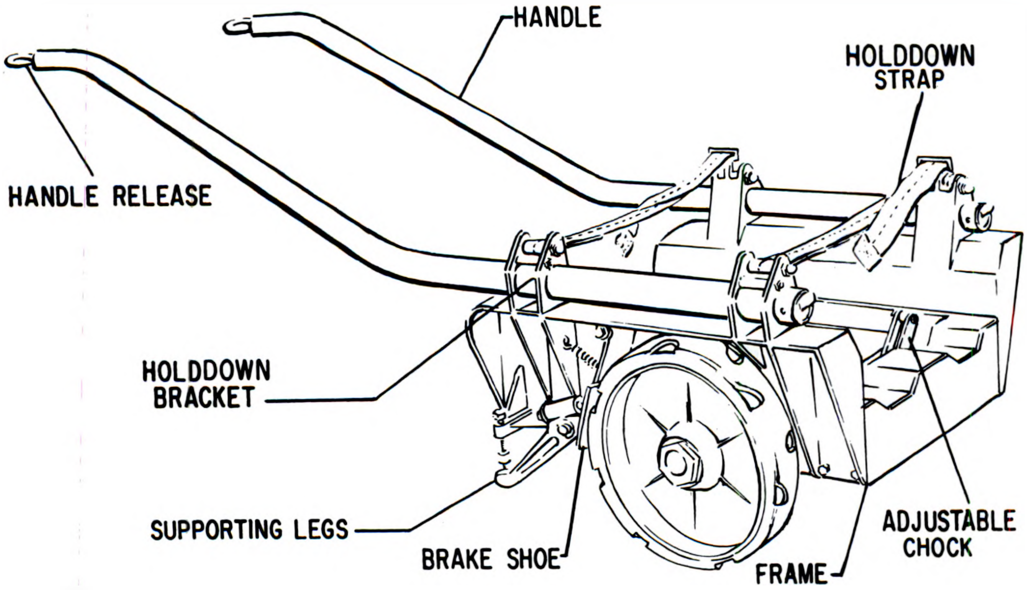


Figure 15-13. —Bomb Skid Aero 12B.

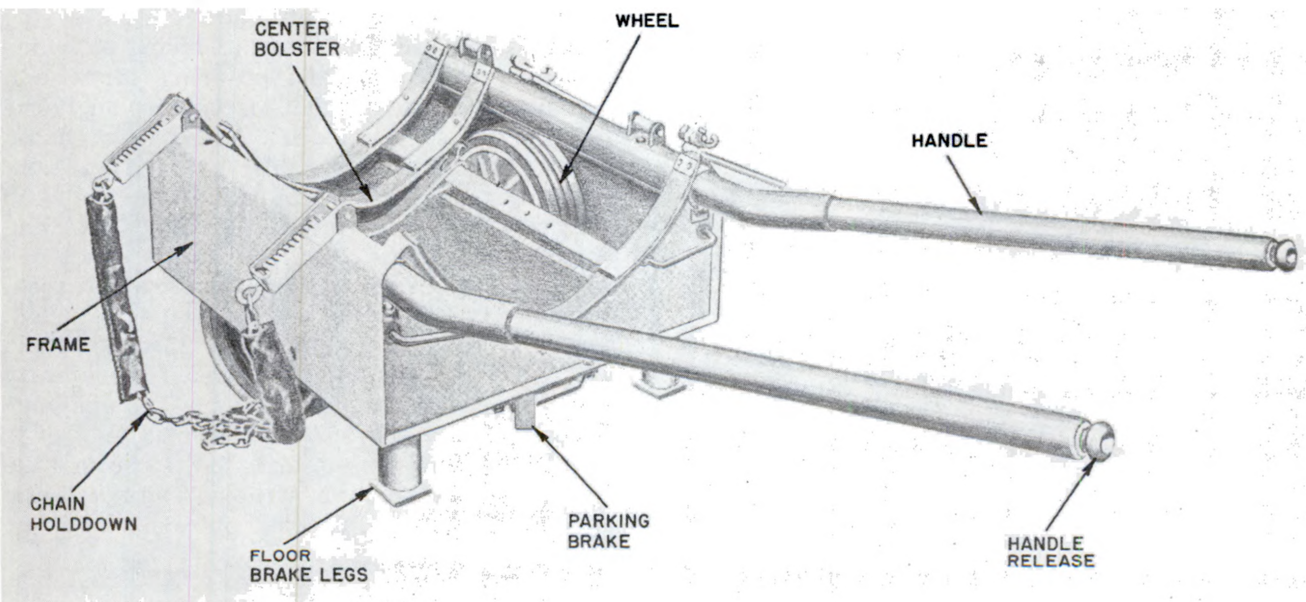


Figure 15-14. —Bomb and Torpedo Skid Mk8 Mod 0.

Weapons Skid Aero 21A

The Weapons Skid Aero 21A (fig. 15-15) is a 4-wheeled vehicle that is designed primarily for transporting ordnance materials with the use of adapters. The skid weighs approximately 250 pounds, and has a load capacity of 4,000 pounds. It can carry single or multiple weapons, depending on the size and shape of the weapons. (See fig. 15-16.)

The skid has been approved for transporting nuclear weapons and guided missiles, as well as conventional ordnance. The Weapons Skid Aero 21A replaces the Mk 5 and Mk 8 bomb skids.

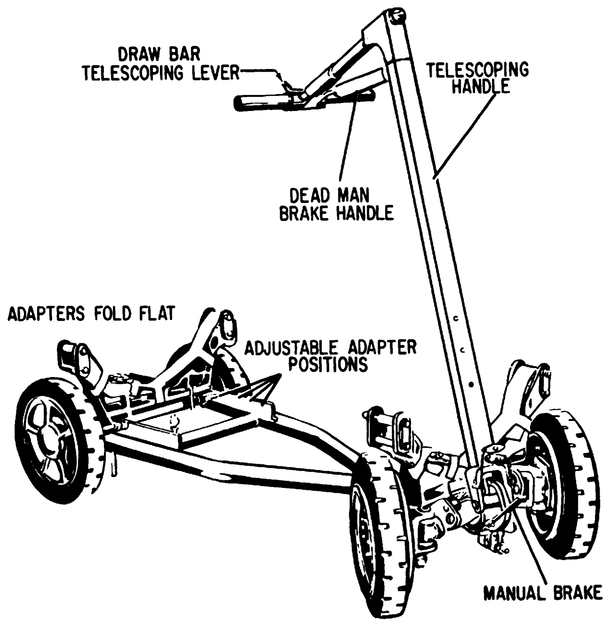


Figure 15-15.—Weapons Skid Aero 21A.

BOMB TRUCKS AND ADAPTERS

A bomb truck is a four-wheeled vehicle which is designed primarily for transporting a load with or without the use of adapters. Some of the trucks are equipped with a hydraulic mechanism which provides a means of lifting a load to various heights.

A truck consists of a frame of welded construction which is usually mounted on four rubber-tired wheels that may be swiveled. Two of the wheels are connected to a tow bar through a steering mechanism which provides steering control of the truck. The truck is equipped with mechanical brakes, applied to the wheels by a hand lever on the tow bar, or a foot pedal on some units. The hydraulic lift mechanism which is provided on trucks is operated by a pump handle. Various truck adapters are provided for adapting the truck to carry loads of various diameters. These truck adapters can be easily assemblied to or removed from the truck as desired.

The important characteristics of a bomb truck, which should be considered when selecting one for a particular handling situation, are capacity, type of load, lift height, related equipment with which it can be used, and type of terrain over which it can be operated.

Bomb Truck Aero 20A

Bomb Truck Aero 20A (fig. 15-17) consists of a channel aluminum frame weldment mounted on four rubber-tired wheels. The frame consists of two parallel members which are joined by three crossmembers-one at the forward end and two toward the rear end. The two rear crossmembers are cradle shaped and can be used to support a load.

Four brackets, threaded into vertical supports which are attached to parallel members of the frame, are located at the ends of the two rear cradle-shaped crossmembers. The brackets provide means of securing the load on the truck or attaching various bomb truck adapters to the truck, thereby adapting the truck for various diameter bombs.

The tow handle, which has a towing eye secured to its end and is attached to the steering mechanism in the front of the truck, provides a method of towing and steering the truck. In addition, the tow handle is used to apply the brakes which are provided. When the tow handle is in a fully raised or a fully lowered position, the brake mechanism in each front wheel is actuated. When the tow handle is in a towing position, the brake lever is in a normal position, and the brake mechanisms are released.

Five adapters may be used with the truck. They are the Aero 20A, 21A, 22A, 23A, and 24A. All of the adapters are used independently except the Aero 21A which is used in conjunction with the Aero 20A adapter. The load is secured to the truck either by bolts through the brackets or by tiedown straps. The maximum capacity of the truck is 3,500 pounds.

Bomb and Torpedo Truck Aero 23B

Bomb and Torpedo Truck Aero 23B (fig. 15-18) is a high-lift type truck. The frame, mounted on four rubber-tired wheels, is a weldment constructed of parallel steel channel members which are joined at the forward end by crossmembers and at the middle by a stiffening I-beam member. The rear end of the frame is open to permit it to straddle a load. A torpedo rest plate is pinned to the

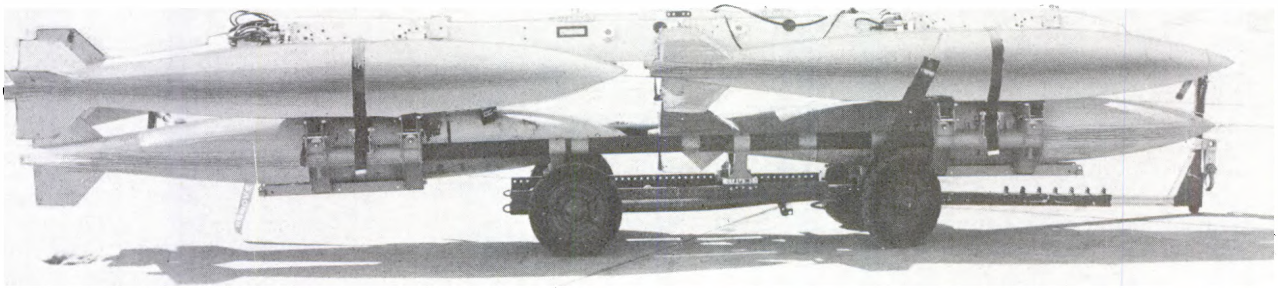


Figure 15-16.—Weapons Skid Aero 21A, sample load.

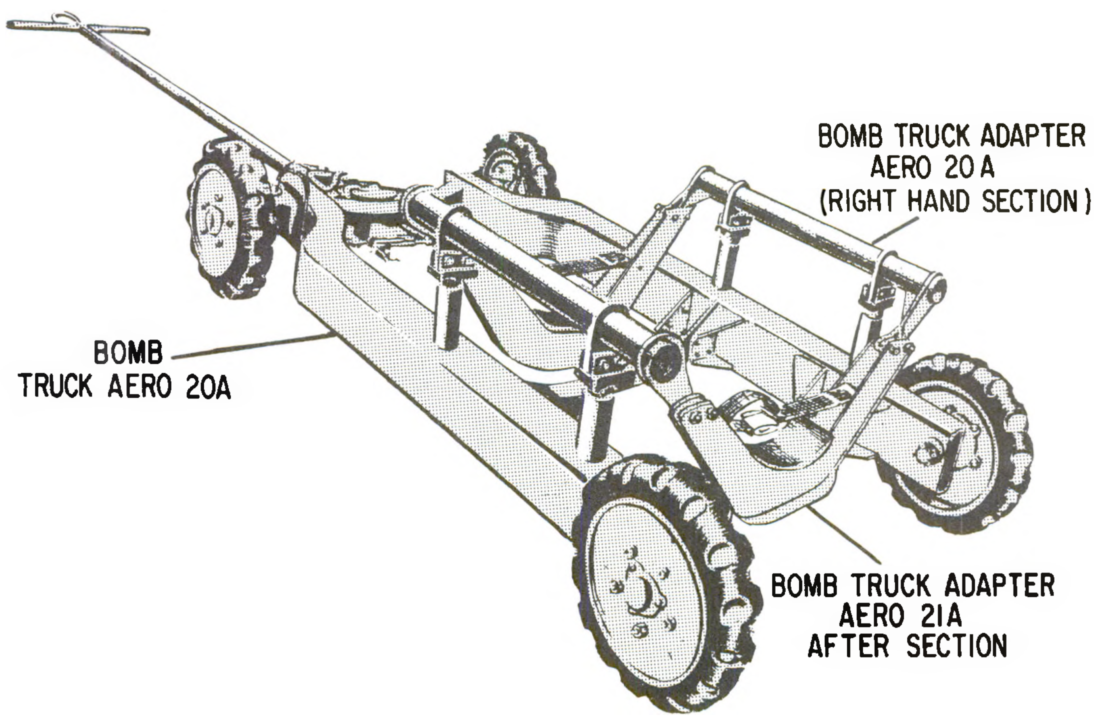


Figure 15-17.—Bomb Truck Aero 20A.

I-beam member. The frame has a clearance of approximately 2 1/2 inches above the deck.

The truck is equipped with a hydraulic lift mechanism which operates to raise two cast steel lift arms when pumping strokes are applied to the pump handle. A release valve is provided on the hydraulic mechanism to lower the lift arms.

The lift arms which are hinged at one end to the frame have lift brackets hinged at the other end. The lift brackets which engage and support the load can be tilted by a gear mechanism that is operated by a handwheel. The lift brackets are connected to the gear mechanism by drag links.

The truck is equipped with brakes which are applied to the front wheels by the brake handle mounted on the towing handle. The rear wheels of the caster type, are separately suspended from caster brackets mounted at the rear end of the frame. Each rear wheel may be either free-swiveling or locked against caster rotation by its caster handle.

The truck weighs approximately 1,000 pounds and is approximately 85 inches long, 45 inches wide, and 15 inches high.

This truck has a capacity of 3,500 pounds and is designed to operate over smooth, hard surfaces. The truck is used to transport and lift to a height of approximately 40 inches loaded Bomb Skid Mk 1, Bomb and Torpedo Skids Mk 3 and 5, and Bomb Cradles 5A and 6C.

Bomb Truck Aero 33C

Bomb Truck Aero 33C (fig. 15-19) is a high-lift type truck. The truck is used in combination with Bomb Cradle Aero 6C or Bomb Truck Adapter Aero 36A. Stores handled include a large family of conventional bombs, nuclear weapons, and guided missiles. The truck is equipped with a hydraulic lift mechanism which operates to raise two arms simultaneously when either pump or both pumps are operated. A release valve is provided to lower the lift arms at a variable rate. A tilt mechanism is provided which allows the load to be tilted 15 degrees noseup or nosedown in order to match the attitude of the aircraft on which the load is to be attached. The truck is equipped with brakes on the front wheels only. All four wheels are casterable, although they may be locked in the fore and aft attitude. The weight of this truck is approximately 1,500 pounds.

This truck has a capacity of 4,000 pounds and is designed to operate over smooth, hard surfaces. The truck is used to transport weapons and to load weapons on naval aircraft. Additional height and maneuverability are gained by the attachment of the Aero 36A adapter. Whenever the Aero 36A adapter is used, its outrigger should also be used to maintain stability of the truck.

AERO 36A ADAPTER.—This adapter (fig. 15-20) is designed for use on the Aero 33A bomb truck to increase the hoisting height

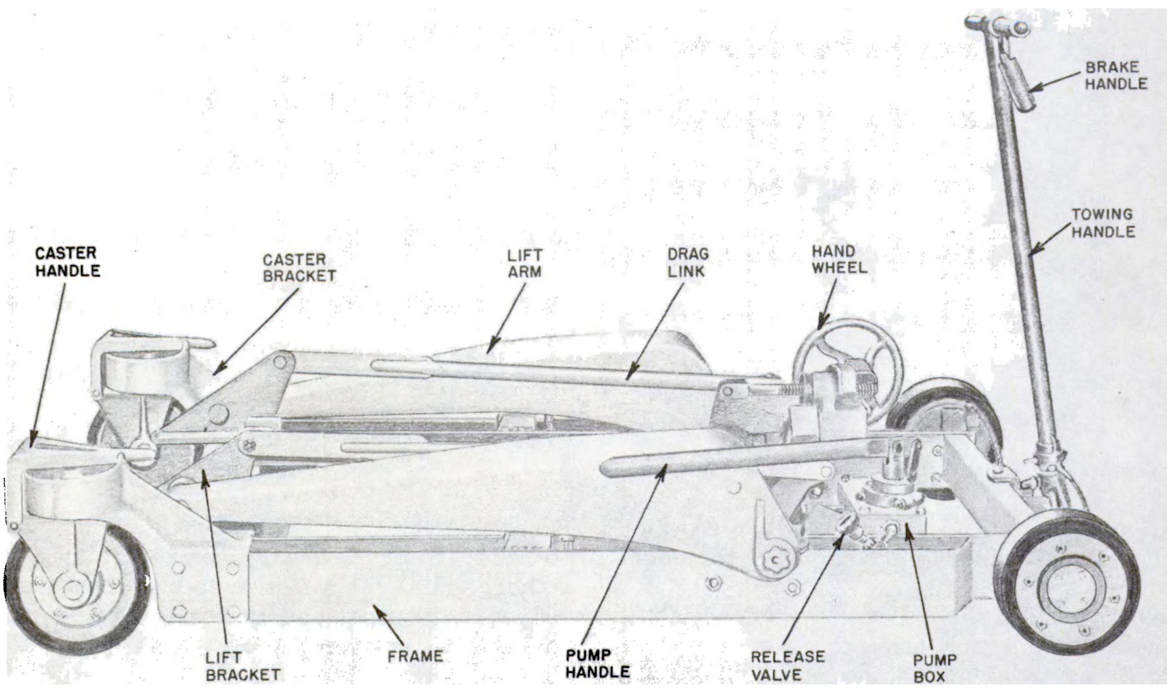


Figure 15-18.—Bomb and Torpedo Truck Aero 23B.

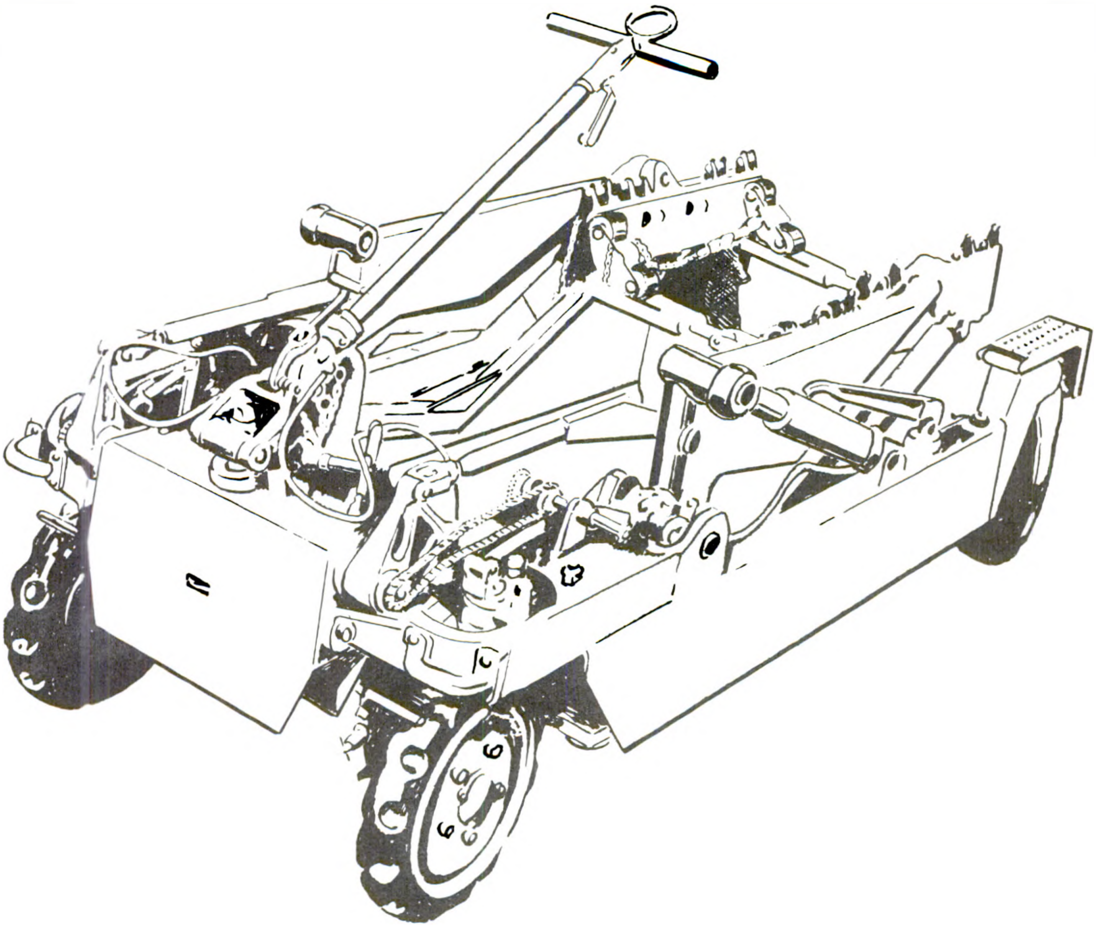


Figure 15-19.—Bomb Truck Aero 33C.

and to enable stores to be mounted offcenter into the aircraft without moving the bomb truck.

For selection of the proper adapter and other detailed information on the Bomb Truck Aero 33A/B/C, refer to the appropriate NavWeps publication.

Bomb Truck Aero 34B

Bomb Truck Aero 34B consists of a frame suspended by two solid rubber-tired front wheels and two steerable, spring-loaded casters on the rear. A tow bar is provided for towing and steering the front wheels. Mechanical brakes on the front wheels are actuated by linkage when the tow bar is in the raised or lowered position. Two hand-operated hydraulic pumps provide hydraulic power to raise and lower the two front and two rear hydraulic jacks which are supporting points of the bomb truck adapters. Adapters are held in place with nuts, washers, and bolts at the jack points. Two swivel bars are mounted in tulip clips on either side of the bomb truck to facilitate turning the casters while maneuvering the bomb truck into the loading position. Four shackles are provided for tiedown purposes. The truck weighs approximately 1,200 pounds and is 152 3/4 inches long, 64 1/2 inches wide, and 17 3/4 inches high.

This bomb truck is designed to provide a mobile, hand-operated truck for transporting and loading bombs on aircraft ashore and afloat. This truck has a capacity of 10,000 pounds.

BOMB AND TORPEDO TRAILERS

The bomb and torpedo trailer is used to transport bombs and torpedoes of various sizes.

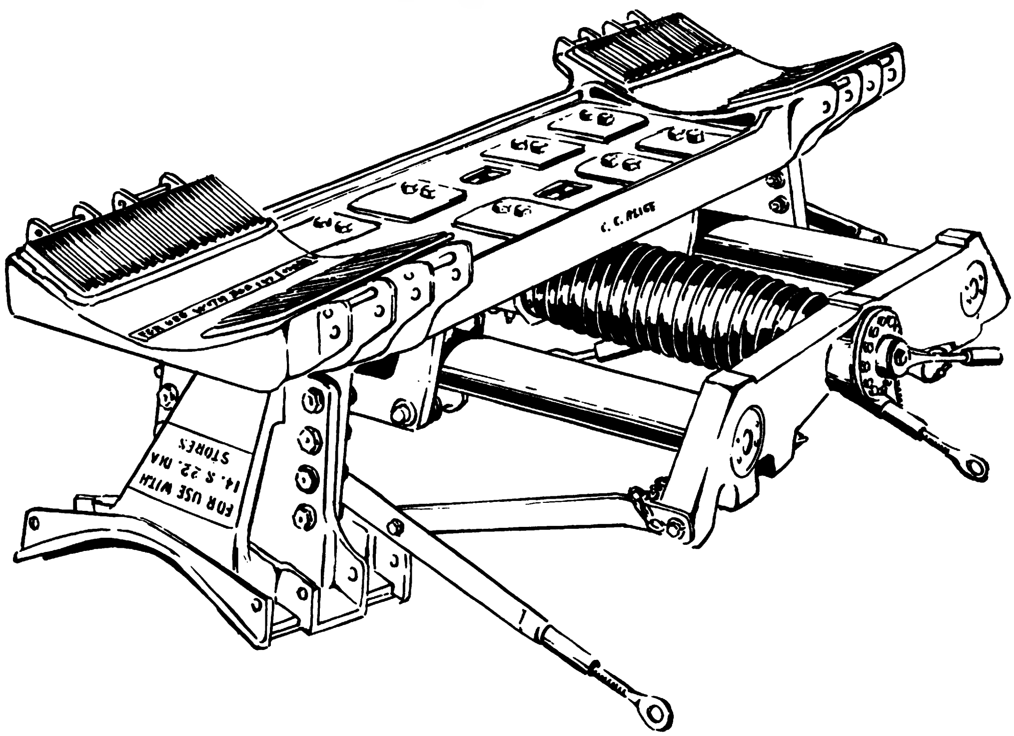


Figure 15-20.—Aero 36A adapter assembly.

The number of bombs or torpedoes which a trailer can carry depends upon the size, type of load, and capacity of the trailer. The trailer is constructed for operation over hilly, moderately soft, or rough terrain. It is designed for use in conjunction with a powered towing vehicle such as a bomb service truck. The trailer is towed in train fashion behind the bomb service truck to which it is coupled. Not more than four trailers should be towed in one truck-trailer train.

When selecting a trailer for a particular ammunition handling situation, several factors should be considered. The trailer's capacity, the weight of load that the trailer can safely support, is of prime importance. In addition, the cradle or bracket arrangement for supporting the load governs the type and size of load which can be carried.

Bomb Trailer Mk 2 Mods 1 and 2

Bomb Trailers Mk 2 Mod 1 and Mk 2 Mod 2 (fig. 15-21) are identical. The different mod numbers indicate different manufacturers. The trailers consist of a low slung (9-inch ground clearance), heavy channel steel frame which is mounted on four small wheels with large balloon type pneumatic tires. A drawbar with a towing eye at its end is secured to the steerable front axle and is used to couple and tow the trailer by a towing unit. A clevis and pin coupling arrangement is mounted at the rear of the frame to provide a means of coupling another trailer in train fashion. These trailers are not equipped with brakes.

Two cradles welded to the frame near the center are used to support the load. A chain holddown is provided to secure the load in the cradles. A loading ramp, which is stowed under the frame, attaches to the rear of the frame when bombs are loaded manually into the trailer.

These trailers have a capacity of 2,000 pounds and are designed to carry a bomb while being towed singly or in trains of four or less behind a bomb service truck or cargo truck. Since these trailers have a low ground clearance, they may be spotted under most aircraft for loading bombs onto the aircraft. The pneumatic tires permit trailer operation over smooth, hard, moderately soft, and relatively rough terrain. Since these trailers are not equipped with brakes, their use over hilly terrain is somewhat limited.

Bomb and Torpedo Trailer
Mk 3 and Mods

Bomb and Torpedo Trailer Mk 3 Mod 0 consists of a welded channel steel frame supported on four leaf type automobile springs and mounted on four pneumatic-tired wheels. The rear wheels are mounted on rigid axles; the front wheels are mounted on a steerable axle. The trailer is towed and steered by means of the drawbar which is attached to the steerable axle at the front of the trailer. A towing eye welded to the end of the drawbar is used to couple the trailer to the drawhead of a towing unit. A pintle hook welded to the rear of the trailer permits coupling another trailer at the rear for towing in train fashion. The trailer is equipped with Warner electric brakes operated by a controller from the driver's seat in the prime towing unit. Electrical sockets are provided on the front and rear ends of the frame. Into these sockets jumper electric cables are plugged to hook up the electrical braking system of all the trailers in a train. A hand-operated parking brake is also provided.

The trailer is equipped with eighteen cradle chocks which are secured to the frame crossmembers to form load-supporting cradles. The outer cradle chocks are rigidly fixed to the frame; the inner cradle chocks are bolted to the frame so that they pivot. When pivoted outward, the inner cradle chocks form a single cradle in the center of the frame for supporting one large bomb or a torpedo. When pivoted inward, the inner cradle chocks along with the outer cradle chocks form two cradles for supporting two or four bombs. Four chain holddowns are provided to secure the load in the cradles.

This trailer has a capacity of 4,000 pounds. It is designed to carry four 500-pound bombs, two 2,000-pound bombs, or one torpedo. The trailer is towed singly or in trains of four or less behind a bomb service truck or cargo truck. The pneumatic tires permit operation over smooth, hard, and relatively rough surfaces.

Bomb Trailer Mk 7 Mod 1

The Bomb Trailer Mk 7 Mod 1 consists of a low-slung heavy channel-steel frame which

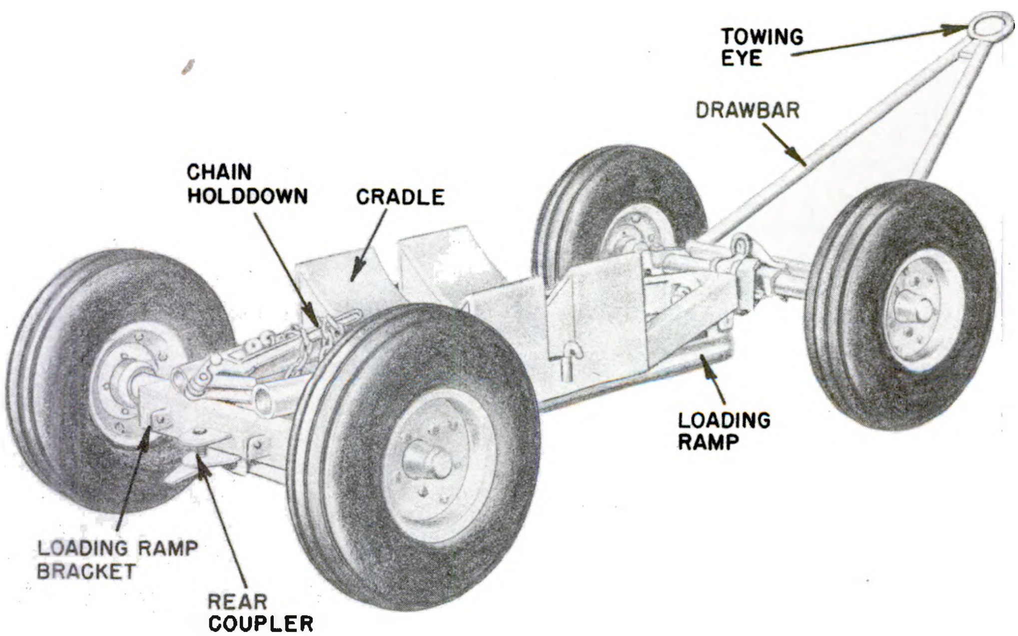


Figure 15-21.—Bomb Trailer Mk 2 and Mods.

is mounted on four small wheels with large, balloon type, pneumatic tires. A drawbar with a towing eye at its end is secured to the steerable front axle and is used to couple and tow the trailer. A pintle hook welded to the rear of the frame permits coupling another trailer at the rear for towing in train. A tilting table and cradle can be adjusted by a handwheel, to facilitate loading a store on an aircraft. The cradle is equipped with straps to secure the store. The secured store can be hydraulically elevated from a minimum height of 16 inches to a maximum height of 65 inches. The hydraulic system is actuated by a manually operated pump. The trailer weighs 810 pounds and will handle a capacity load of 2,200 pounds. The width of the trailer is 42 inches and the length, with drawbar handle assembly retracted, is 178 5/8 inches. The wheelbase is 120 inches.

This trailer is used for transporting and loading bombs, missiles, rocket packages, and other stores. A suitable prime mover will tow one trailer with a 2,200-pound store at 15 miles per hour. If more than one trailer is being towed, 5 miles per hour should be the maximum speed. The elevating arm should always be in the retracted position when towing.

Ordnance Utility Trailer F2A

Ordnance Utility Trailer F2A (fig. 15-22) is a 2 1/2-ton stake-side trailer which converts to a flatbed (120 x 48 inches). Pneumatic tires (6.00 x 9) are mounted on steel disk wheels. Wheelbase length is 81 inches. The trailer has no suspension components and should not be used in transporting guided missiles (Sidewinder excepted) or other ammunition that has delicate mechanism installed (as the Sparrow III) and which could be damaged by shock. The load on the trailer should be evenly distributed at all times due to the fifth wheel steering design. The trailer weighs approximately 900 pounds. It is approximately 96 inches wide, 120 inches long, and 84 inches high. Platform height is 27 inches. This trailer is used to transport numerous explosive items and general ordnance equipment.

GUIDED MISSILE HANDLING EQUIPMENT

The guided missile handling equipment discussed in this chapter consists of the following four missile skids and their associated adapters. (NOTE: Missile assembly equipment is discussed in chapter 19 of this text.)

Missile Skid Aero 16B

The Aero 16B missile handling skid (fig. 15-23) has a capacity of 1,100 pounds and is used to transport missiles such as the Bullpup and the Sparrow. Missiles are positioned on suitable adapters such as the Aero 41A and Aero 42A and are secured to the skid by use of strap assemblies.

The skid consists of a mobile unit supported in front by two hard rubber wheels and in the rear by two adjustable casters. The front and the rear of the skid are connected by means of an adjustable tube assembly which can be telescoped for stowage purposes. The skid is furnished complete with two Aero 42A adapters (fig. 15-23) on which are located the cushioned pads that support the missiles. The adjustable towing handle provides leverage for steering the skid by the casters. The towing handle also provides a means of automatically applying or releasing the skid's mechanical brakes which are located in the front wheels. When the handle is in a vertical or horizontal position, the brakes are automatically applied; when the handle is approximately in a 45-degree position, or normal towing angle, the brakes are released.

This missile skid is designed for shipboard transportation of one or two Bullpup or Sparrow missiles. When used with Adapter Aero 41A, it will handle one missile; when used with Adapter Aero 42A, it will handle two missiles.

Missile Skid Aero 16A

Missile Skid Aero 16A is very similar to the Aero 16B in operation and description. The skid has three wheels, a capacity of 500 pounds, and weighs 150 pounds. It is used to transport guided missiles and missile components. Adapters can be used with this skid in the handling of special missiles. The skid is designed for operation over smooth, hard surfaces.

Bomb Skid Aero 12B

Bomb Skid Aero 12B which was discussed earlier in this chapter and shown in figure 15-13 is mentioned here to emphasize its use

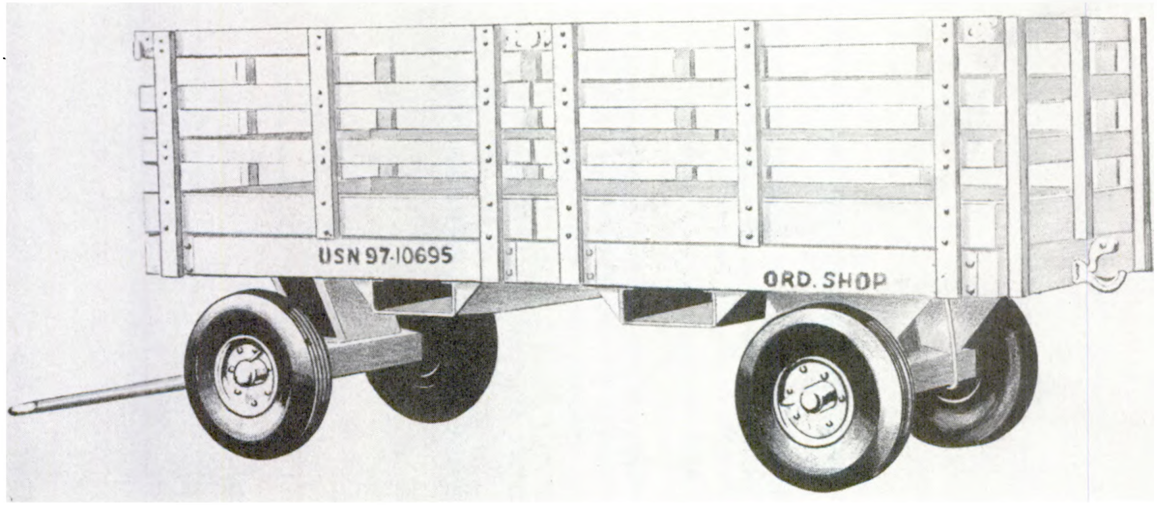


Figure 15-22.—Ordnance Utility Trailer F2A.

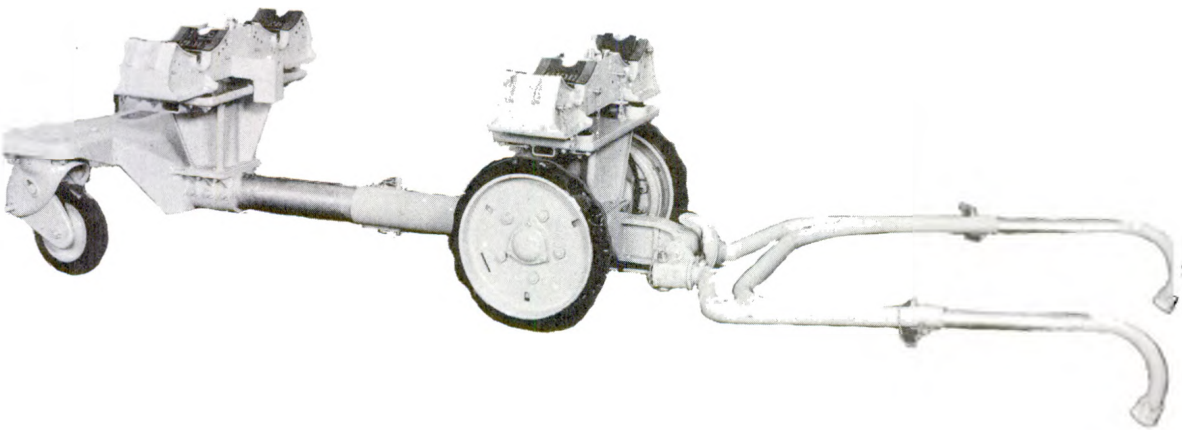


Figure 15-23.—Aero 16B missile skid with Aero 42A adapter.

as a missile carrier. Besides the previously mentioned adapters, this skid is used in conjunction with Bomb Skid Adapter Aero 8C with Adapter Kit Aero 30A (fig. 15-24) to handle Sidewinder missiles. To facilitate its use with missiles, the handles of the bomb skid must be replaced by the extra long handles in Adapter Kit Aero 30A.

Bomb Skid Aero 12B, used in conjunction with Adapter Aero 8C, makes possible the handling of four Sidewinder missiles. The Aero 30A vibration isolation unit aids in absorbing the shock and vibration produced in skid movement.

CRANES AND FORKLIFT TRUCKS

After bombs have been delivered to a magazine, one of the best devices for use in stowing them is the electric magazine crane truck, TLN-2, shown in figure 15-25. This is an industrial truck equipped with a 60-inch boom capable of swinging through a 60-degree arc on each side of the centerline of the truck. The boom has a 1-ton lifting capacity and has an overall lifting height of 117 inches from hook to deck. It is powered by a 16-cell, 450-ampere-hour, lead-acid battery. The truck

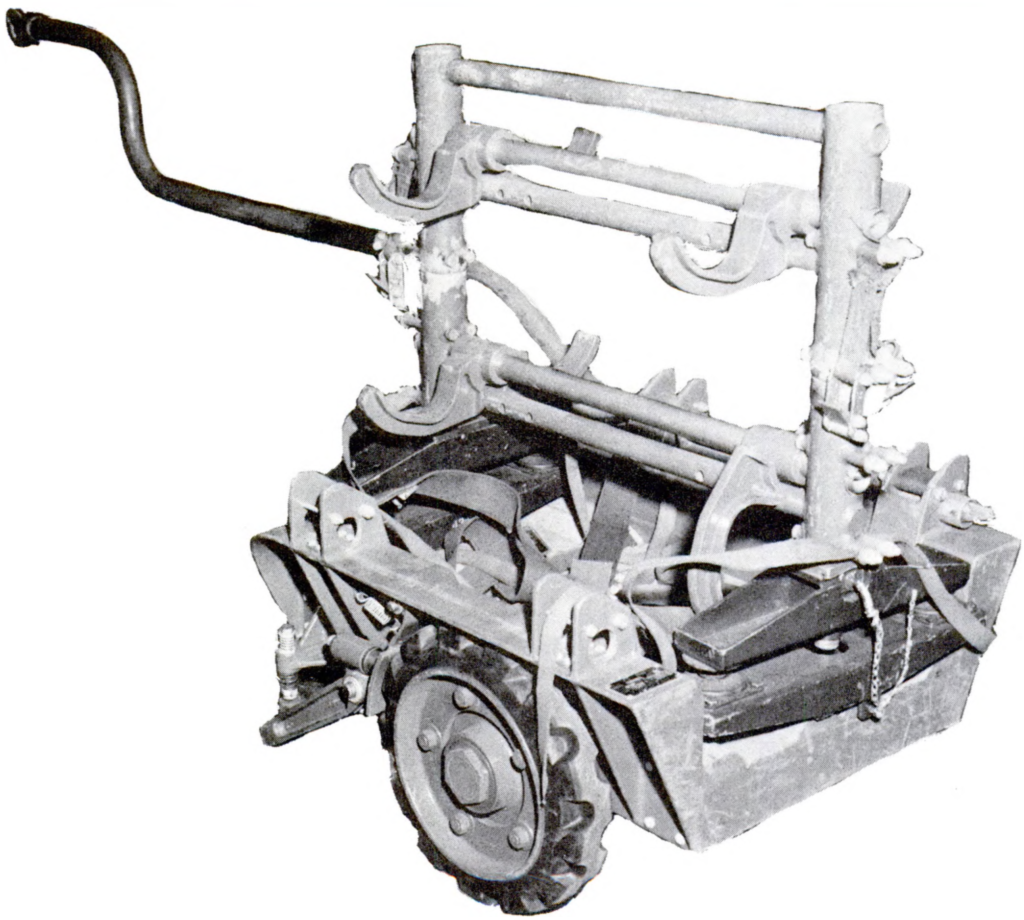


Figure 15-24.—Aero 8C adapter and Aero 30A vibration isolation unit.

is used for handling bombs in high-explosive magazines and railroad boxcars.

The electric magazine crane truck is transported from the battery-charging house to the magazines in a low-bed machinery trailer. Batteries may be changed in the field by use of the movable chain fall on the MJ-2 bomb service truck. The bomb-lifting hooks then serve to lift the battery.

Another stowing device, similar to the electric crane truck, is the forklift truck. Many different models of this type of forklift truck are currently in use at naval activities. The 2-ton model (fig. 15-26), which will lift material to a height of 120 inches, is equipped with a 450-ampere-hour, 16-cell, 19-plate, lead-acid battery. The truck is sparkproof for use in semihazardous locations. The truck, with its forks, is especially useful in handling all types of pallets in sizes up to 48 inches square. It has been designed to withstand severe treatment over long hours of use.

Use of this type of truck is permissible in handling inert components, boxed stores, and ammunition containing cast TNT. The following special items of handling equipment are available with the truck: a set of forks for bombs, a set of forks for boxed stores, and a crane attachment for stores.

The diesel type forklift truck (similar in appearance to the battery electric forklift trucks) is also an indispensable item for moving boxed and palletized ammunition in unconfined areas. There are different models from various manufacturers of this type of forklift truck which are currently in use at various naval activities. All models of this type of forklift truck have an adjustable, two-tined fork that is secured to a vertical supporting frame which telescopes and tilts. The lifting and tilting mechanisms are hydraulically operated. An overhead guard is provided for the operator's safety. The truck is powered by a four-cylinder diesel engine with a two-speed forward and two-speed reverse transmission. The forklift truck may be provided with either pneumatic or solid rubber tires.

Another useful mechanical device in ammunition handling is the tractor crane. Versatility of the tractor crane is well demonstrated by considering the various features. The tractor crane (fig. 15-27) has a hydraulic powered retractable boom with a 360-degree swing. It is supported on a pedestal and mounted on an International tractor, type T-9.

The retractable boom makes it possible to extend the lifting radius of the crane from 8 to 16 feet. The lifting capacity of the crane is 5,000 pounds at 8 feet and 2,500 pounds at 16 feet. Maximum lifting height from the ground is 18 feet 10 inches. By using an auxiliary cable reel, a load 2 feet below the ground may be picked up.

PALLET TRUCKS

The pallet truck is a four-wheel or three-wheel vehicle designed to handle palletized unit loads. Unlike the forklift truck, the pallet truck is designed to support the load on its entire wheelbase. Consequently, the pallet truck is smaller in size because it does not utilize its weight to counterbalance the weight of the load. Pallet trucks are classified as high-lift or low-lift trucks, depending upon the height to which the load can be elevated; and as self-propelled or hand-operated trucks, depending upon the type of motive power provided.

Pallet trucks are designed for use in picking up and transporting palletized loads that do not exceed the truck's capacity. They are primarily used in situations where space is limited and handling operations are so small that the use of forklift trucks is not justified from an efficiency or economic standpoint.

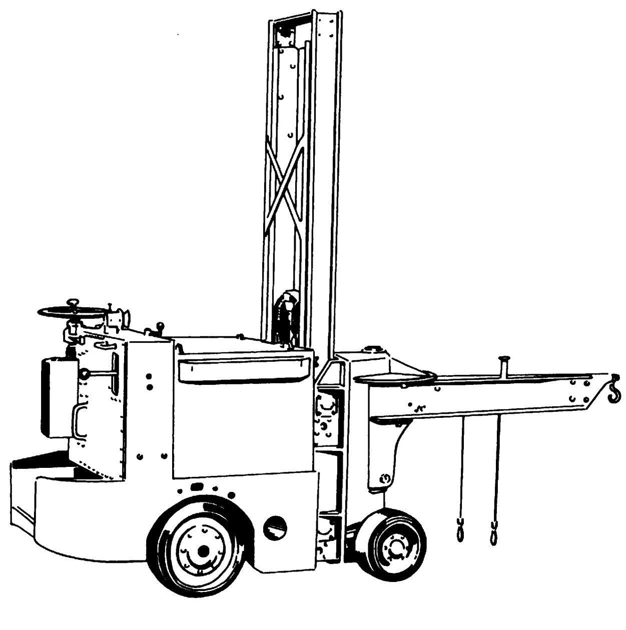


Figure 15-25.—Electric magazine crane truck.

CARGO AND SERVICE TRUCKS

This section of the chapter covers weight handling (automotive) trucks which are used by naval activities for ammunition and explosives handling. These trucks are included in ammunition handling equipment for advanced based or are specialized items of mobile equipment that are used for, or in support of, a particular ammunition handling operation. The equipment discussed includes cargo trucks of various weight handling capacities and trucks designed for special uses, such as bomb service and weapon carrying.

Cargo Truck M37

The 3/4-Ton Cargo Truck M37 (fig. 15-28) (commonly called a "weapons carrier") has an all-steel body with an open type driver compartment and folding, wood-slat side extensions. The truck is powered by a 6-cylinder, 4-cycle, water-cooled, gasoline engine with a four-forward-speed transmission, four-wheel drive, and a radio-radar suppression electrical system. Four-wheel service brakes and a hand-operated, mechanical parking brake are provided. The truck is equipped with four pneumatic tires (8 ply - 9.00 x 16) mounted on steel disk wheels. A winch is mounted on the front of the truck chassis. In addition, the truck is equipped with sealed beam headlights, combination taillight and stoplight, blackout lights, reflectors, dual windshield wipers, exterior rearview mirror, two towing hooks (front mounted), rear pintle hook, tarpaulin cover and bows for driver compartment and body, and a

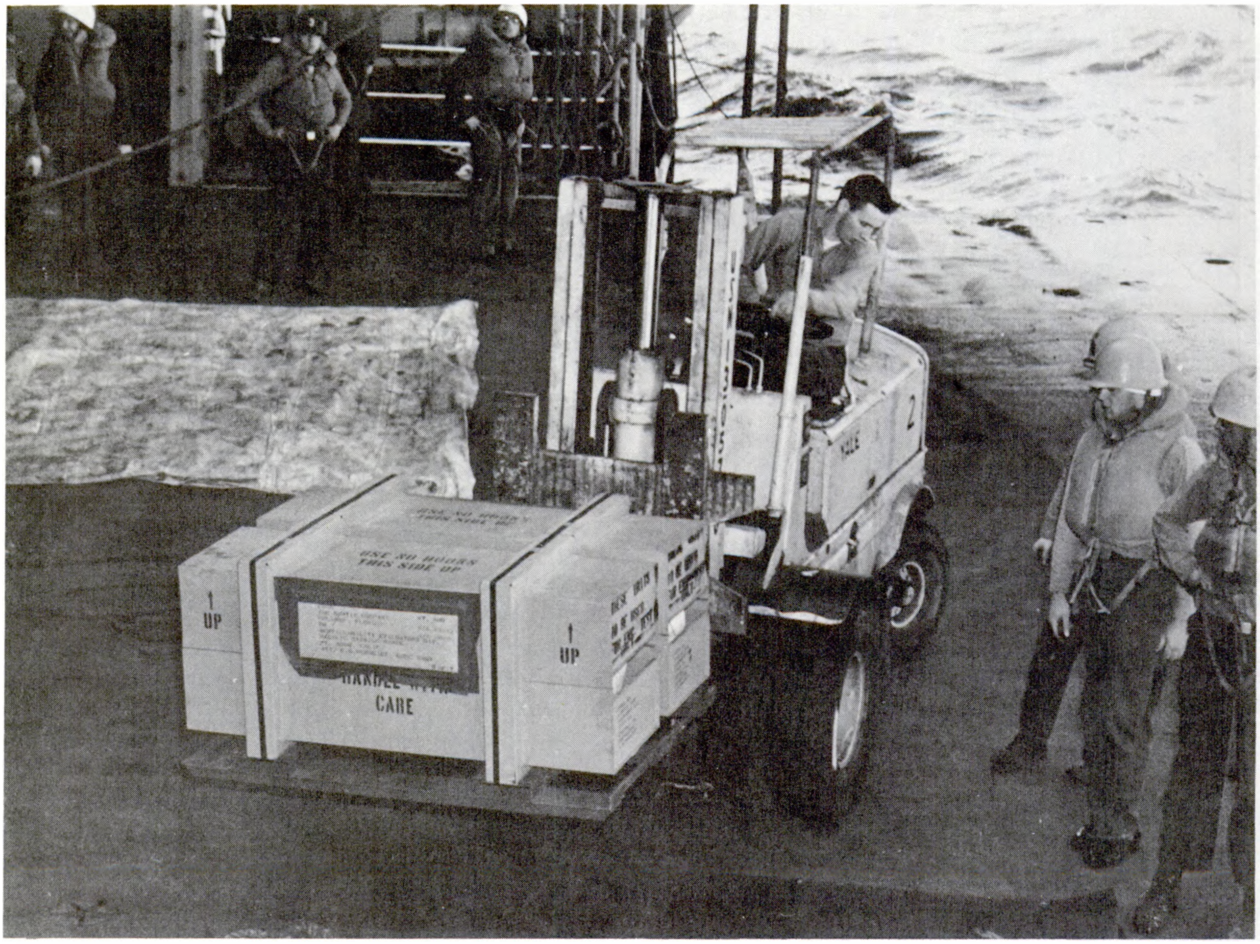


Figure 15-26.—Battery electric forklift truck.

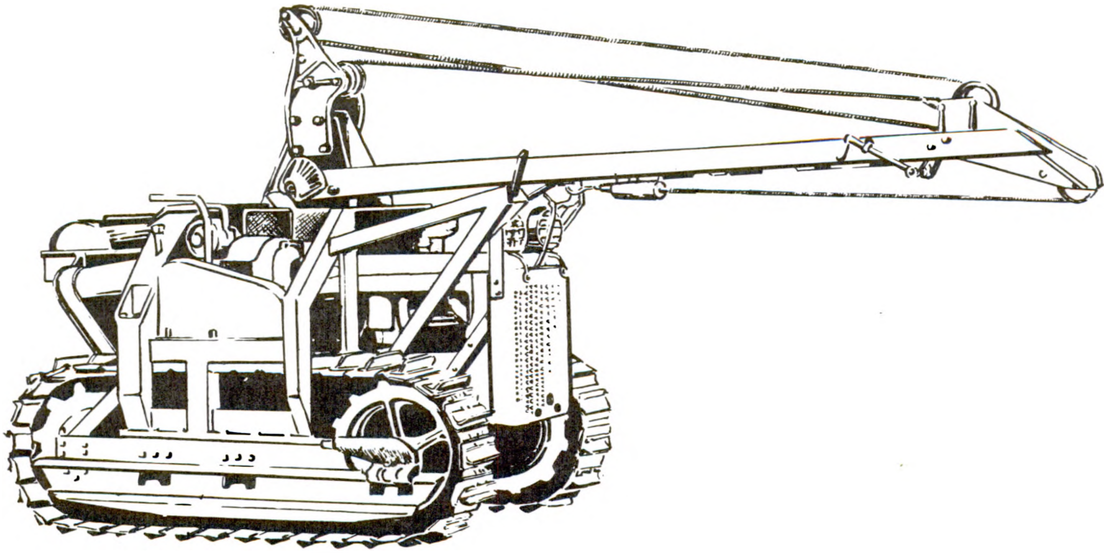


Figure 15-27.—Hydraulic tractor crane.

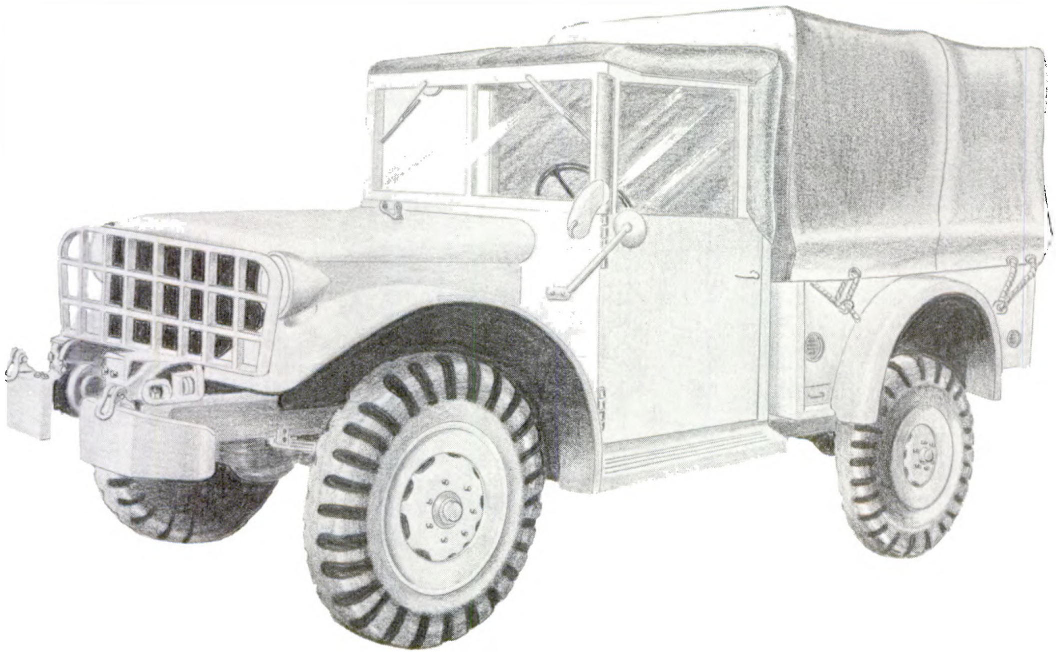


Figure 15-28.—The 3/4-Ton Cargo Truck M37.

spare wheel, tire, and tube. The truck weighs approximately 5,870 pounds.

This truck, used to carry ammunition and explosives, can operate over moderately rough terrain, soft, sandy, or muddy ground, and smooth, hard surfaces.

Bomb Service Truck MJ-2

The Bomb Service Truck MJ-2 (fig. 15-29) may be used in transporting ammunition from the magazine to the arming areas. However, it is primarily a crane designed to load and unload bombs up to 3,000 pounds.

The MJ-2 is a 1 1/2 ton truck equipped with a steel platform type body and a revolving type crane. The engine is equipped with a manually controlled transmission which has four forward speeds and one reverse speed. The crane, hydraulically operated through a power takeoff by the truck engine, is mounted on the truck chassis so that it can be quickly removed from the truck chassis. The crane has an 8-foot telescoping boom which may be extended to a maximum of 12 feet. Its capacity through a sluing arc of 270 degrees is 2,000 pounds at a working radius of 12 feet, and 3,000 pounds at a working radius of 8 feet.

Hoisting, sluing, boom raising or lowering, and boom extension or retraction of the crane can be accomplished simultaneously or independently by controls mounted near the crane structure. A winch, mounted on the front of the truck, has a capacity of 7,000 pounds. The truck is equipped with hydraulic service brakes and a mechanical parking brake.

The truck may or may not be equipped with outriggers at the rear. When equipped with outriggers at the rear, the truck can handle loads weighing up to 4,000 pounds. The truck weighs about 11,000 pounds, has a wheelbase of 154 inches, and is equipped with a four-wheel drive and two-speed axle. The front wheel drive may be disengaged for operation on smooth surface with normal loads, but must be engaged before the two-speed axle can be placed in the low range.

Pickup Truck, 1 Ton

The 1-ton pickup truck illustrated in figure 15-30 has an all-steel body with a closed type driver compartment. This truck is powered by a 6-cylinder, 4-cycle, water-cooled, gasoline engine with a four-forward-speed transmission four-wheel drive. Four-wheel hydraulic service brakes and a transfer case type of parking brake are provided. The truck is equipped with four pneumatic tires (8 ply - 9.00 x 16) mounted on steel disk wheels. A winch is mounted on the front of the truck chassis. In addition, the truck is equipped with sealed beam headlights, combination taillights and stoplights, reflector, dual windshield wipers, exterior rearview mirror, and a spare wheel, tire, and tube.

This truck is used to carry ammunition, explosives, and a variety of ordnance utility

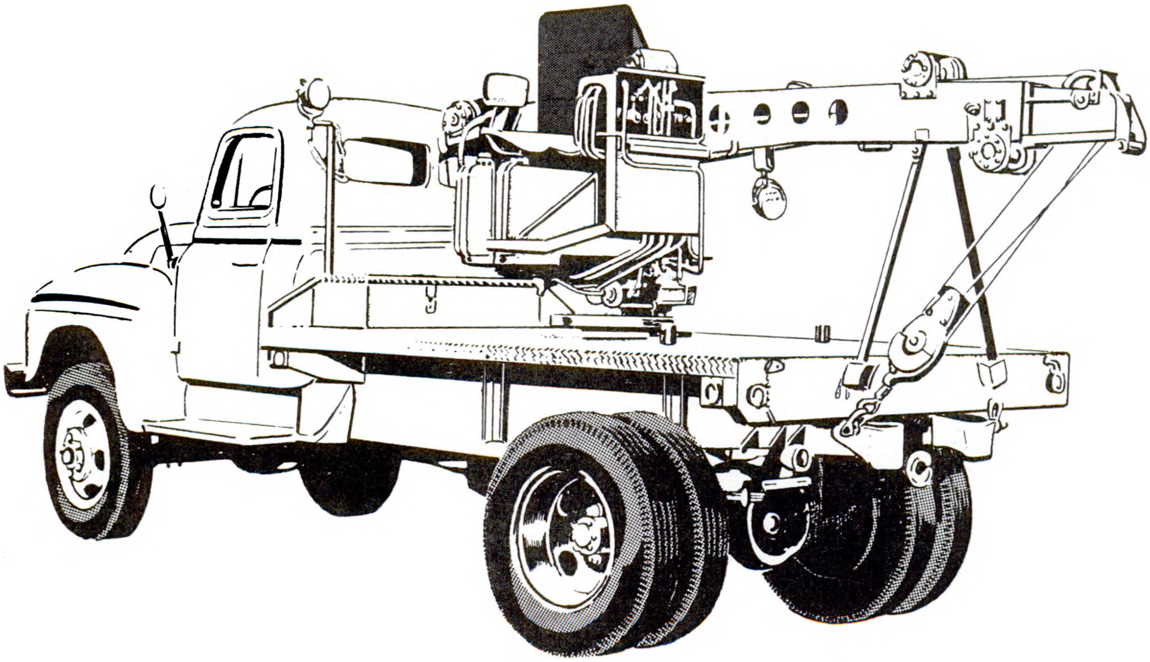


Figure 15-29.—Bomb Service Truck MJ-2.

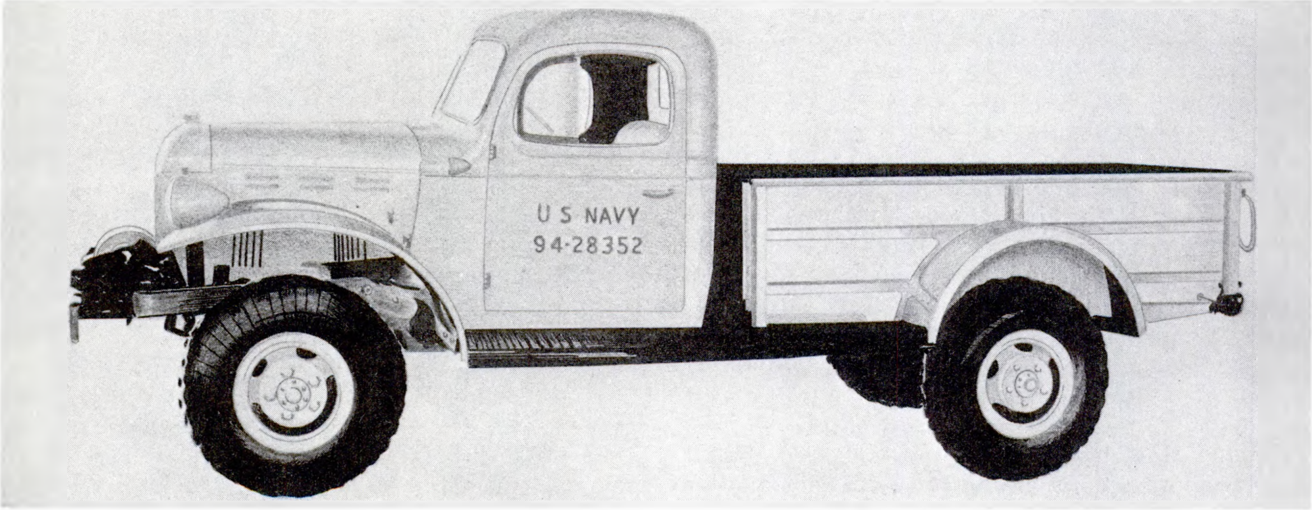


Figure 15-30.—Pickup Truck, 1 Ton.

equipment. It can operate over moderately rough terrain, soft sand or muddy ground, and smooth, hard surfaces.

SAFETY PRECAUTIONS FOR HANDLING EQUIPMENT

The safety precautions and instructions pertaining to the safe operation and use of ammunition and explosives handling equipment must be strictly observed, where applicable, by all naval activities afloat and ashore. The task of ammunition and explosives handling is enormous and, by nature, inescapably hazardous. Accidents arising in ammunition and explosives handling kill and injure human beings, destroy essential supplies, damage valuable equipment and property, and reduce the speed and efficiency of the handling operation. These accidents do not "just happen." They are caused by carelessness or unfamiliarity with the use and limitations of handling equipment as well as relaxation or failure in observance of safety precautions, orders, and regulations pertaining to the handling and storage of ammunition and explosives. The accidents caused by misuse of handling equipment can be prevented by thoroughly understanding the operation, use, and limitations of the handling equipment before its utilization. Safety precautions and instructions are a vital element of safe ammunition and explosives handling operations and must be given careful and constant study.

Appendixes A and B of NavWeps OP 2173, Volumes 1 and 2, contain numerous safety precautions that deal with the equipment covered in this chapter. The Aviation Weapons Officer should review these precautions. Some of the precautions listed in Appendixes A and B are reiterated in the following paragraphs.

NONMOBILE

The following precautions should be observed in handling nonmobile equipment:

1. Select the proper type of hoist, carrier, sling, or band for the type of handling situation involved and the item of ammunition to be handled. Selection factors which should be considered are the capacity of the hoist, carrier, sling, or band; the type and size of load the carrier, sling, or band is designed to handle; type of hoisting provisions (single cable or double cable); and the possible load positions (vertical or horizontal) during handling.
2. Always inspect handling equipment for defects and damage before use. Never use defective or damaged equipment.
3. Never handle a load in excess of the capacity of the handling equipment.
4. Always inspect the hoist or lift for defects or damage, particularly to the hoisting cable or cables.
5. Always properly position and secure the hoist to the aircraft before hoisting a load.
6. Always positively secure the hoisting cable to the hoisting sling or band on the load in such a manner that the load will be in proper alinement with the bomb rack or shackle when hoisted.
7. When using an adapter with a lift, always make certain that the proper adapter is used to support the load and that the adapter is positively secured to the lift.
8. Hoists and lifts must be periodically serviced and maintained to assure maximum safety and efficiency in operation.
9. Always properly assemble, position, and positively secure the carrier, sling, or band on the load.
10. Slings and bands must be positioned on the load at approximately the center of gravity of the load to make sure the load will be well balanced when hoisted.
11. Always positively secure the hoisting device to the lifting eye or clevis of the carrier, sling, or band.
12. Carriers, slings, and bands must be periodically serviced and maintained to assure maximum safety and reliability in use.

MOBILE

The following precautions should be observed in handling mobile equipment:

1. Select the proper type of equipment for the items of ammunition to be handled and the type of handling situation involved. Selection factors which should be considered are capacity of the equipment, type of load the equipment is designed to carry, use and availability of accessories for equipment adaptation to handle particular types of ammunition, ability of the equipment to elevate the load to a certain height, and type of terrain the equipment is designed to operate over.

2. Always inspect the equipment's brakes, steering apparatus, load-supporting surfaces, load securing chains, and any other safety devices and controls for any defects or damage.

3. Never use defective or damaged equipment.

4. Never attempt to carry a load whose weight is in excess of the capacity of the equipment.

5. Always properly position and secure the load to the load-carrying surface of the equipment.

6. When using equipment which can elevate the load, always carry the load in the lowered position while the equipment is in movement. The equipment must be braked against movement while the load is being elevated.

7. Equipment accessories such as adapters and cradles must be properly assembled and secured to the equipment.

8. Always apply the brakes of the equipment when leaving the equipment unattended. Never leave the loaded equipment unattended on an incline.

9. Always be alert while the equipment is in movement, and be especially careful when approaching corners and low overhead clearances and going down or up inclines.

10. When towing the equipment with a powered towing vehicle, never exceed speeds which are consistent with safety for the type of equipment and type of terrain.

11. Never tow more than four bomb and torpedo trailers at any one time.

12. Equipment must be free of any unauthorized attachments and devices. Special and locally designed attachments and devices must be authorized by the cognizant bureau before use.

13. Equipment must be periodically serviced and maintained to assure maximum safety and efficiency in its operation.

CHAPTER 16

SUSPENSION, ARMING, AND RELEASING EQUIPMENT

During the early days of combat aircraft, small bombs were sometimes thrown over the side into enemy positions. They were only as effective as the bombardier's sense of timing and seaman's eyes. As the various aircraft stores were developed, suspension, arming, and releasing devices had to be produced which were capable of carrying and releasing these stores. These devices were designed to release the stores without delay, and to operate safely at all times.

The continuous progress in the development of naval combat aircraft, weapons, and air-launched guided missiles has made it necessary for the employment of highly complex suspension, arming, and releasing devices. This is due partly to the necessity for a greater variety of equipment to suspend, arm, and release the many new weapons and missiles. The high speed and performance of potential targets, as well as the speed and performance of our own aircraft, necessitate electronic operation of most of our present suspension, arming, and releasing equipment.

TYPES OF EQUIPMENT AND METHODS OF OPERATION

The devices described in this chapter are all parts of the numerous aircraft search or kill stores systems. They are generally electrically operated and are therefore placed in the aircraft's electrical circuits. They are actuated at the instant desired either by hand switch or automatically through some circuit closing device in the system. Provisions are also made for manual operation if the neccssity arises.

Current suspension, arming, and releasing devices for aircraft also require the use of associated electrical gear such as intervalometers to time the release of stores, and rack selectors to control the pattern of store releases. There are other units which preselect the desired arming of bomb fuzes, and establish definite order and grouping of rockets fired. Each serves a definite purpose in accurately delivering stores against the enemy.

With the development of nuclear weapons, monitor and control systems were also developed. A number of these systems are utilized by the Navy at the present time. The development of electric fuzing for conventional stores required the development of fuze arming control (charging) systems.

Primarily as an economy measure, a practice bombing system was developed to train pilots and crews in the delivery of various types of ordnance including nuclear weapons. This system simulates all phases of delivery utilizing miniature bombs. (Consequently, its operation is very economical.) Practically all of the above mentioned equipment has been utilized for some time and may be termed as "conventional."

New developments which may be found only in the latest service aircraft are the linear bomb bay (discussed in Chapter 5) and a system utilizing missile cavities (equipped with ejector launchers) which are located in the fuselage. These systems may not readily be termed "conventional."

A new concept of weapons system (aircraft) is at present under development utilizing a medium performance aircraft with capabilities of carrying heavy armament loads over long distances. This system depends for its efficiency upon high performance missiles and its ability to locate and track targets at long ranges.

Aircraft bombs, torpedoes, mines, and other stores are suspended either internally or externally from the aircraft by bomb racks, shackles, and combination bomb racks and rocket launchers. The function of these devices is to carry, arm, and release these stores. The racks are usually bolted to the wings, or fuselage, or placed in the bomb bay of the aircraft. Shackles are generally suspended from internal guide rails by utilizing pivoting supports. Normally, the bomb rack has its own arming and releasing unit integral with the rack. These units are operated remotely by electrical impulse or a manual release. Shackles are usually dependent on an attached unit, or units, to arm and release their stores. The combination bomb racks and rocket launchers are usually attached to the underside of the aircraft's wings, and are actuated through an electrical circuit or manually from the cockpit.

Suspension, releasing, and indicating systems in current aircraft may range from the simple to the complex. Some aircraft with a simple system utilize bomb racks or shackles (containing the necessary electrical switching devices to provide indication of the station status) with their releases and solenoid type arming devices for nose and tail arming.

The more complex systems consist of fuze function controls (for electrical arming of conventional stores), electrical operation and control of ejector racks and ejector guns, and electrical control and monitoring systems for nuclear weapons. Indicating systems may be controlled by separate switches which are actuated by the stores to indicate the station status. Most current aircraft also have provisions for wing or fuselage mounted pylon/launchers, with the necessary controls for carrying and launching a variety of guided missiles.

SUSPENSION EQUIPMENT

There is a wide variety of suspension equipment used in the Navy. A few of the more typical types of suspension equipment currently in use are discussed in the following paragraphs.

BOMB RACKS

Bomb rack Mk 51 Mods 11, 12, and 14

The Mk 51 aircraft bomb rack is designed to carry and release any currently used mine or mechanically fuzed, conventional bomb up to a nominal weight of 2,240 pounds. Auxiliary fuel and chemical tanks may also be carried provided their suspension lugs are 14 inches apart.

Aero 1A adapters can be installed in the Mk 51 bomb rack to increase the suspension from 14 to 30 inches and the capacity from 2,240 to 4,000 pounds. Installation of the Aero 1A adapters allows a choice of either 14- or 30-inch suspension capabilities by merely engaging or disengaging the outer (30-inch) hook assemblies. (See fig. 16-1.)

Manual release of stores is effected by a wire cable leading from the rack to the desired position in the aircraft. For electrical releasing, the rack is wired into the electrical system of the aircraft. The arming mechanism may be operated either electrically or manually.

The Mk 51 racks are used externally on the wing pylons or fuselage of the aircraft, and used internally or externally when used with nuclear stores.

The Mk 51 bomb rack is latched by lifting up on either of the two pawl latching screws (pins) (fig. 16-2). Lift until the release pawl engages the shoulder of the release lever. Manual release is accomplished by pulling the release cable a distance of about three-fourths of an inch. A pull of 12 to 20 pounds is required.

Electrical arming is fully selective. Energizing the arming solenoids will arm either the nose or tail fuzes, or both. Energizing the solenoids causes their plungers to protrude and block the rotation of the arming wire retainers. This positively locks the arming wires to the rack. Manual arming is only semi-selective. Either the tail fuze can be armed, or both the nose and tail fuzes can be armed together. The nose fuze cannot be manually armed without first arming the tail fuze. In order to arm the tail fuze manually, the arming cable is pulled a distance of about three-fourths of an inch. A pull of 6 to 8 pounds is required. The nose fuze is still safe in this position. To arm the nose fuze, pull the cable another three-fourths of an inch. A pull of 10 to 12 pounds is required to arm the nose fuze. When the arming solenoids are not energized and the arming cable is relaxed, both the nose and tail fuzes are in the safe condition.

Both the electrical and manual releases perform the same operation—they retract the release lever. This allows the release pawl of the hook and link assembly to drop,

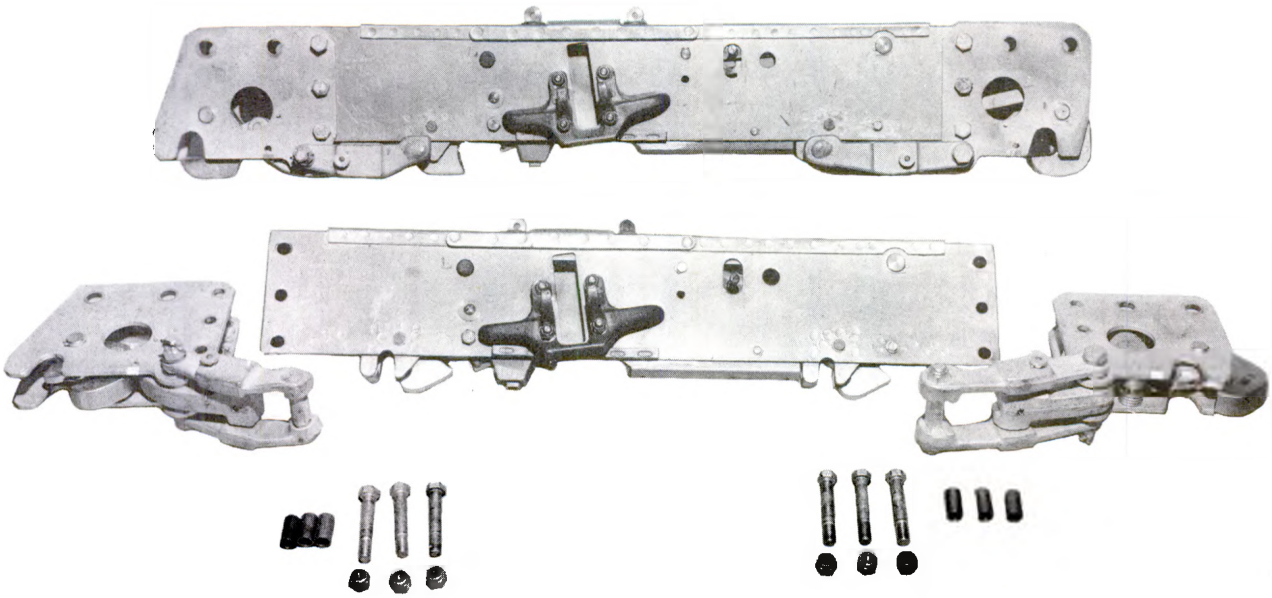


Figure 16-1. –Mk 51 bomb rack with Aero 1A adapters.

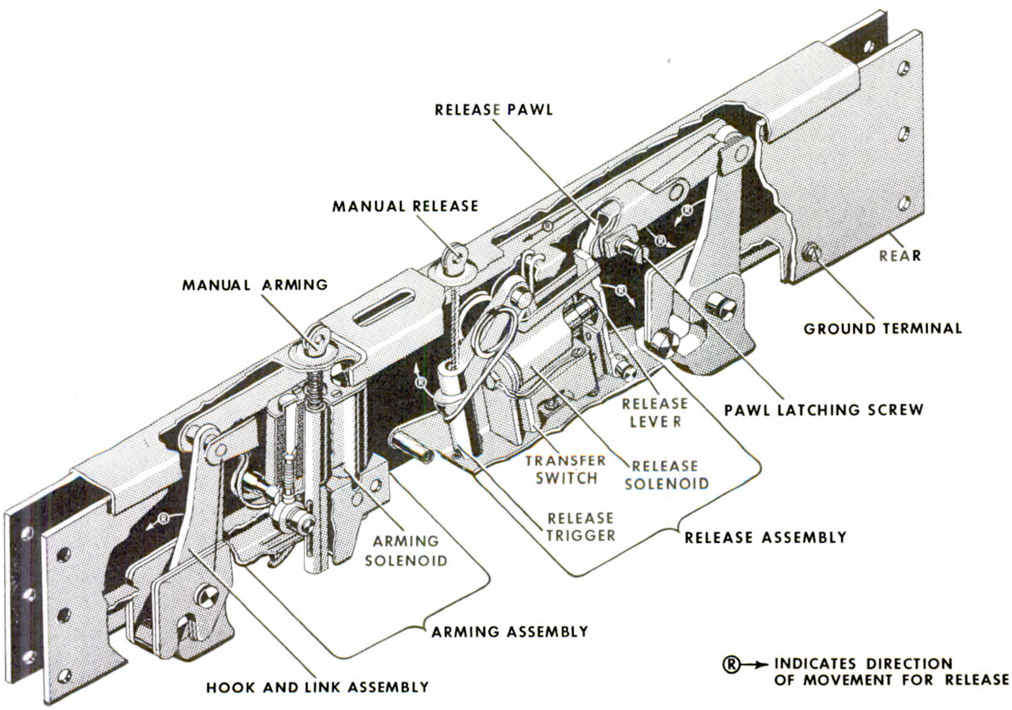


Figure 16-2. –Cutaway view of Bomb Rack Mk 51 Mod 11.

permitting the hooks to open. As the release pawl drops and rotates, the connecting link slides forward until the suspension hooks open and the bomb falls free. Rotation of the release pawl is caused partly by the action of the coil spring on the release pawl link and partly by the weight of the bomb. However, this spring will cause the hooks to open even though there is no bomb on the rack.

When the release pawl has rotated down and the electrical impulse to the release solenoid ceases, a spring forces the release lever to pivot until the transfer switch actuating lever operates the transfer switch. Actuation of the transfer switch disconnects the release solenoid of the rack from the release circuit and bypasses any succeeding impulses to the next rack in the series. The transfer switch is provided in a single wire release system which does not have a distributing device. When the manual release is actuated, the release trigger rotates. The extension of the trigger pulls the release lever to which it is connected by the stirrup. The release lever is then disengaged from the release pawl and the hooks open.

The Mk 51 Mod 12 rack is essentially the same as the Mk 51 Mod 11. The transfer switch, and its wiring, and the manual arming plunger, and its spring and cable assembly, have been removed from the Mod 12. Thus, the Mk 51 Mod 12 rack cannot be used in aircraft which require the use of a transfer switch.

There are several features incorporated in the Mk 51 Mod 11 rack which do not exist in earlier modifications. Some of these are as follows:

1. Release solenoids are approximately twice as powerful as earlier models.
2. Arming solenoids are more powerful and capable of continuous operation.
3. A pilot lightswitch is not used in the Mod 11.
4. Arming assemblies are more positive for safe release at all attitudes.
5. Hoisting brackets are stronger (support 2,240 pounds).
6. The release assembly is easily removed for inspection without disassembly of the electrical receptacle.
7. A quick-disconnect is provided.
8. Major components are made of corrosion-resistant materials.
9. The contour of suspension hooks is modified to insure positive release of bombs in diving attitudes.

Bomb Racks Mk 51 Mod 14 and Mod 11 are identical except that a buffer device has been added to the hook and link assembly of the Mod 14 to absorb the shock on the hook and link assembly caused by the triggering of the release solenoid..

Bomb Rack Aero 65A1

The Aero 65A1 bomb rack (fig. 16-3) is designed to provide adequate suspension, safe and selective arming, and positive release of stores suspended on it. The rack has double hook suspension spaced 14 inches apart and a maximum capacity of 1,000 pounds. The rack employs the Aero 7B release assembly. The bomb rack consists of an alloy steel frame, which is a deep narrow channel with holes in the side to provide bearings for pins on which the linkage assembly is carried. The linkage assembly is illustrated in figure 16-4.

The rack is installed on the aircraft with six mounting bolts. A mechanical release cable assembly and an electrical connector must be attached to complete the installation.

When loading the Aero 65 A1 bomb rack, first cock the release assembly Aero 7B. Hoisting is accomplished by attaching a hoist bracket to either side of the frame (hoist brackets are not a part of the rack and should be removed before flight) and hoisting the store with a Mk 8 or Aero 14B hoist. Lift the store into the open hooks. The hooks will close as the store's lugs strike the hook's tangs. When the store is lifted just clear of the bottom of the hooks, pushing forward on the hooks insures closing. Visual inspection of each latch hole insures that the hook's pin end (red) is in the center of the hole and properly seated in the hook latch. A safety lockpin (with a red flag on it) may then be inserted in the safety hole until ready for flight.

Since the bomb rack is electrically armed and fully selective, either tail, nose, or nose and tail arming wire retainers may be energized as selected. These arming solenoids are of the continuous duty type. Stores suspended from this bomb rack may be released electrically or manually. When released electrically, the release solenoid plunger moves forward, actuating the bellcrank through the connecting link. The sear link is rotated to free

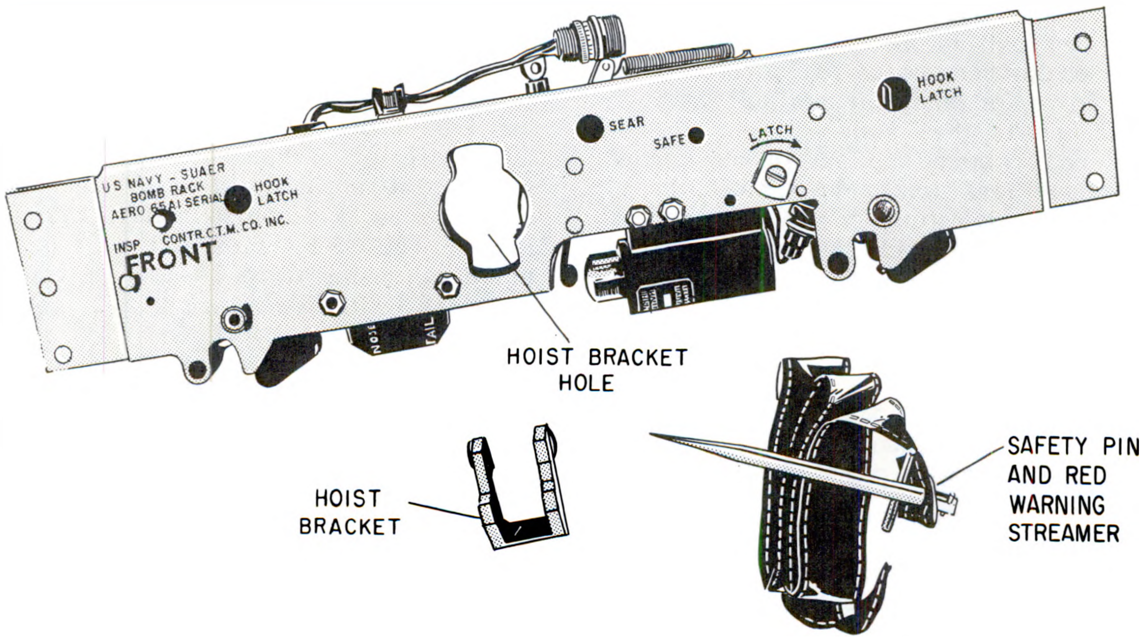


Figure 16-3. -Aero 65A1 bomb rack.

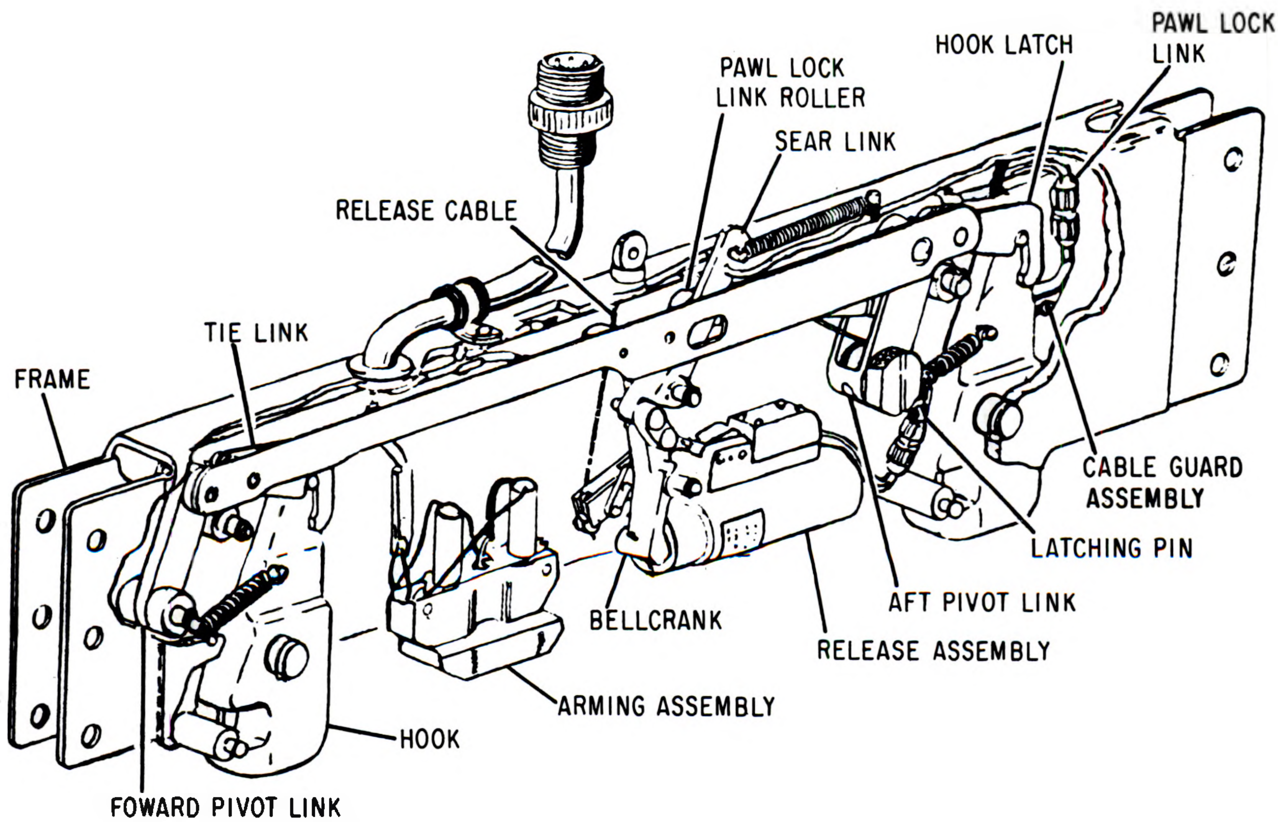


Figure 16-4. -Cutaway of Aero 65A1 bomb rack.

the pawl lock link. Further rotation causes the sear link to strike the bumper on the tie link, giving positive motion to the tie link. As the hook latches, which are pivoted on the tie link, move forward, springs pull the hooks open. The hooks then come to rest with the hook latches cammed up out of engagement and the pawl lock link held against the aft link by the pawl return spring. The rack is released manually by pulling up on the manual release cable, which is connected to the bell-crank, causing the bellcrank to pivot. The rest of the action is the same as the electrical release.

Three modified versions of the Aero 65A1 rack are presently being used in the P-3A type aircraft. They are the MAU/38/A, the MAU-13/A and a third version which utilizes Aero 1/A adapters (fig. 16-1) for heavier store capabilities. The first two racks are very similar except for a manual release mechanism.

For further information on the Bomb Rack Aero 65A1, refer to Operation Maintenance, and Overhaul Instruction Manual with Illustrated Parts Breakdown, NavWeps 11-5E-50.

Aero 67A Rack Assembly

The Aero 67A rack assembly (fig. 16-5) consists of a body assembly with a hook housing assembly at each end. Each hook housing assembly contains a pair of hooks, spring loaded to the closed position. The hook assemblies are mechanically linked through sears to a manual release handle in the forward housing. Also located in the forward housing are the two breeches into which are inserted electrically fired primers (Mk 25 Mods 1, 2, and 3). An indicator switch, mounted on the underside of the rack body assembly, gives an electrical indication of the loaded or unloaded condition of the rack. The rack has double hook suspension spaced 67 inches apart, a capacity of 3,200 pounds, and weighs 32 pounds. It has an overall length of 75 inches, a height of 6 1/16 inches, and a width of 4 1/4 inches.

For detailed information on preloading, checks and operation, refer to Operation, Maintenance and Overhaul Instruction Manual with Illustrated Parts Breakdown, NavWeps 11-5-106.

A/A37B-1 Multiple Bomb Rack

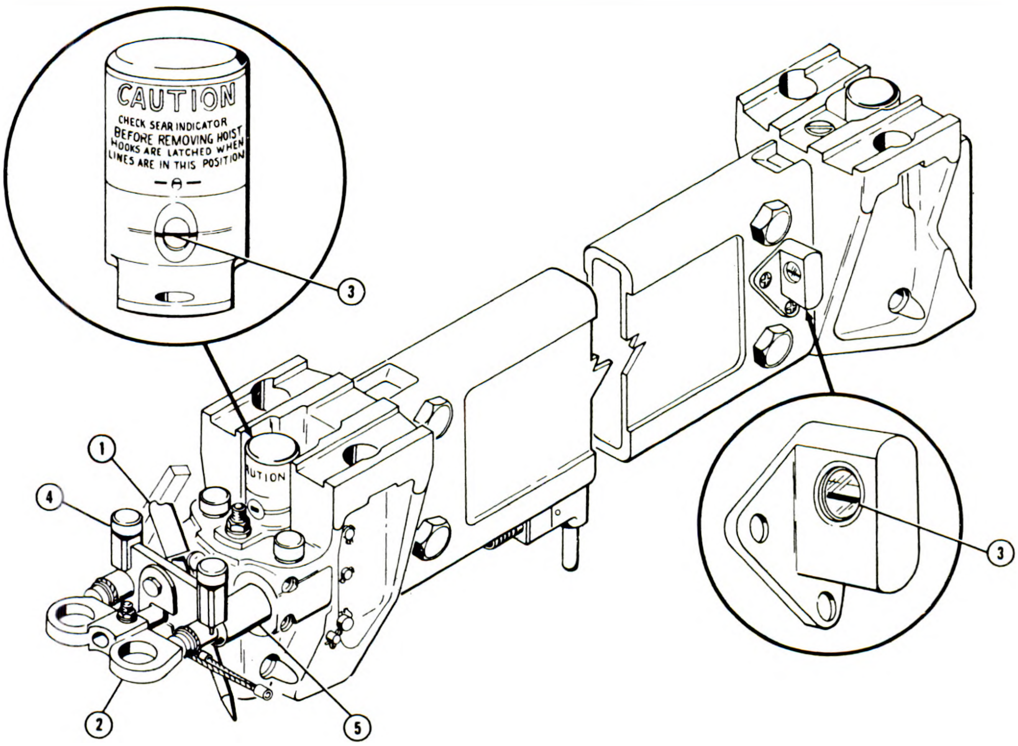
The Multiple BombRack A/A37B-1 (fig. 16-6) provides carriage and individual, dual, or train release of six bombs or stores. It is designed for installation on the Aero 7A-1 and Aero 20A-1 ejector racks. The multiple bomb rack weighs 159 pounds and is 15 inches high, 11 inches wide, and approximately 142 inches in length. The A-4 series aircraft has the rack installed on the Aero 7A-1 centerline ejector rack and on the two Aero 20A-1 ejector rack pylon positions.

Two configurations of the multiple bomb rack are presently being used. The first configuration uses lugs spaced 30 inches apart for carriage on the Aero 7A-1 ejector rack. The second uses lugs spaced 14 inches apart for carriage on the Aero 20A-1 ejector rack.

The multiple bomb rack assembly may be divided into three basic subassemblies. They are the adapter, wiring support, and bomb rack assembly.

ADAPTER ASSEMBLY.—The adapter assembly is a hexagon aluminum extrusion approximately 10 feet long and forms the main support for the multiple bomb rack assembly hardware. Six bomb racks are bolted to the adapter assembly in two groups—three forward and three aft. Attach points on the adapter assembly are provided for 30-inch or 14-inch spacing of suspension lugs. Four pads are provided on the adapter assembly as bearing areas for ejection rack sway braces.

SUPPORT ASSEMBLY.—The support assembly consists of a tail cone assembly, a stepper switch, and an electric fuzing harness and wiring assembly. The tail cone assembly, at the aft end of the adapter assembly contains the RELEASE MODE selector, an electrical receptacle for a "homing" test unit attachment, and a momentary-on toggle switch for use in conjuction with the "homing" test unit. The RELEASE MODE selector switch, preset before takeoff, selects single or dual bomb release, or bomb train release with a timing interval of 15, 30, or 60 milliseconds. A "homing" test set (ground support equipment) is used to insure that the stepper switch is properly "homed" before aircraft takeoff. The electrical harness is coupled to the aircraft normal-release electrical lead, the mechanical arming lead, and the electric fuzing lead. Breakaway type disconnects on the harness assembly



1. Safety lockpin.
2. Manual release handle.
3. Sear indicator.
4. Breech lockpin.
5. Gun assembly.

Figure 16-5. —Aero 67A rack assembly.

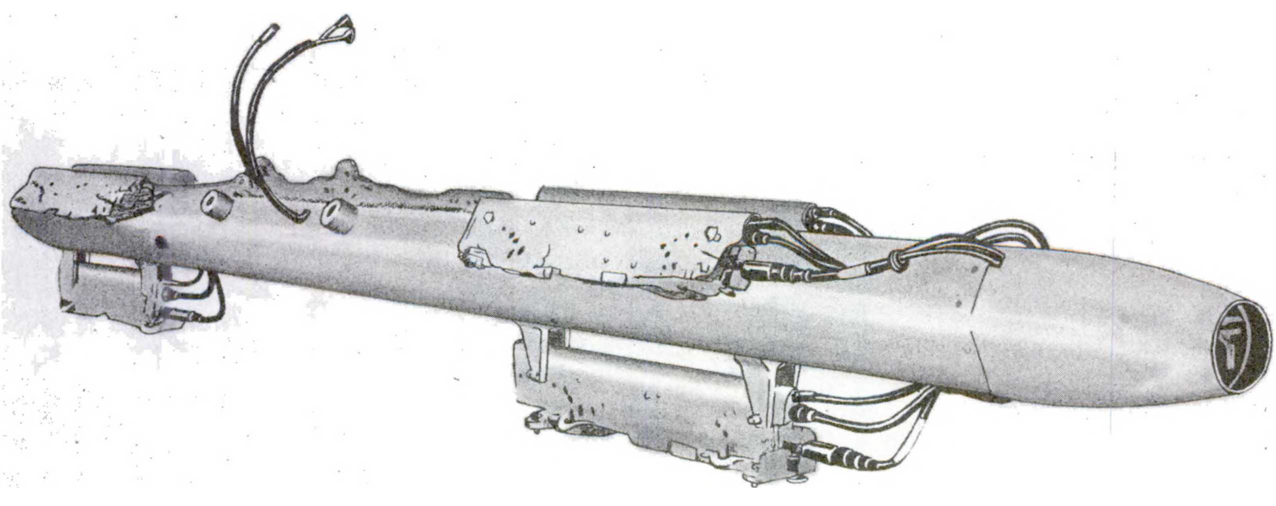


Figure 16-6. —Multiple Bomb Rack Assembly A/A37B-1.

prevent damage to the aircraft wiring if the multiple bomb rack assembly is jettisoned.

BOMB RACK ASSEMBLY—Each of the six bomb racks has its own integral wiring, a breech mechanism, a nose and tail arming unit for mechanically armed bombs, provisions for an electric fuzing unit (AAW-1) for electrically fuzed bombs, suspension hooks, and sway braces. Jam screws are provided for sway bracing. The shoulder-mounted stores rest against the adapter assembly structure and are sway braced on the outboard side only. The two lower bomb racks each have two pairs of sway braces. Hooks on the individual racks are spaced 14 inches apart and are independently self-latching.

For ground operation, a manual release lever at the front of the rack is provided for opening the hooks. A release hook is used for this purpose. Release of the individual bomb(s) during flight is accomplished by the firing of the Mk 17 Mod 0 separation cartridge in each bomb rack. Firing of the cartridge actuates an overcenter toggle to effect release. Safety pins are provided to prevent accidental manual or electrical release while the bomb rack is loaded.

The multiple bomb rack when utilized with the Aero 20A-1 ejector rack is capable of carrying six Mk 81 250-pound bombs. When the multiple bomb rack is used with the Aero 7A-1 (14-inch suspension), it is capable of carrying the same load as the Aero 20A-1. However, when used with the Aero 7A-1 (30-inch suspension) it is capable of carrying six Mk 82 500-pound bombs.

NOTE: Ejection of individual stores is not provided. For jettison or emergency release, the multiple bomb rack assembly, including bombs, may be ejected by firing the Aero 7A-1 or Aero 20A-1 ejector rack.

For further information the reader is referred to the Operation, Maintenance and Overhaul Instruction Manual with Illustrated Parts Breakdown, NavWeps 11-5C-18.

COMBINATION BOMB RACK AND ROCKET LAUNCHERS

Aero 15C

THE Aero 15C bomb rack and rocket launcher (fig. 16-7) is a fixed pylon unit designed to carry and launch rockets or bombs. The launcher is attached to the underside of the wing and launches the rocket or store, in the armed or safe condition, by either conventional or toss launching. The launcher is capable of carrying one 500-pound store, one 5-inch HVAR rocket, or one 2.25-inch rocket when equipped with the Aero 1A subcaliber rocket launcher. The launcher has double hook suspension spaced 14 inches apart for bombs or is equipped to install rockets with lugs 24 inches apart. The launcher has installed internally two electrical arming solenoids for mechanical arming bombs. The launcher has four sway brace screws and pad assemblies. Incorporated in the forward end of the rocket launcher are two contact points. The most forward contact point is lowered and used when firing Zuni rockets. The aft contact point is lowered and used when firing SCAR's using the Aero 1A adapter.

An emergency jettison device, located on the after end underside of the launcher, is provided for ejecting dud rockets and releasing stores when normal release systems malfunction.

Operation

When loading rockets, place the sway braces in the vertically up position. Raise both rocket contact points. Raise the rocket to a position under the launcher with the lugs forward of each support. Slide the button lug in the forward rocket support and the tunnel lug in the aft rocket support. Be sure to push the rocket aft until locked. Plug the rocket pigtail into the receptacle on the trailing edge of the launcher. An electrical impulse then will go through the rocket circuit in the launcher to the pigtail of the rocket. When the subcaliber Aero 1A rocket adapter is used with the Aero 15C, the firing voltage is supplied to the adapter firing circuit by the aft rocket contact being lowered so that it will contact the button lug on the Aero 1A subcaliber rocket adapter.

In the emergency jettison of rockets, a Mk 25 primer is fired. Gas pressure pushes the piston forward which raises the rear end of the rocket latch and pushes on the rocket tunnel lug until the rocket is free from the launcher.

When loading bombs, turn the cocking handle on the right-hand side of the Aero 15C in a counterclockwise direction to cock the rack release assembly. Raise all sway brace screws and pad assemblies until the pad lightly touches the sway brace arm. Using two hoists, raise

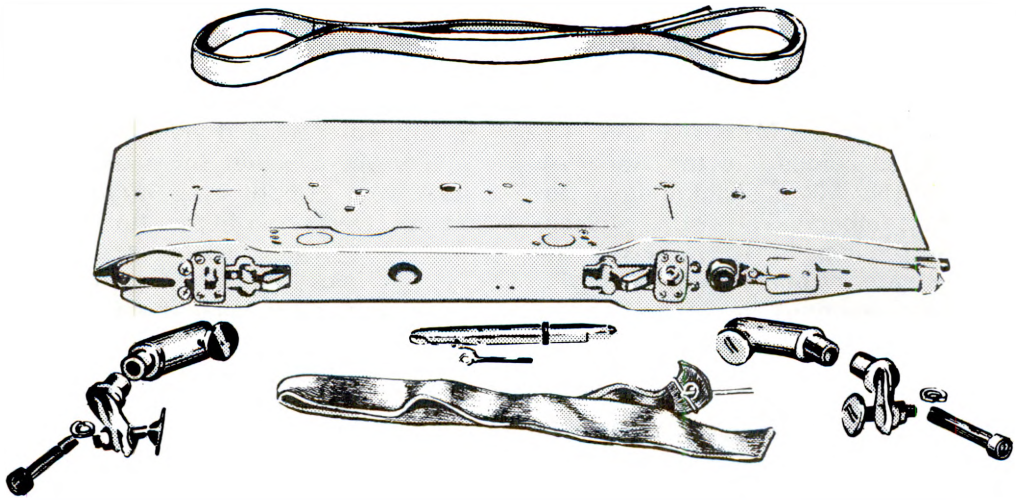


Figure 16-7.—Bomb Rack and Rocket Launcher Combination Aero 15C.

the bomb so that its lugs engage the cocking extension on the hooks. Then slowly raise the bomb until the hooks close around the bomb lugs. Finger-tighten the four sway brace screws and pad assemblies evenly on the bomb until the pads squarely contact the store. Tighten each screw one-half turn more with a wrench.

When releasing bombs, energizing of the rack solenoid releases the solenoid plunger which moves and unlocks the toggle linkage. The weight of the bomb and main link spring will open the hooks and release the bomb lugs. The bombs are released manually by inserting a screwdriver in the manual release hole. This trips the release mechanism and main link spring, opening the hooks.

In the emergency jettison of bombs, the Mk 25 screw type primer is fired. Gas pressure pushes the piston forward, raising the rear end of the rocket latch. When the rear end of the rocket latch is raised, it pivots the emergency release cam. When the emergency release cam pivots, it pulls on the emergency release cable. When the emergency release cable is pulled, the manual release mechanism and main link spring are tripped, opening the hooks.

The arming units consist of a push-type solenoid and two spring-loaded arms. There are two arming solenoids in each rack, one for nose arming and one for tail arming. The arming units provide fully selective arming for either rockets or bombs. The arming units permit the dropping of bombs or firing of rockets with the fuzes in the armed or safe condition. When dropped safely, the pin plunger remains unactivated in the solenoid. As the arming wire is pulled by the rocket or bomb, it moves the balls allowing the arming wire to leave the arming unit and remain with the rocket or bomb. When dropped armed, the arming solenoid is energized, pushing the pin plunger between the rollers, preventing any movement of the arms. The arming wire is then retained by the arming solenoid when the rocket or bomb is launched. The arming wire pulls out of the fuze connection on the rocket or bomb, thereby arming the fuze.

The Aero 15C-1 is the same as the Aero 15C except that the Aero 15C-1 utilizes the Bomb Arming Unit Aero 2A-1 (discussed later in this chapter). The change required other small changes to be made in the physical appearance of the rack.

Detailed information on the Bomb Rack and Rocket Launcher Combination Aero 15C and 15C-1 can be found in NavAer 11-75A-18.

BOMB SHACKLES

Mk 8 and Mods

The Mk 8 bomb shackle (fig. 16-8) can carry and release any Navy or Army-Navy bomb store weighing from 100 to 2,240 pounds.

The Mk 8 may be used for either horizontal or dive bombing. It may be operated either manually (emergency, operation or unloading only) or electrically. Electrical releasing is accomplished by attaching the Aero 4A, 4B, or 7A release assembly to the Mk 8 shackle. The most currently used release is the Aero 7A.

The frame of the Mk 8 shackle is an inverted U-shaped member. The frame suspension lugs are also U-shaped. They are attached to the ends of the frame by pivot bolts which also retain the hook link assembly in place within the frame. Other components of the Mk 8 shackle are the cocking lever, release lever, latching lever, and associated springs.

There is only a single difference between the Mk 8 Mod 0 and the Mk 8 Mod 1 bomb shackles. The Mod 1 shackle has had one-sixteenth of an inch removed from the rear of each hook. The Mod 0 could not be used in certain aircraft due to the fact that the aft carrying hook protruded one-sixteenth of an inch beyond the shackle frame when the shackle was released.

In cocking the Mk 8 shackle, the cocking lever is moved aft until the latching block on the link assembly engages in the slot of the latching lever. The roller on the latching lever rides up and seats on the top of the release lever cam. When the release lever is moved forward (either electrically by the bomb shackle release or manually), the latching lever moves down and away from its engagement with the latching block. This action allows the hook opening spring and the weight of the bomb to move the hook link assembly forward. The bomb is then released.

The Mk 8 shackle should be kept in the released position except when actually carrying bombs. When work is being performed on an aircraft loaded with stores, a No. 5 safety pin should be inserted in the safety pinhole of the shackle. Suitable signals (such as red streamers) should be attached to the safety pins in order that they will be seen and the pins removed prior to the aircraft taking off.

Aero 16A and Aero 17A

The Aero 16A and Aero 17A bomb shackles (fig. 16-9) are modifications of the USAF shackles D-7A and D-6A, respectively. The Navy modified these shackles by adding two adapter plates. These plates support a bomb release unit (Mk 1 Mod 4) and its mount. They are bolted and clamped to the forward end of the frame assembly. The Aero 16A has a carrying capacity of 4,000 pounds. The Aero 17A has a carrying capacity of 2,000 pounds. These shackles consist of a frame assembly, link assembly, bomb release adapter plates, and an arming assembly. The frames are of stainless steel and are spot-welded to an upper and lower channel for added strength. The link assembly (1) consists of two forged hooks permanently riveted to two links of stainless steel. The carrying hooks (9) are located at the ends of the links. The bomb release adapter plates are fastened around the frame assembly with machine screws on the lower end, and a clamp type arrangement on the upper end. This assembly is used to support the Mk 1 Mod 4 bomb release unit and its mount. An adapter has also been included on the Aero 16A shackle to support the Aero 4A, 4B, or 7A bomb shackle release.

The lugs of the bomb store will close the hooks of the Aero 16A and 17A shackles as it is lifted into position on the shackle. Although the hook will appear to be locked, it is necessary to manually push the release lever (tripper hook (4, fig. 16-9)) towards the arming hook latch (5) and allow it to return before the bomb store is actually locked to the shackle.

Electrical impulses received by the release unit actuate the tripper hook (4). These devices release the bomb in either an armed or safe condition, as required. The tripper hook has two positions—LOCK and RELEASE. In the lock position the pawl (3) is held in the upper position by the hook. The pawl engages the pawl stop lug (2) on the link assembly. This prevents the opening of the carrying hooks. When the tripper hook is in the release position, the pawl is disengaged from the stop lug. The weight of the bomb is then sufficient to open the carrying hooks.

Bombs suspended from the Aero 16A and Aero 17A bomb shackles are armed by means of two remote arming controls—usually two AN-A-2 bomb arming controls.

BOMB EJECTORS

Aero 3A

The Aero 3A bomb ejector rack assembly (fig. 16-10) is designed to carry stores up to and including 3,600 pounds. The rack has hook suspensions spaced 14 and 30 inches apart. The 14-inch hooks have a capacity of 2,000 pounds and the 30-inch hooks have a capacity of 3,600

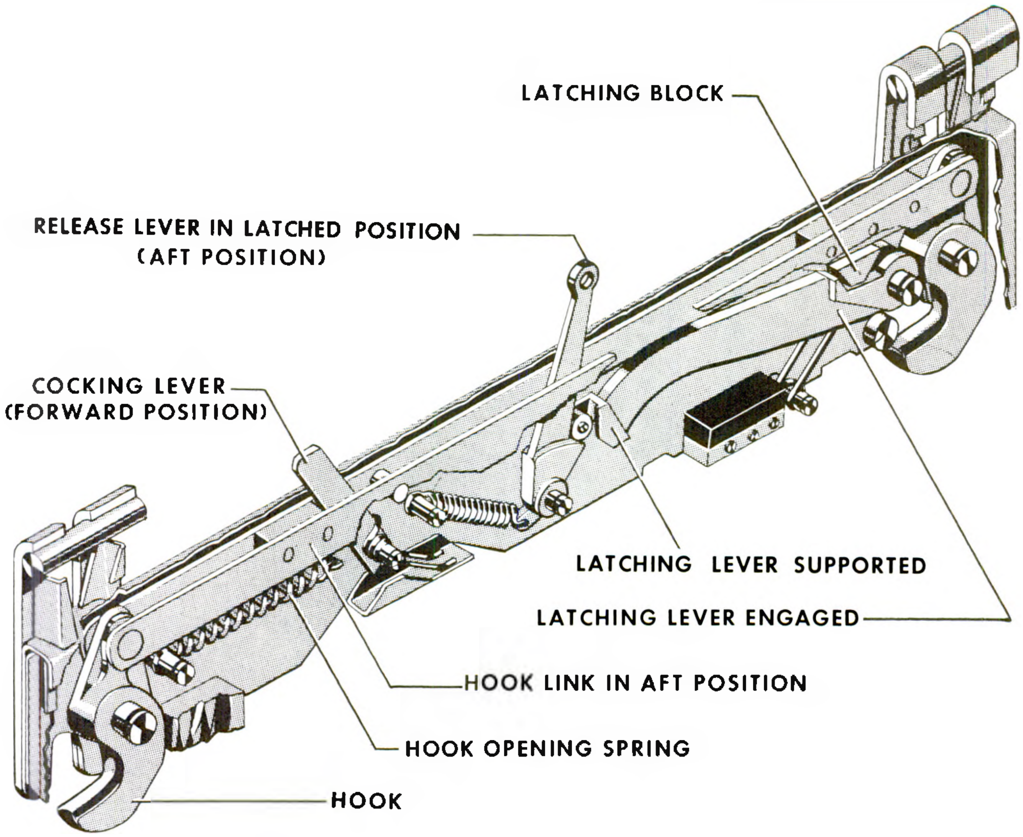
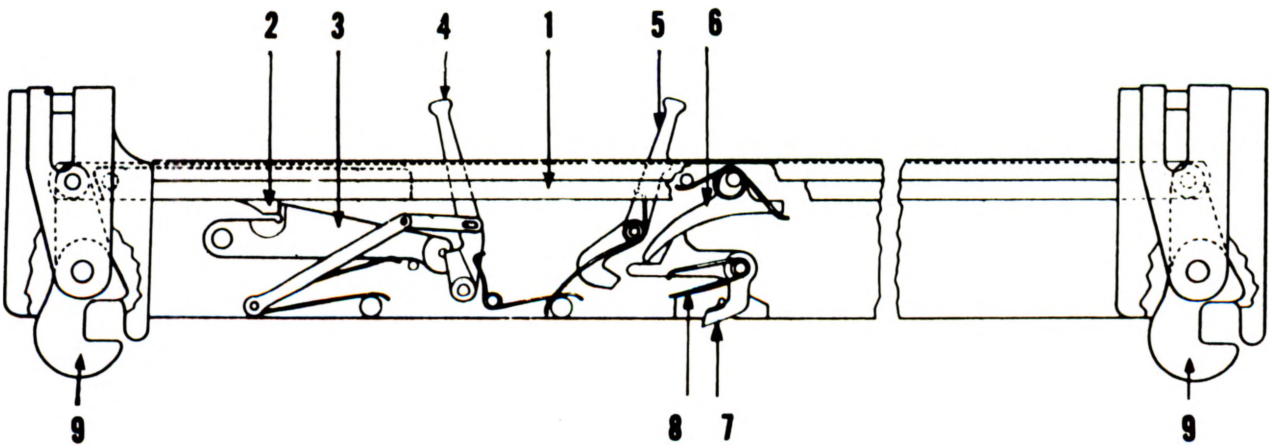


Figure 16-8.—Cutaway view showing the Mk 8 shackle in the latched position.



1. Link assembly.
2. Pawl stop lug.
3. Pawl.
4. Tripper hook.
5. Arming hook latch.
6. Link assembly lever.
7. Arming hook.
8. Arming hook spring.
9. Carrying hooks.

Figure 16-9.—Sectional view—Aero 16A and Aero 17A shackle.

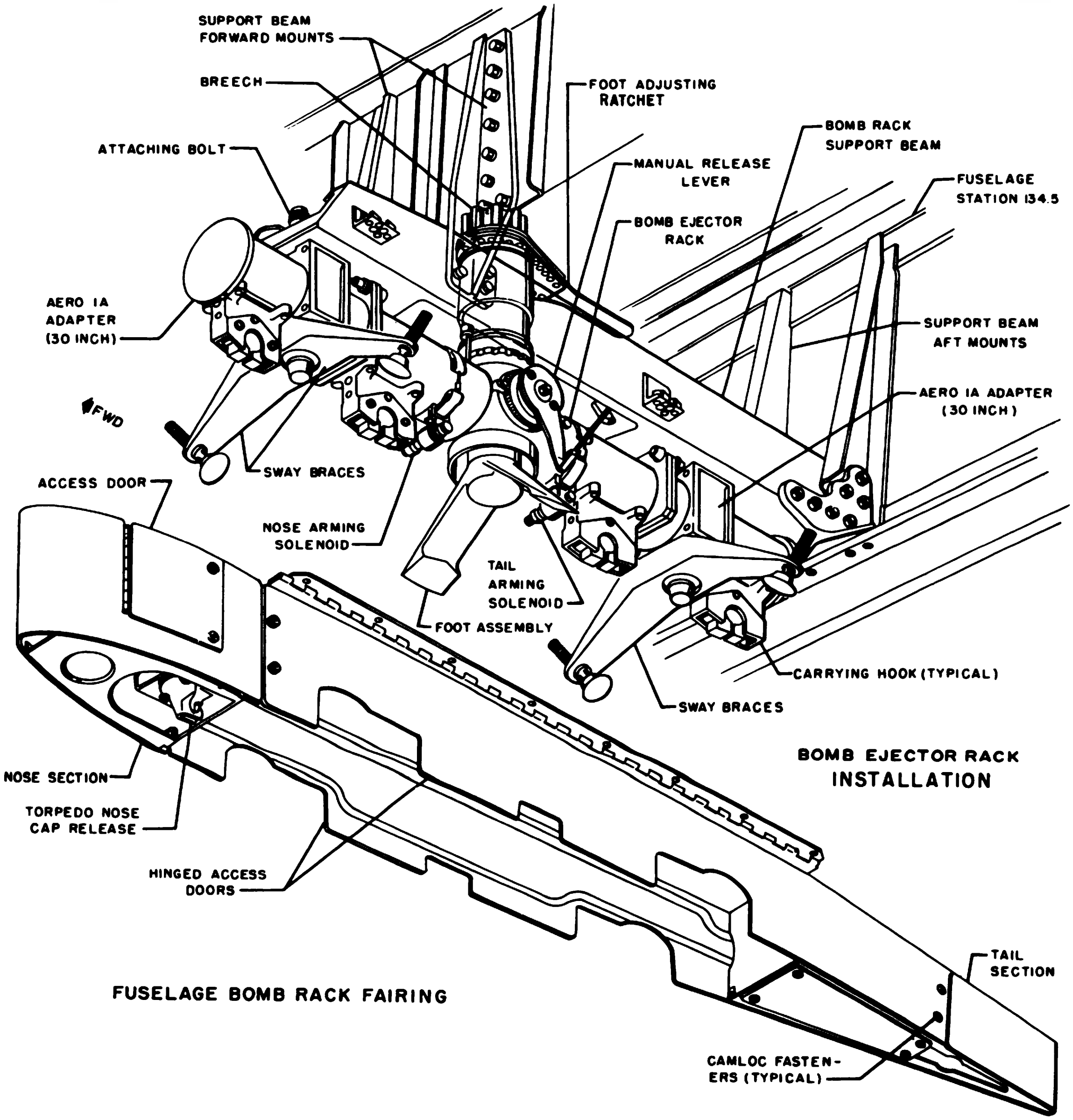


Figure 16-10.—Bomb ejector—fuselage bomb rack installation.

pounds. The rack, as currently used on the A-1 type aircraft, is installed along the centerline of the aircraft's fuselage. The major part of the rack itself is inside the fuselage, but the foot and suspension hooks project outside. The ejector rack assembly serves both as a support for the stores carried and as a device for releasing them.

The ejector is electrically controlled but is actuated by means of a 1-inch or 3-inch cartridge. When the cartridge is fired, the gases between the foot assemblies and the piston expand. This moves the piston upward against the piston spring. The upper sleeve and release sleeve are moved upward at the same time. When the pressure in the cylinder reaches

82 psi, the retainer plate mounted on the shoulder of the release sleeve has moved upward enough to release the carrying hooks through the action of the release linkage. The pressure continues to rise and the action reverses its direction. All pressure is then exerted against the foot assembly, forcing it downward with sufficient force to eject the store clear of the aircraft. After the foot is forced down, the gases escape through the ports in the piston assembly. The piston spring then draws the foot back into the ejector. The foot acts as a sway brace for stores of 1,600 pounds and under. Auxiliary sway braces must be used on heavier stores.

The store may be released manually if desired or when necessary. A cable operates the manual release lever to open the hooks and release the store. The store may not be released manually during dives steeper than 50° without danger of the store striking the aircraft.

The components of the Aero 3A ejector rack are a detonating breech, telescoping sleeves, and hooks and linkage. The piston and foot assemblies are centered above the store in the hooks.

The ejecting force employed by the ejector rack is created by the Mk 2 Mod 0 cartridge for stores weighing 325 pounds or less, and by the Mk 1 Mod 2 cartridge for all the heavier stores. The Mk 2 Mod 0 cartridge is also used for stores that are delicate or have light cases, such as aircraft mines.

Aero 7A/7A-1

The Aero 7A ejector rack assembly is a four-hook external stores rack consisting of a housing containing a dual breech that holds two cartridges, four tandem hooks, piston and ejector foot assembly, mechanical linkage connecting the hook sears to the piston assembly, and two adjustable sway braces. The Aero 7A is identical to the Aero 7A-1 shown in figure 16-11 except for the electrical fuzing. The Aero 7A has a 14-inch suspension that will carry 2,000 pounds and a 30-inch suspension that will carry 3,600 pounds. The ejector rack assembly has two operating voltages—28 volts d.c. or 115 volts a.c.

In normal operation, two cartridges are simultaneously detonated by an electrical impulse. The resultant pressure, generated by detonation of the cartridges, builds up within the cylinder and pistons and moves the ejector mechanism upward. This action, through mechanical linkage, raises each hook sear. The hooks then open allowing the foot to eject the store clear of the aircraft. Emergency operation of the rack (also electrical) is identical to normal operation except complete separate wiring is used in the aircraft to insure detonation of the cartridges.

The Aero 7A and Aero 7A-1 ejector rack assemblies (fig. 16-11) are identical, except Aircraft Armament Change No. 217 has been incorporated in the Aero 7A-1 ejector rack assembly. The armament change provides electric fuze capabilities for the rack. The Aero 7A-1 is capable of using either the Aero 2A-2 or Aero 2B bomb arming unit. The Aero 2A-2 bomb arming unit must be installed in the ejector rack assembly when bombs with 14-inch suspension and electric fuzing is used. (Aero 2B is used with 30-inch suspension electric fuzing.)

Aero 20A/20A-1

The Aero 20A and Aero 20A-1 ejector racks are similar to the Aero 7A except the 20A and 20A-1 are limited to a maximum load of 1,200 pounds. These racks have only 2 suspension hooks spaced 14 inches apart. Installation, operation, maintenance, and safety precautions are identical to the Aero 7A.

The Aero 20A and Aero 20A-1 (fig. 16-12) ejector rack assemblies are identical, except for the following additions to the Aero 20A-1:

1. The Aero 2A-3 bomb arming unit and an interlock switch assembly.
2. A bracket seal assembly.
3. A cable jack with mounting and connector bracket.
4. A triaxial cable for connecting the cable jack to the fuze charging signal source.

MAU-9/A Rack

This ejector rack is a fixed pylon unit designed to carry and launch stores weighing from 200 to 4,000 pounds. It incorporates suspension hooks that will lock on stores having tandem lugs on 14-inch or 30-inch centers. The rack may be installed on the underside of the wing or fuselage of aircraft. It releases the store in the armed or safe condition. The rack is attached to the aircraft by four 3/4-inch internal bolts. The rack is provided with electrical connections, electric fuzing, and mechanism for releasing and arming stores. The

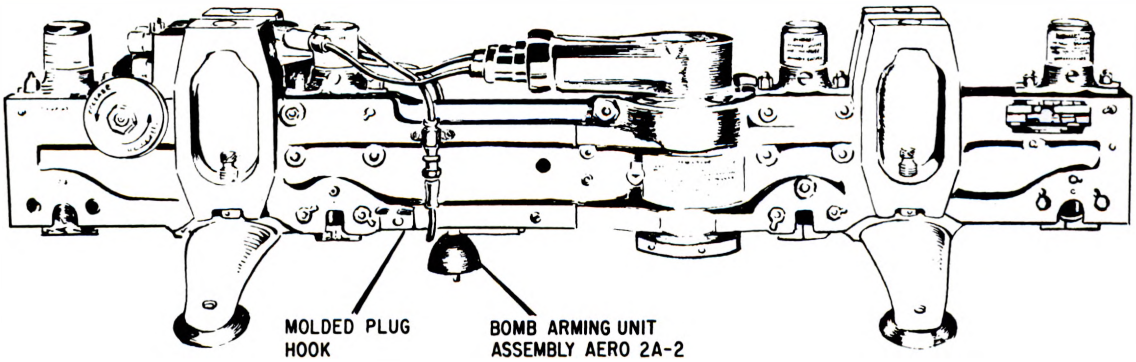


Figure 16-11.—Aero 7A-1 ejector rack assembly.

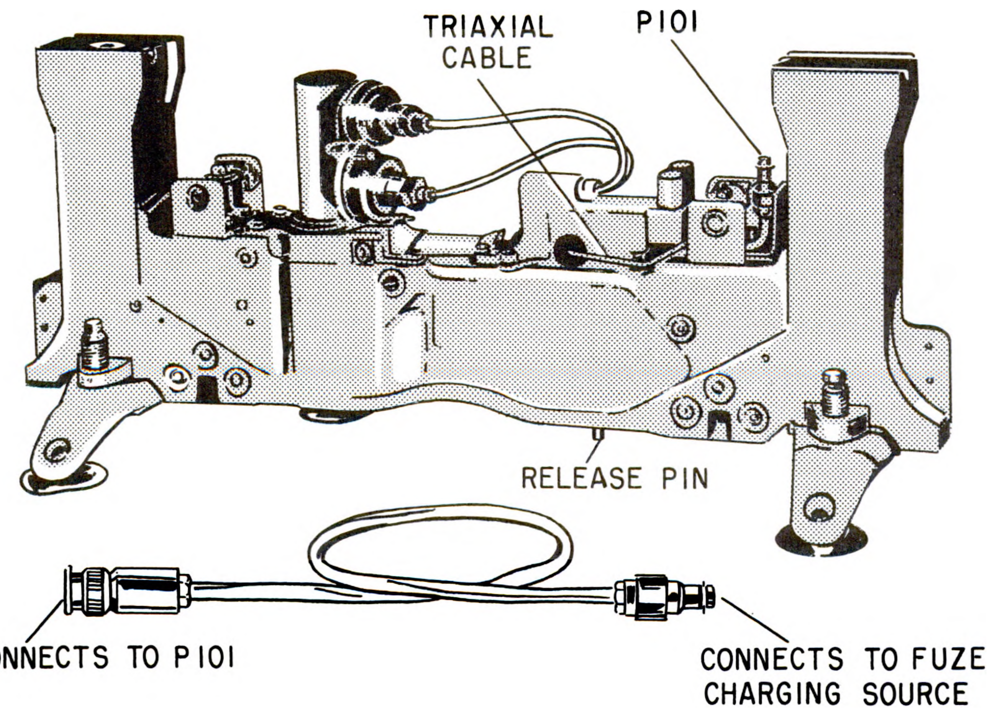


Figure 16-12.—Aero 20A-1 ejector assembly.

electrical release system operates from a 28-volt d-c system. (See fig. 16-13.)

The rack is designed to accommodate either one or two ejector units. The ejector unit (fig. 16-13) may be inserted in the rack in any of four positions depending upon the aircraft and store requirements. Normally, only one ejector unit is required. The use of two ejector units requires special authorization from BuWeps. The ejector unit may be removed from the rack for cleaning, loading, and preparation for rearming.

The ejector unit is designed to accommodate the Mk 1 (Mod 2 or 3) and Mk 2 (Mods 0, 1, or 2) bomb ejector cartridges. As a general rule when ejecting lightweight stores (250 pounds and less), the use of two Mk 2 cartridges is recommended. For heavier stores a

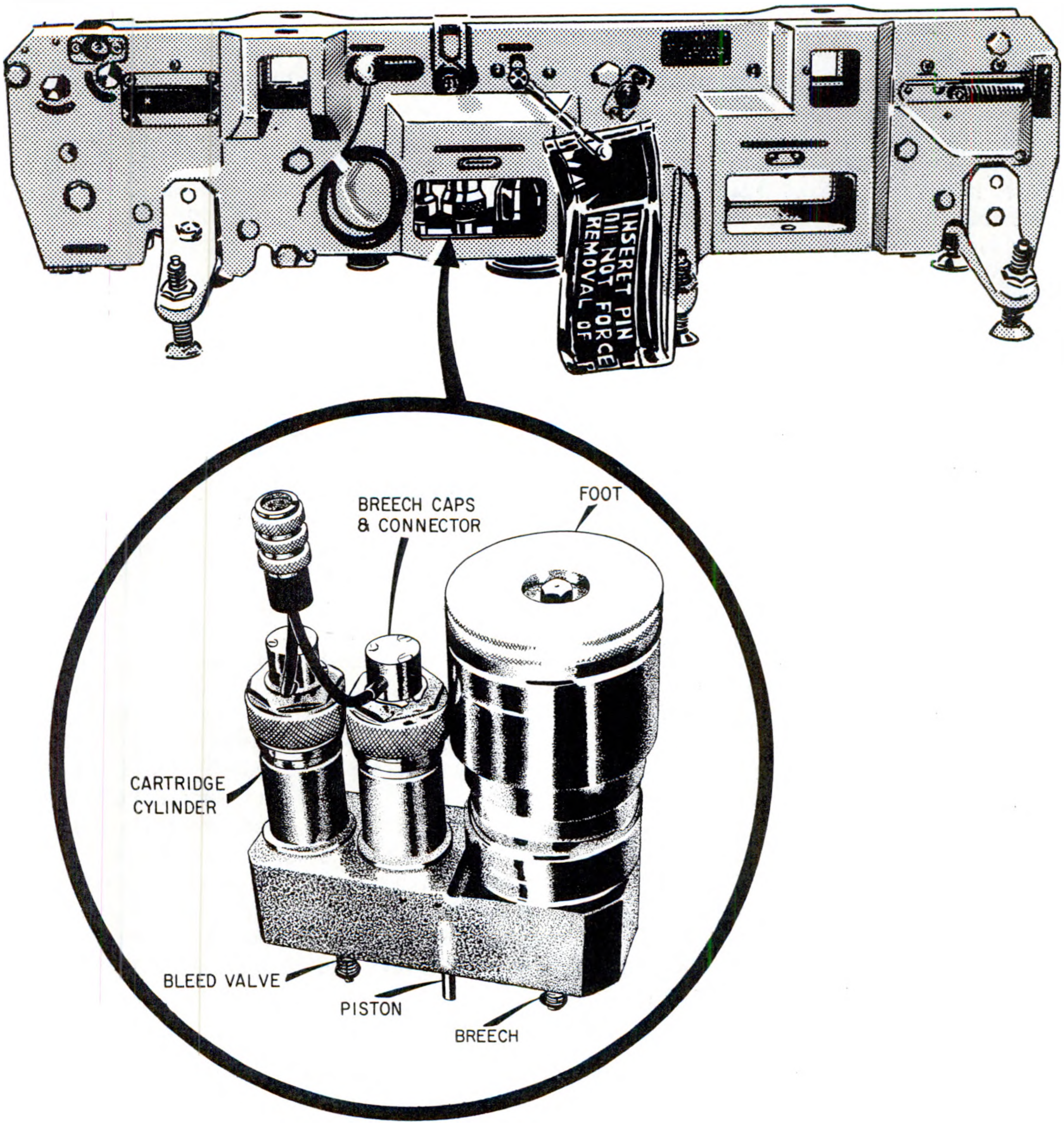


Figure 16-13.—Aircraft Bomb Ejector Rack MAU-9/A.

combination of one Mk 1 and one Mk 2 cartridge is recommended. The ejector will also accommodate two Mk 1 cartridges; however, no store as yet has been found that requires this much energy.

Reliability of firing the ejector is attained by using a dual electrical firing system. A choice of cartridge combinations for the ejector unit is available, permitting force variations for different store separation requirements.

The rack is provided with an auxiliary release unit, premitting release of the store when ejection is not required or desired. When so used, the ejector unit need not be installed in the rack. The auxiliary release unit provides an emergency method of jettison should the ejector units or its electrical systems fail. Three sets of integral low drag sway braces are provided to accommodate stores requiring additional stabilization. Removal of either one of the aft pair of braces is recommended, depending upon which pair of hooks is used.

The rack is provided with a removable hoist bracket which is attached to the rack by the hoist bracket strap. The hoist bracket provides attachment for the Mk 8 type hand-powered hoist or the electrical-powered version thereof. The safety pin locks the linkage and prevents inadvertent releases during ground operation. Accidental firing of the ejector unit or auxiliary release unit with the safety pin installed will not release the rack linkage and hooks thereby providing increased safety for servicing personnel.

Arming of bombs suspended on this rack is accomplished by means of two solenoid type bomb arming controls for mechanical arming or an Aero 2C electrical arming unit for electrical arming.

NOTE: The Aero 2C electrical arming unit has the same principle of operation as other electrical arming units, although the physical appearance has been changed slightly to accommodate the MAU-9/A ejector rack.

When either the primary or secondary bomb release circuit is energized, the cartridges in the ejector unit are ignited simultaneously. The gases generated by the exploding cartridges actuate the two movable pistons in the ejector unit. The small release piston pushes upward, striking the lever of the release mechinism, thus unlocking the latch bar and hooks. The telescoping pistons force the ejector foot downward approximately 6 1/2 inches, ejecting the store. Emergency operation is accomplished by means of the auxiliary release unit, using a Mk 25 primer. Exploding the primer actuates the release mechanism, thus releasing the latch bar assembly, unlatching the hooks, and releasing the bomb. No provision is made for manual release of the rack while the aircraft is airborne; however, manual release is provided for bench and flight line checkout.

BOMB CONTAINERS

Aero 4B

The Aero 4B bomb container (fig. 16-14) is a streamlined cylindrically shaped metal container. It carries eight miniature practice bombs, type AN-Mk 23. It is designed to be suspended from a bomb rack of either single or double suspension type. The bombs may be released either manually or electrically on the ground and electrically only while airborne. A predetermined number (up to the total load) may be released at a fixed rate if an intervalometer is placed in the electrical circuit. The container is designed for use with a double suspension type bomb rack. However, it may be converted to suspend from a single lug type rack by removing a plate and attaching a center suspension lug that is provided. The Aero 4B is fitted with two suspension lugs and an electric cable on its top side. The bottom has two open bays through which the practice bombs are loaded and released. A safety latch and a manual release (centered flush in the nose fairing) are the other two external features.

The inside mechanisms of the Aero 4B are divided into four sections. These are the nose, the forward bay, the rear bay, and the tail section. In the nose is a release solenoid, a latching device, and a manual release rod. These devices control the release shaft which is located lengthwise along the open bays. The forward and rear sections each contain a rotor assembly into which the practice bombs are loaded. These rotor assemblies are fastened together by a central shaft, and work together as one unit. The tail housing contains the power spring and a ratchet system for indexing the rotors during loading. The entire container may be dropped in an emergency by actuating the manual bomb rack release. The electric cable is constructed so that it will uncouple without fouling when the container is dropped.

AERO 5C

The Aero 5C type bomb container (fig. 16-15) is quite similar to the Aero 4B in operation. However, it is much more streamlined and designed to operate on high-speed aircraft. It can be mounted externally on wing stations or internally in bomb bays. The streamlined housing with an internal mechanism provides a means of carrying and releasing six Mk 76 Mod 0 practice bombs or Mk 15 Mod 0 practice depth charges. The container consists of a structure assembly, ejector mechanism, and an electrical system to operate the ejector mechanism. Release of the bombs is controlled by the pilot of the aircraft through armament control switches.

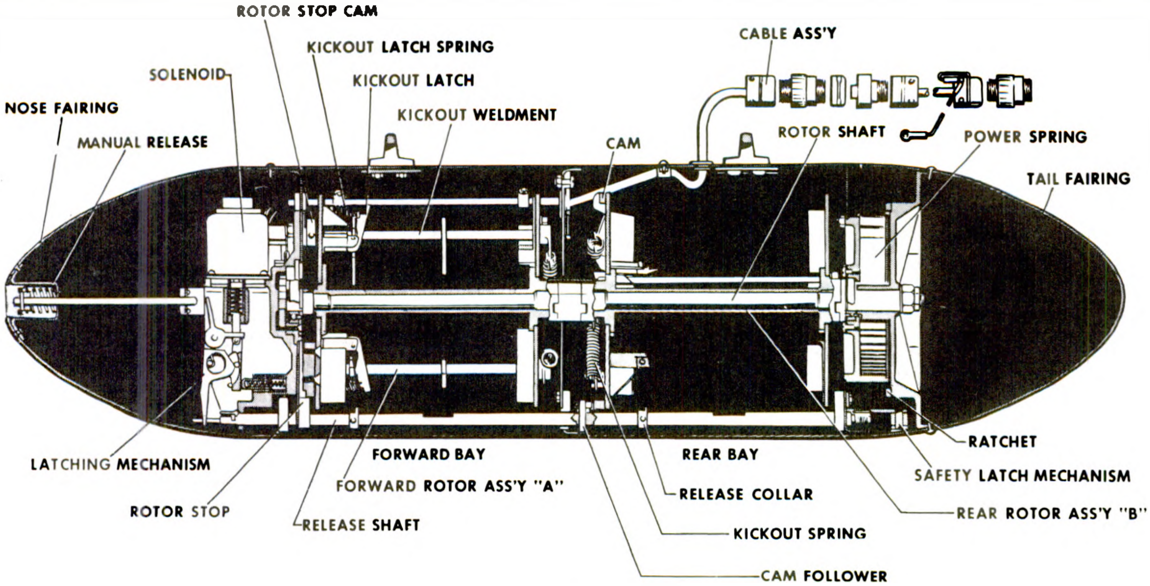


Figure 16-14. —Cutaway and sectional view—Aero 4B bomb container.

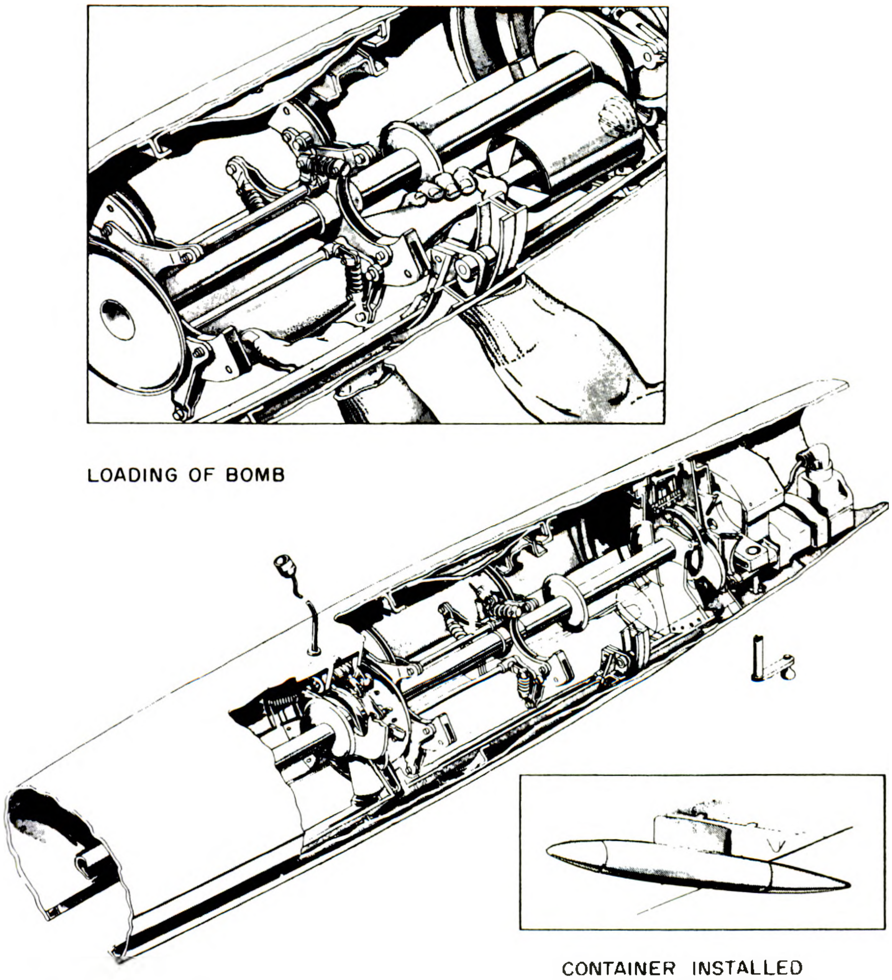


Figure 16-15. —Cutaway view of Container Assembly Aero 5C.

Bombs may be ejected during a 45° climb and dive at airspeeds up to 450 mph. The container is easily mounted on the aircraft and loaded by ground personnel, preferably while in the suspended position. A manual drive assembly and handcrank is provided to rotate the drive shaft for loading operations. The handcrank must be removed after loading operations. There are no provisions for stowing it within the container.

Depressing the bomb release button on the pilot's control stick energizes the ejector mechanism motor relay which, in turn, energizes the motor. Shaft power from the motor is transmitted through two sets of planetary reduction gears and turns the Geneva mechanism driver. The Geneva mechanism in turn, indexes the bomb ejector drive shaft which trips the bomb retaining latches, releasing the bomb. The motor is engaged until the bomb ejector drive shaft is turned 60°. At that time, the automatic revolutions control switch energizes the selector relay to open the motor circuit, completing the cycle.

CAUTION: Remove the electrical plug from the Mk 51 rack, and connect it to the Aero 5C practice bomb container electrical plug. When loading the practice bombs into the container, do not rotate the handcrank after six bombs are loaded. Continued rotation will cause the mechanism to commence the discharge cycle. The container must be rotated to the proper position before starting the loading procedure.

AERO 8A-1

The Aero 8A-1 practice bomb container (fig. 16-16) is an airborne device used primarily for training aircraft pilots in the delivery of special weapons. With modifications to the electrical system, it may also be used for general purpose bombing practice. The Aero 8A-1 may be carried on subsonic, transonic, and supersonic aircraft.

The Aero 8A-1 permits a pilot to carry out a complete bombing run against a target and perform all the operations required for the release of a full-scale store. Provisions are built into the container for the realistic simulation of the procedures the pilot must follow in the delivery of nuclear weapons.

The Aero 8A-1 (fig. 16-16) is composed of an aerodynamic case, four bomb ejector mechanisms, a bomb sequencing relay box, two weapon simulators, a bomb bay door actuating assembly, associated wiring harnesses, simulator-bypass, and bomb dispenser simulator. It is designed for external attachment on several new types of aircraft, and is at present mounted internally in the A-3 aircraft. It is normally mounted on 14-inch, or 30-inch suspension hooks on the bomb racks carried by special purpose pylons.

Information on the preparation for use, operation and maintenance of the Aero 8A-1 may be found in Operation and Maintenance Instruction Manual Aero 8A-1 Practice Bomb Container, NavAer 11-5-98.

MARINE MARKER EJECTORS

Retro Marine Marker Ejector Aero 1B

The Retro Marine Marker Ejector Aero 1B (fig. 16-17) is an electrically controlled and pneumatically operated ejector. It is a semiautomatic ejector, designed to launch the Marine Marker Mk 7 or Mk 25 and Mods, signal in an aft direction, 180 degrees to the line of flight, with a maximum allowable variation of 10 degrees. The purpose of the retro marine marker ejector is to mark a spot on the water, directly under the launching aircraft. This is accomplished by being able to vary the velocity of the gun so that the round may be fired aft with a velocity equal to the forward speed of the aircraft.

The unit consists of the ejector assembly, the pneumatic supply assembly, and the remote and local control boxes. (See fig. 16-17.) The ejector assembly contains:

1. The magazine assembly, which houses the rounds to be fired.
2. The launcher assembly, which contains the injector and all the solenoid valves necessary for injecting the round into the barrel.
3. The ejector barrel assembly from which the round is fired.

The pneumatic supply system includes a 480 cubic inch compressed air storage bottle, capacity rated at 3,000 psi working pressure, which functions to supply air pressure necessary to load the round into the barrel and to fire the round from the ejector.

The unit is normally operated from the remote control box located either in the navigator's or pilot's compartment of the aircraft. A local control box, located within the fuselage not over 10 feet from the ejector, is provided

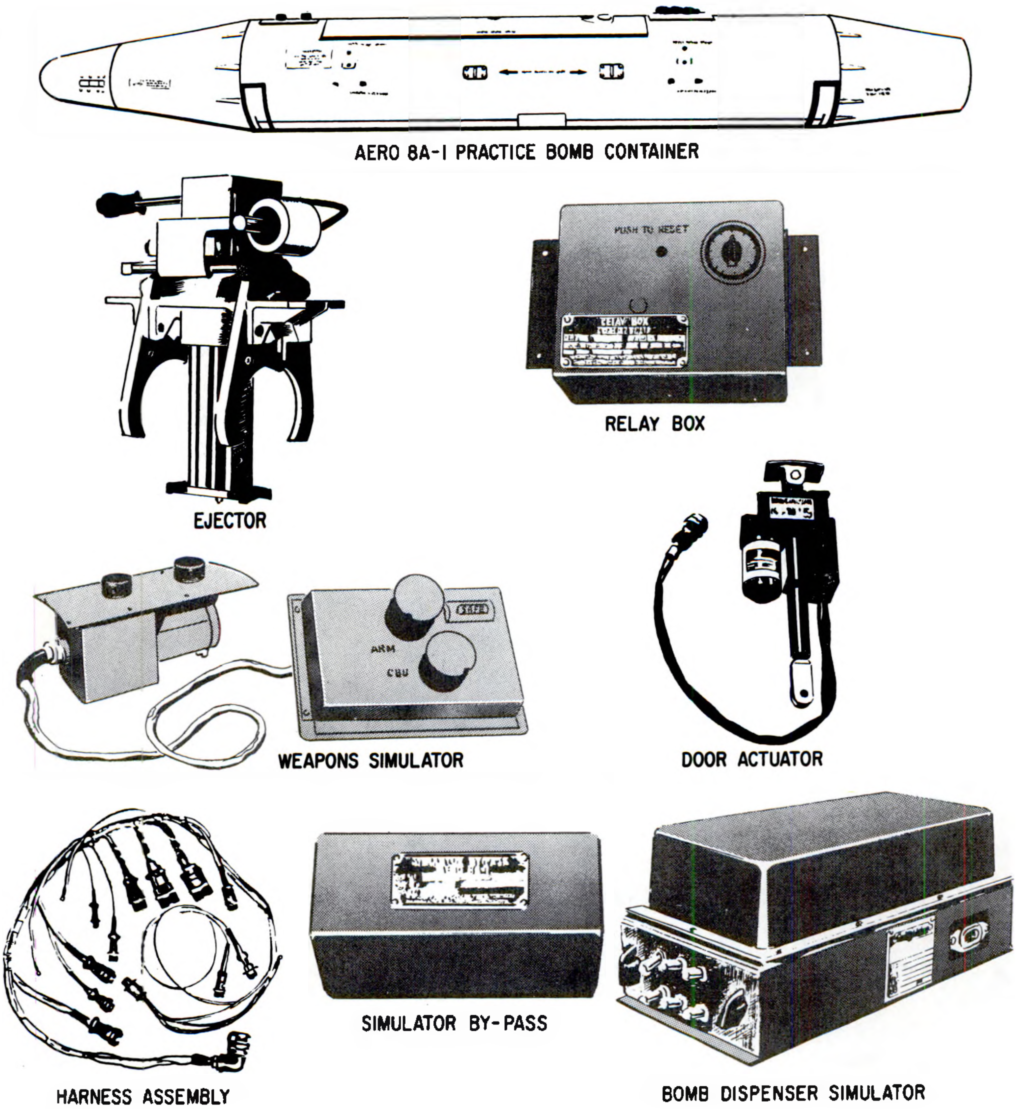


Figure 16-16.—Aero 8A-1 practice bomb container and components.

for emergency use. Both boxes are equipped with a dial calibrated in knots. A speed control on the remote control box permits manual regulation of ejector velocity. The velocity calibration on the local box is only approximate. An open firing circuit is provided with both control boxes and is closed manually by a release pushbutton on either box for the purpose of firing the round.

Before loading rounds into the magazine, make certain that high air pressure has been applied to the ejector, that all electrical power is off, and that the magazine is fastened securely to the launcher. The magazine is loaded by placing eight rounds in the left side of the magazine and four rounds in the right side.

After loading has been completed, electric power is applied. This is normally accomplished by turning the power switch on the remote control box to ON. The Power-ON (AMBER) light on the remote control box will come on, the storage chamber swings out-of-battery and the first round falls down into the loading area. The injector moves forward, pushing the round into the barrel. When the

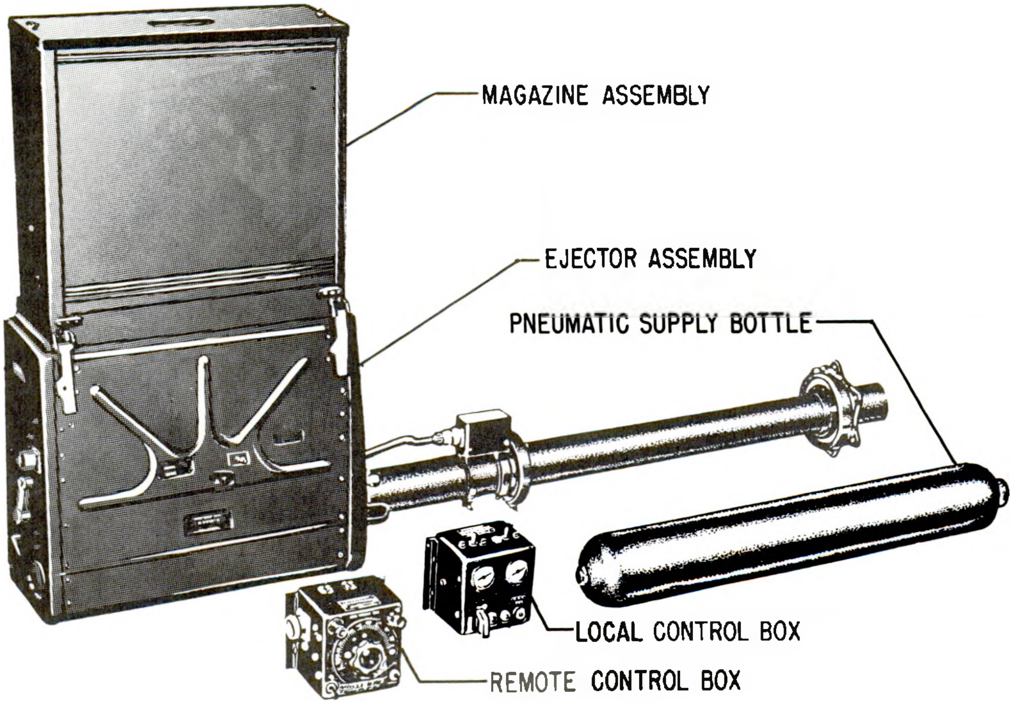


Figure 16-17.—Pneumatic Retro Marine Marker Ejector Aero 1B.

round is fully positioned in the barrel, the spring-loaded injector returns to the rear and the storage chamber swings to the IN-BATTERY position. The green light on the remote control box comes on indicating a round in the chamber. The gun is now ready to fire.

To fire the gun from the remote control box, set the speed control knob on the remote control box to the desired groundspeed. The correct amount of air to fire the round at this speed will automatically be loaded into the storage chamber and the green ready light on the remote control box will come on. Pressing the release button on the remote control box will fire the round.

Firing from the local control box is effected by turning the remote-local switch on the local control box to the local position. Press the load button on the local control box until the groundspeed dial reads greater groundspeed than desired, then press the bleed button until the desired speed is attained. Press the emergency release button to fire the round.

CAUTION: The Pneumatic Retro Marine Marker Ejector Aero 1B is an air gun. Respect and treat it accordingly. Keep fingers and hands out of the gun when high pressure has been applied to the system.

Detailed information on the Pneumatic Retro Marine Marker Ejector Aero 1B can be obtained from the appropriate aircraft Maintenance Instructions Manual or NavWeps publication.

DEPTH CHARGE DISPENSER, LAU-8/A(XN-1)

The purpose of the Depth Charge Dispenser, LAU-8/(XN-1) is to dispense depth charges from an aircraft by remote electrical or manual control. (See fig. 16-18.)

The depth charge dispenser consists of a chute assembly, a relay box assembly, an actuator assembly, and a frame assembly. The manual release rods and jettison rods are located on top of the frame assembly next to the chute assembly. A wrench which is stored in a bracket attached to the chute assembly is used to manually operate the ejector shafts. Eight stores can be loaded in each side of the dispenser.

The LAU-8/A(XN-1) can be operated one side at a time or both sides can dispense concurrently as desired. The option of manual or electrical jettison of all the practice depth charges is also incorporated in the dispensing system.

WARNING: Make certain that no power is applied to the unit when manually rotating ejection shafts; injury to personnel may result.

For further information on the LAU-8/A (XN-1) the reader is referred to the current Overhaul Instruction Manual, NavWeps 11-5E-16.

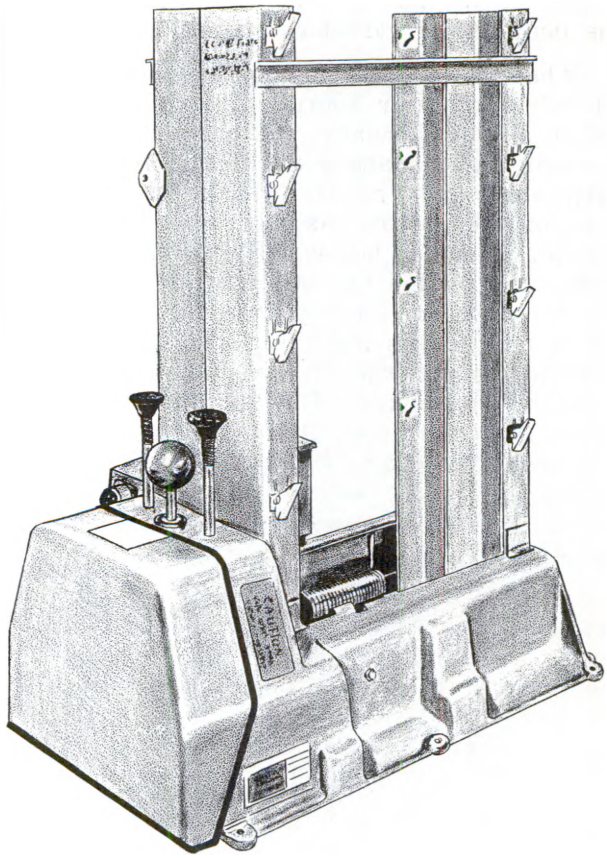


Figure 16-18.—Depth Charge Dispenser, LAU-8/A(XN-1).

ASW STORE LAUNCHERS

ASW Stores Launcher Model 6159

The ASW Stores Launcher Model 6159 (fig. 16-19) is an electrically controlled, pneumatically operated ejector which is used primarily with ASW sonobuoys and other stores of similar configuration. The launcher functions to deliver a launching force sufficient to eject a store perpendicular from a fuselage enclosure of an aircraft into a 250 mph airstream.

The launcher consists basically of an ejector assembly installed within an aluminum alloy cover and cradle assembly. The ejector assembly consists of a solenoid operated air valve assembly mounted upon an air cylinder which encloses a piston assembly. The air cylinder is fabricated from round aluminum alloy tubing, which is slotted along the entire

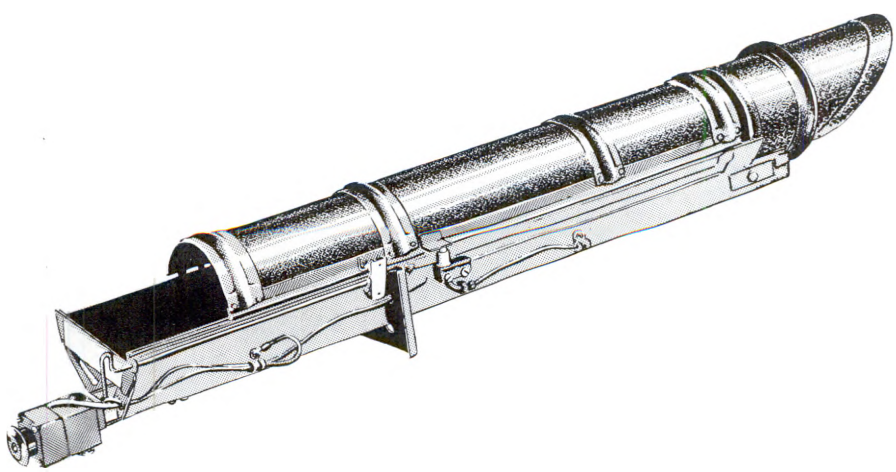


Figure 16-19.—ASW Stores Launcher Model 6159.

length of one longitudinal surface, to allow the finger of the piston assembly to extend from the body of the cylinder and engage the store.

When the launcher is supplied with an 18- to 24-volt d-c power source and a 1,500 psi dry air or nitrogen supply, the energized solenoid permits high pressure air to flow through the main valve into the air cylinder on the power side of the piston. As the piston begins its stroke, pressure builds up between the piston and valve, within the air cylinder. When sufficient pressure has developed, it exerts a force and moves the valve, the cylinder, and sear in the reverse direction from the movement of the piston. This action releases the latch, which retains the store at the lower end of the launcher. Simultaneously, the piston, having begun its stroke, imparts a forward motion to the store which is sufficient to cause the stores ejection.

To load the store, release the cover latch and open the cover, insert the store into the cradle assembly, close the cover, and attach the lanyard to the clip which is riveted on the aft side of the piston finger. Push the piston finger forward until it engages the aft end of the store.

The launcher may be fired manually with equal results. The same procedure is used in manual operation as electrical, with one exception, that is the pulling of the manual override knob on the end of the air valve assembly. In the event of both electrical and pneumatic power failure, and it is necessary to jettison a store from the launcher, observe the following emergency procedures: Pull firmly on housing of the solenoid operated air valve in an aft direction until the air cylinder pulls the sear far enough back to disengage the store latch. Insert a pole or rod into the cradle assembly until it engages the aft end of the store and push the store forward and out of the launcher.

ASW Stores Ejector
Model No. 976 and 7014

The Model 976 and 7014 ASW stores ejectors (fig 16-20) are similar and the following information on the Model 976 is also applicable to the Model 7014.

Model 976 ASW stores ejector is electrically controlled and pneumatically operated. This ejector is primarily used with ASW sonobuoys and other stores of similar configuration. The ejector functions to deliver a launching force sufficient to eject a store perpendicular from the fuselage enclosure of an aircraft in a 250 mph airstream at an operating pressure of 750 psi and at 500 psi minimum pressure when the aircraft speed is reduced. The ejector basically consists of an ejector assembly, which consists of a solenoid operated air valve assembly, mounted on an air cylinder, which encloses a piston assembly. At the opposite end of the air cylinder from the air valve, a bracket assembly is installed, which contains a spring-mounted latch and sear. Other subassemblies of the ejector assembly include an indexing piston, a piston slow approach system, a piston return system, and a manual override system. The manual override system permits the ejector to be fired without an electric impulse.

When a store is loaded into the launcher tube or cradle, the reaction latch at the forward end of the ejector, holds the store in position. With high pressure air applied and the firing circuit energized, the launcher piston travels slowly down the air cylinder until the piston finger engages the store. This engagement restricts further movement of the launching piston and air pressure builds up in the cylinder. This buildup of pressure is sensed by the valve mechanism, which removes the restriction and thereby permits full air pressure to flow into the air cylinder. The reaction force of this high pressure air moves the valve body and air cylinder sufficiently in a reverse direction from the stroke of the piston to separate the sear. This action permits the reaction latch to rotate approximately 90° and release the store. The preliminary restricted approach of the launching piston prevents damage from occurring to the store or ejector assembly. It also acts as a safety precaution, in the event the launcher is fired without a store in place.

After ejection takes place, the reaction latch is repositioned by spring action and the launcher piston is returned aft to its load position by high pressure air. The indexing piston also retracts and provides clearance for loading a new store into the tube or cylinder assembly. The ejector may be fired manually by pulling the manual release knob on the head of the air valve assembly and holding it extended until the store is ejected.

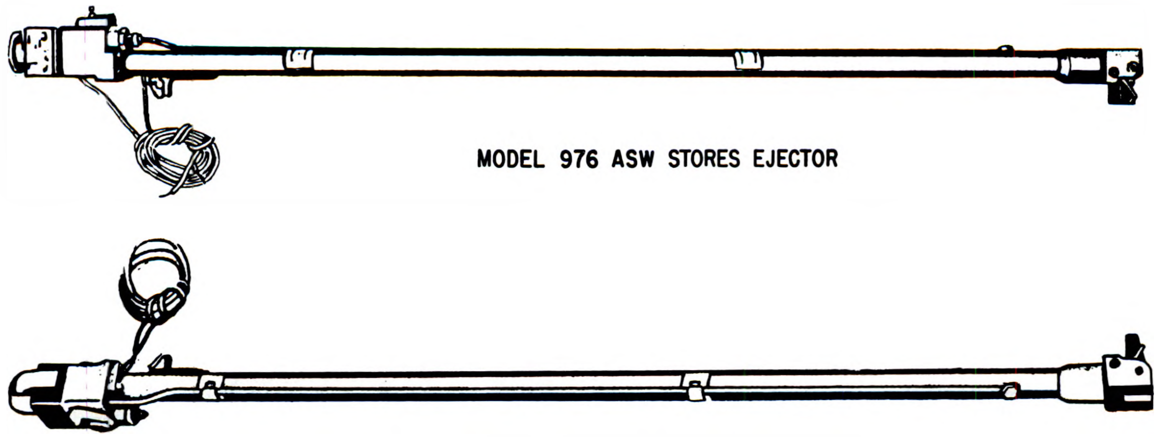


Figure 16-20.—Model 976 and 7014 ASW stores ejectors.

PHOTOFLASH CARTRIDGE EJECTOR MODELS 9A AND 9B

The photoflash Cartridge Ejector Model 9A (fig. 16-21) is designed to be used to eject photoflash cartridges in order to take night photographs. NOTE: Models 9A and 9B are similar in operation and appearance and differ only in the type and quantity of cartridges used; therefore they are discussed together.

The ejector is comprised of a cartridge retainer assembly and a breechblock. The breechblock consists of firing pins, safety switch, stepping switch, and electrical wiring. Normally the ejectors are located so that they are accessible for loading from outside of the aircraft. The ejector fires a photoflash cartridge when an electrical pulse is received at the respective firing pin in the ejector. The pulse is initiated by a programer in the respective camera control panel.

One cartridge is ejected each time a firing pulse is received by the ejector until all cartridges have been ejected. When the last cartridge from the first ejector has been fired, a relay switches the electrical circuit to the next ejector.

The ejector is used with flash detectors to synchronize the camera operation with each flash cartridge burst. The 9A ejector holds 26 M-112 cartridges and the 9B ejector holds 10 M-123 cartridges.

Provisions are made for the ejection of cartridges in an emergency. Energizing the jettison circuit causes jettisoning of the photoflash cartridges at a rate of 6 cartridges every 2 seconds.

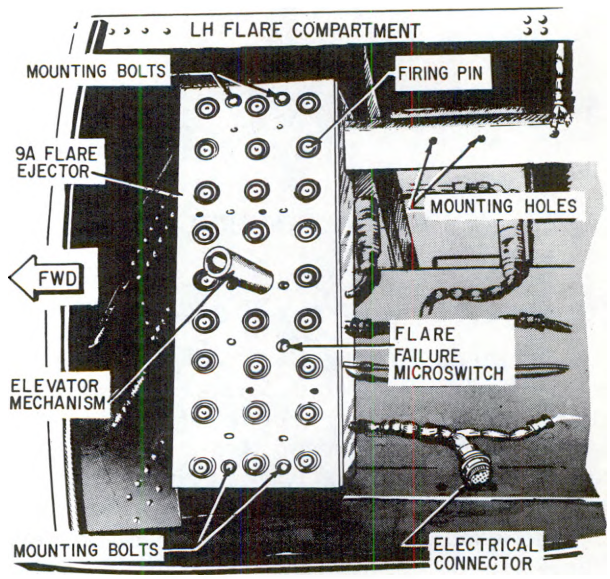


Figure 16-21.—The 9A ejector installed in a flare compartment.

The Maintenance Instructions Manual for the applicable aircraft should be consulted by the Aviation Weapons Officer for details required for any photoflash ejector installation or loading procedures.

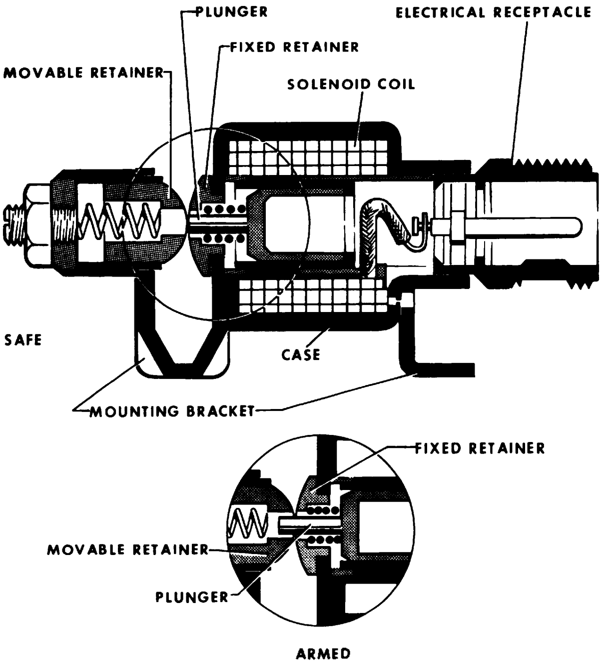


Figure 16-22.—Bomb Arming Control Type AN-A-2.

ARMING CONTROLS

AIRCRAFT BOMB ARMING CONTROL TYPE AN-A-2

The Bomb Arming Control Type AN-A-2 is an electrically operated device. It is designed to provide selective arming of bombs. Each control is constructed so that it will retain or release a fuze arming wire as the bomb is released. The bomb will then drop in an armed or safe condition as desired. One or more of these bomb arming controls is used at each bomb station in the aircraft. The number used depends on the type of bomb shackles and bombs used.

The AN-A-2A is an improved design completely interchangeable with the AN-A-2. The differences are entirely internal to improve reliability of operation.

The electrical circuit of the bomb arming control AN-A-2 is separate from the aircraft's bomb release system. These arming controls are connected in parallel and are operated by one arming switch. More arming switches may be used in varying the grouping of the arming controls if desired. The bomb arming control is designed as a dusttight, moistureproof, cadmiumplated unit weighing about 5 ounces. It contains a solenoid coil, plunger, and movable retainer. (See fig. 16-22.) The movable retainer, being spring loaded, is held against the fixed retainer by spring action. The loop of the fuze arming wire is placed between the movable and fixed retainers. The force necessary to free the arming wire loop from between the retainers when the arming control is deenergized is normally adjusted from 3 to 5 pounds. The movable retainer and the plunger act together to retain the loop of the fuze arming wire. When in the locked position (arming control energized), the plunger prevents the arming wire loop from being dislodged from the arming control, thus causing the arming wire to be pulled from the fuze, arming the device after the bomb is released.

The AN-A-2 bomb arming control is locked by the energizing of the solenod coil. This moves the plunger outward into the hole in the movable retainer. (See fig. 16-22, insert showing armed condition.) The control remains in the locked position as long as the solenoid coil is energized. The bomb arming control will operate normally in temperatures varying from -70° to +200° F.

The plunger and plunger stop of the AN-A-2 arming control should be washed and cleaned periodically to remove salt and other foreign matter which may prevent the plunger from operating properly.

When installing this arming control, insure that the mounting screws make a positive grounding circuit between the control and the mounting surface. Also insure that the control is mounted so that the pull on the fuze arming wire loop is as near to 90° to the longitudinal axis of the plunger and the movable retainer as possible. If the angle of this pull is too far off from 90°, it may be impossible to drop the bomb stores in a safe condition as the fuze arming wires will not pull free from the arming control, but remain in the control.

FUZE FUNCTION CONTROL SET AN/AWW-1

The majority of operational aircraft are either equipped with or have provisions for the installation of electric fuze function control systems. While the systems may vary slightly for different types of aircraft, their basic functions are similar.

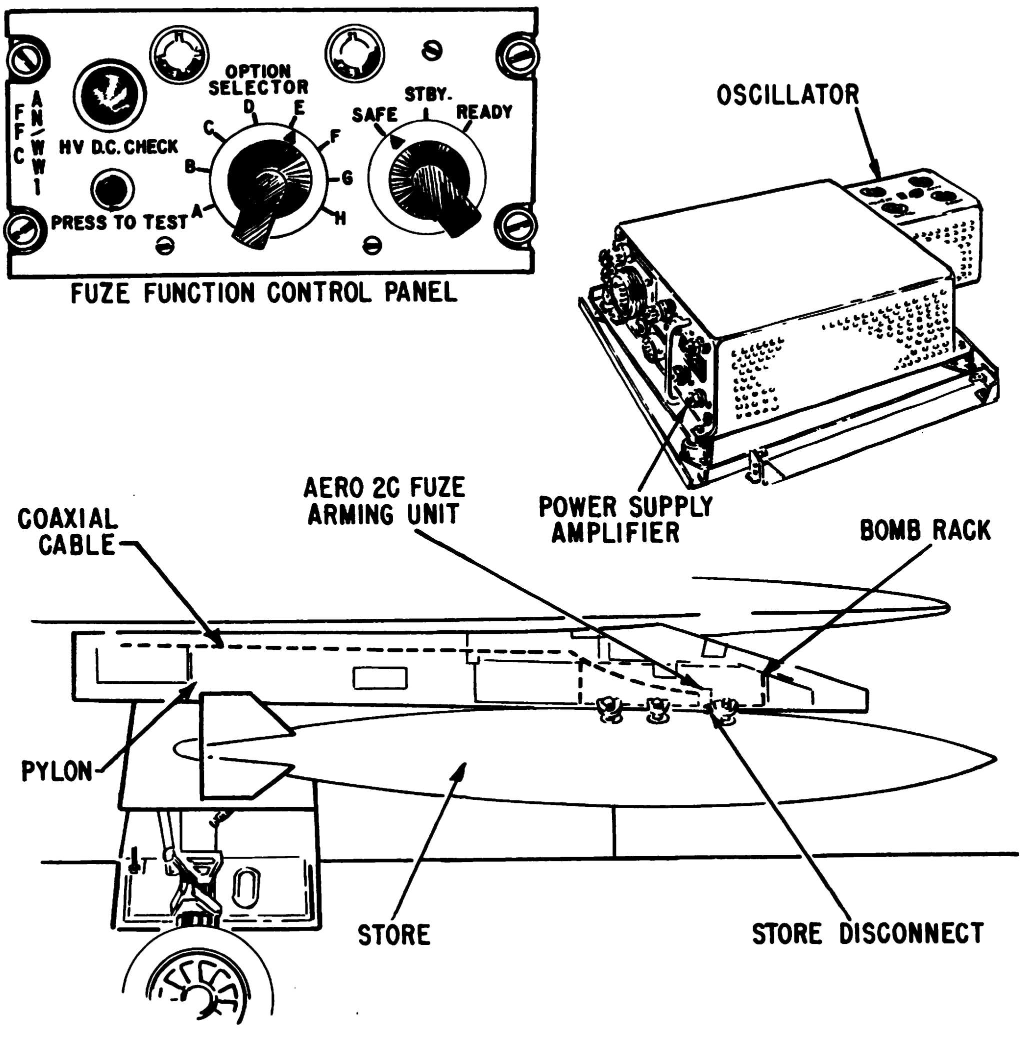


Figure 16-23.—Electric fuze function control system components.

A typical system consists of a fuze function control panel, power supply amplifier, an oscillator, and a fuze arming unit. (See fig. 16-23.) Also, as a safety feature, an interlock switch is located in the output circuit preceding the fuze arming control unit.

The system is designed to charge both direct current (d.c.) and radiofrequency (RF) type of fuzes. It utilizes a method of selecting any one of the various fuze function options (an option is a specific arming delay and impact delay time) available for charging electrical armed fuzes while in flight. Four options are available to charge d-c type fuzes and various combinations, in groups of five, are available to charge RF type fuzes.

The four options used in charging d-c type fuzes are always available. Although there is a total of eighteen different options available for charging RF type fuzes, limitations permit only five of these to be selected while in flight. These five options must be correlated with the type of fuzes to be charged. The desired options are chosen from prepared tables and proper plug-in units are selected and inserted into the system prior to preflight check of the system.

To arm stores having RF type fuzes, any one of the five predetermined options may be selected by placing the option selector switch

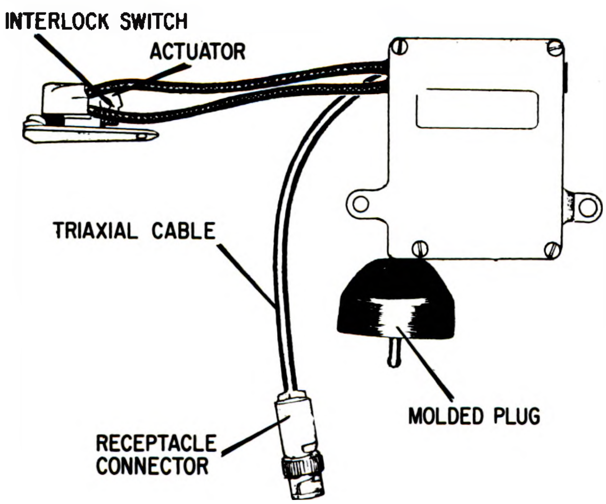


Figure 16-24.—Aero 2A-2 bomb arming unit.

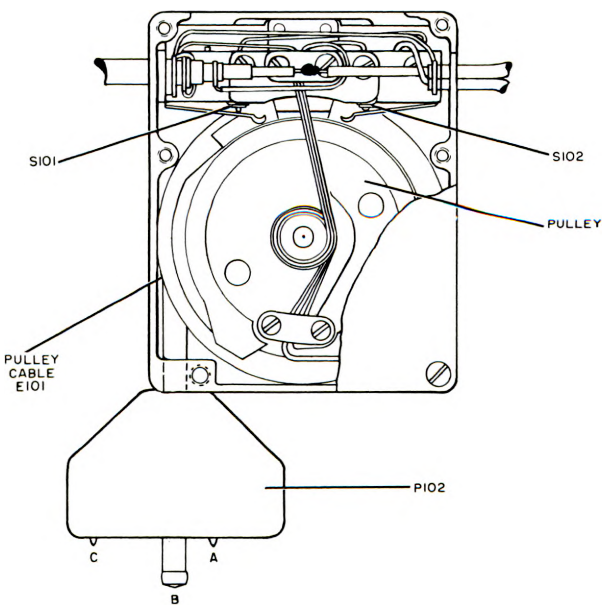


Figure 16-25.—Typical inside view of bomb arming unit.

(located on the control panel) to the desired one of the first five positions (A through E). If d-c fuzes are being used, the switch should be placed on the desired one of the last four positions (E through H).

The system operates on a 115-volt, 400-cycle a-c power source which provides power to (1) charge d-c type fuzes and (2) the RF oscillator and amplifier circuits. The RF circuits in turn provide the RF energy to charge RF types fuzes. In addition to the previously mentioned interlock switch, the charging (center) wire is grounded through a resistor. This ground prevents the fuzes from becoming accidentally charged by voltage leakage.

The operation of the fuze function control system is described briefly as follows: Set the option selector switch to the desired position for the type of fuze to be charged. Place the READY/SAFE switch in the STANDBY position; this supplies primary power to the transformers which supplies power to the thermal delay relay and filament power to the electron tubes. After approximately 20 seconds warmup time the thermal delay relay will close. Placing the READY/SAFE switch in the READY position supplies power to the rest of the circuits and fuze charging output power up to the interlock switch. From this point no further action will occur until the store is released.

As the store is released, the bomb rack release mechanism closes the interlock switch supplying power to an open set of contacts (Micro switch) located in the fuze arming unit. This unit is located in the pylon and essentially consists of a spring loaded pulley, a Micro switch, and a cable assembly with a molded plug which plugs into the harness of the store.

As the store falls, approximately 4 inches of the arming unit cable is unreeled. At this point it actuates the Micro switch, ungrounding the firing lead and connects it directly to the store harness by closing the open set of contacts in the Micro switch. The charging circuit is now complete and the fuze is charged. Further fall of the store pulls the plug out of the store harness and the cable snaps back into the pylon.

BOMB ARMING UNITS AERO 2A-1, AERO 2A-2, AERO 2A-3, AND AERO 2B

Aero 2A-1, Aero 2A-2, Aero 2A-3, and Aero 2B bomb arming units are electromechanical devices intended for use in transferring arming signals from electrical fuze charging signal sources to electroprimed bombs. The arming units are installed in bomb ejector racks and launchers. They prevent application of arming signals to the bomb until the bomb is released from the rack or launcher. (See fig. 16-24.)

Each of the four arming units have a molded plug that plugs into the bomb, and a receptacle that is connected to the fuze charging source or a junction box. The interlock switch assemblies are mounted so that they are activated as the bomb ejector rack hooks open. The bomb arming unit Aero 2B, without an interlock switch assembly, is mounted on the bomb ejector rack so that it connects to a junction box and to an interlock switch assembly. Basically, Aero 2A-1, Aero 2A-2, Aero 2A-3, and Aero 2B bomb arming units consist of a spring-loaded pulley, 2 subminiature switches, a molded plug, and a cable assembly. The two subminiature switches are used to arm the bomb as it falls from the aircraft and before it is free of the molded plug. The cable assembly mounted on a spring loaded pulley which activates the two subminiature switches, snaps back into place after the molded plug disconnects from the bomb. The length of cable travel is 5 3/16 inches in each arming unit. (See fig. 16-25.)

The bomb arming units and the electrical fuze charging systems are tested with the Fuze Function Control Test Set AN/AWM-4. A complete continuity check of the bomb arming units circuitry is made with Multimeter TS-352B/U.

The bomb arming units are installed in bomb ejector racks or combination bomb rack and rocket launchers. Listed in table 16-1 are the arming units installed in particular racks. These arming units are not interchangeable between racks. Two different bomb arming units may be installed in the Bomb Ejector Rack Aero 7A-1. The choice of arming unit to be installed depends upon the type of store to be released from the Aero 7A-1. Publications applicable to each arming unit are listed in table 16-2.

The bomb arming signal is applied to the arming unit from the aircraft's fuze charging signal source. The arming unit, mounted in the bomb ejector rack, does not transmit the signal to the bomb until the rack hooks open. This closes a switch, as the bomb continues to fall, a cable unreels from the arming unit and closes another switch which stops the signals to the bomb at some point before the bomb is completely free of the molded plug. This prevents the arming signal from striking an electrical arc with the bomb as it is separated from the molded plug. After the bomb is disconnected from the molded plug, the molded plug snaps back into place.

Table 16-1.—Arming units and applicable racks.

Bomb arming unit	Installed in
Aero 2A-1	Aero 15C-1 bomb rack and rocket launcher.
Aero 2A-2	Aero 7A-1 ejector rack assembly.
Aero 2A-3	Aero 20A-1 ejector rack assembly.
Aero 2B	Aero 7A-1 ejector rack assembly.

Table 16-2. —Arming units and applicable publications.

Bomb arming unit	Installed according to
Aero 2A-1	NavWeps 11-75A-18—Bomb Rack and Rocket Launcher Combination Aero 15C and Aero 15C-1, Operation, Maintenance, and Overhaul Instruction Manual, with Illustrated Parts Breakdown.
Aero 2A-2 and Aero 2B	NavWeps 11-5-591—Rack Assembly, Aero 7A Ejector, Overhaul Instructions, with Parts Breakdown. Aircraft Armament Change No. 217, Bomb Ejector, Aero 7A; Modification to Model 7A-1.
Aero 2A-3	NavWeps 11-5-592—Rack Assembly, Aero 20A Ejector, Overhaul Instructions, with Parts Breakdown. Aircraft Armament Change 210 Rev. A, Bomb Ejector, Aero 20A; Modification to Model Aero 20A-1.

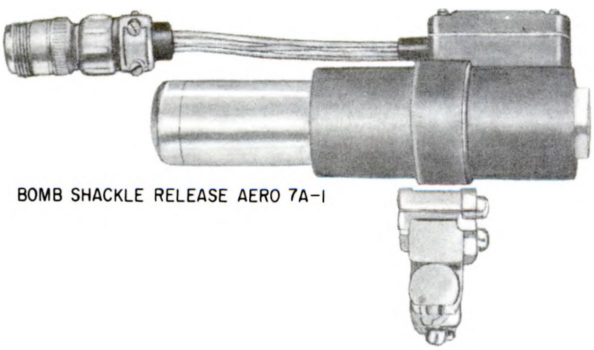
DANGER: Do not connect the arming unit output plug to the bomb unless the fuze charging signal source is inoperative.

RELEASE MECHANISMS

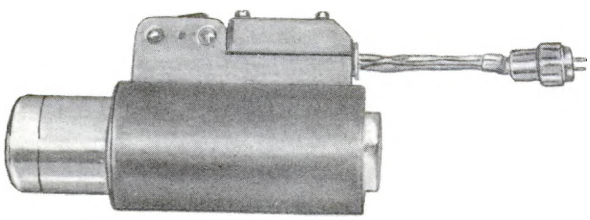
BOMB SHACKLE RELEASE AERO 7A, BOMB RACK RELEASE AERO 7B

The Aero 7A and Aero 7B are electrically fired, mechanically actuated, spring loaded release mechanisms designed to operate instantaneously and with hammer blow force. Their function is the positive movement of the lever of a bomb rack or shackle for load release.

Since the Aero 7A-1 and the Aero 7B-1 models are later modifications of the Aero 7A and Aero 7B, all references to the Aero 7A and Aero 7B also apply to the Aero 7A-1 and Aero 7B-1, respectively, unless otherwise stated. (See fig. 16-26.)



BOMB SHACKLE RELEASE AERO 7A-1



BOMB RACK RELEASE AERO 7B-1

Figure 16-26.—Release units Aero 7A-1 and Aero 7B-1

The Aero 7A is a compact unit weighing approximately 1 3/4 pounds and is 4 3/4 inches long, 1 3/4 inches wide, and 3 1/4 inches high. The unit is barrel shaped and is attached to a bomb shackle by means of its mount which is detachable from the release body. An electrical cable with an AN connector is provided for connection to an external power source.

The Aero 7B is 4 1/4 inches long, 1 3/4 inches wide, and 2 1/2 inches high. Since the Aero 7B is shorter and has no separate mount, it weighs slightly less than 1 1/2 pounds. The unit is barrel shaped and is attached directly to a bomb rack. An electrical cable with a miniature connector is provided for connection to an external power source. The Aero 7B mounts directly to the bomb rack.

The operation of the Aero 7A and Aero 7B is identical, therefore only the operation of the Aero 7A is discussed. The Aero 7A is a spring loaded mechanism that is electrically activated and mechanically released to deliver a positive minimum force of 55 pounds in a hammer blow actuation of the plunger.

From a "cocked" position, the release is fired by the closing of a switch in an external circuit to which it is connected. This causes an instantaneous and sequential series of actions in which the plunger is released. The electrical activating power is then mechanically transferred to another release in the series (if more than one is used in each series, or the circuit is opened) through the transfer switch. At the same time, the external indicator lamp circuit of the release (which was fired) is opened.

For further information on the Aero 7A, 7A-1, 7B, and 7B-1 release units, the reader is referred to the Operation, Service, and Overhaul Instructions Manual with Illustrated Parts Breakdown, NavWeps 11-5D-17.

AIRCRAFT BOMB SHACKLE RELEASE AERO 4B

The Aero 4B bomb shackle is similar in appearance to the Aero 7A and 7A-1 releases and consist of three major assemblies as follows:

1. The release assembly.
2. The transfer unit assembly.
3. The mount assembly.

The release is basically an electrically operated spring loaded plunger and sequence switch. It is equipped with a mounting clamp for attachment to a bomb shackle.

Cocking of the release is accomplished by pushing in the plunger until it is held by an internal locking device. The shaft is released electrically by a solenoid. A control relay and switching assembly in the unit operate an indicator light and transfer circuit. The Aero 4B release may be used with the Mk 8, Aero 16, Aero 17, and other similar shackles.

The Aero 4B release unit is being replaced by the Aero 7A or Aero 7A-1 release units (which were discussed earlier in this chapter). However, the Aviation Weapons Officer may still come in contact with this equipment in certain activities.

OTHER ASSOCIATED EQUIPMENT

RACK SELECTOR-2 (RS-2)

The rack selector was designed for use in a bombing system to distribute electrical impulses from the bomb release switch or intervalometer to the bombing circuits. (See fig. 16-27.)

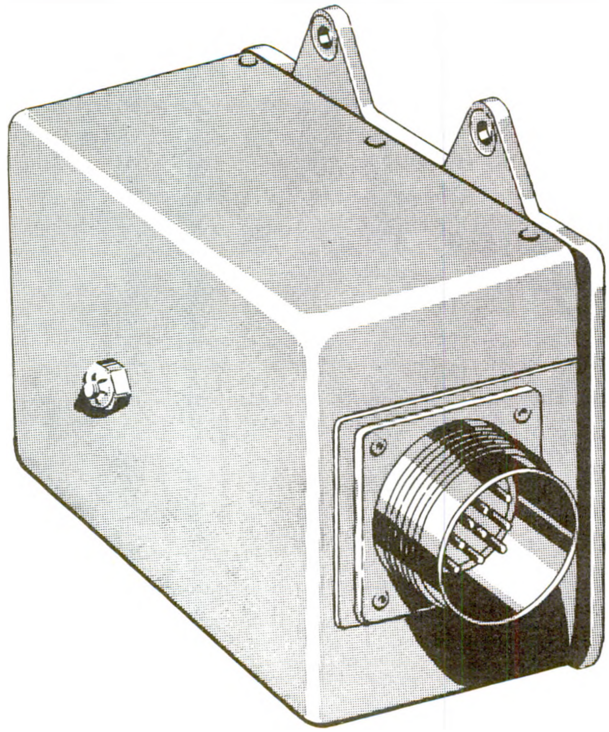


Figure 16-27.—Rack Selector-2 (RS-2).

Each rack selector controls two circutis at a maximum rate of 22 impulses per second. The selector and the circuits to the release units are connected in such a manner that as the impulses are distributed to the bombing circuits, the bombs are dropped so as to keep the load in balance. Two rack selectors may be wired in series to control four circuits, etc.

Each bomb circuit contains releases connected in series by means of the transfer switches. Each rack selector is controlled by a selector switch. With the selector switches ON, and the bomb release switch closed, the impulses are automatically directed from one circuit to the other until all the releases in one circuit have been released. Succeeding impulses are directed to the circuits having cocked release units.

STATION SELECTOR MK 2 MODS 0, 1, AND 2

The Station Selector Mk 2 and Mods is used to electrically effect the firing of rockets or release of bombs from aircraft. It is mounted in the cockpit and provides means of controlling the number and order of rockets or bombs to be fired or released. Stations may be selected manually or, when operated electrically, it will move clockwise one position on each impulse. The station selector Mk 2 Mod 0 (fig. 16-28) permits the firing of rockets or the release of bombs singly or in pairs. When the pointer on the dial is set at the first position, it will fire singles and when set one number above, the half-way point, it will fire pairs. The Mk 2 Mod 0 station selector can accommodate the 4, 6, 8, 10, 12, or 16 station dial face. The Mk 2 Mod 1 station selector can fire rockets or drop bombs in singles only and can accommodate the 11 station dial face only. The Mk 2 Mod 2 comes equipped for a selection of dial faces the same as the Mod 0 and Mod 1 (7 total) but contains white spaces on the dial faces, to allow desired write-in information to indicate the load on each individual station. When the station selector Mk 2 Mod 2 has an even numbered dial face installed on it, it can fire rockets or drop bombs singly or in pairs, but when a 11 station dial face is installed, it will fire singles only.

Circuit connections in all Mods of the Mk 2 selector are made by means of an external firing key or intervalometer. These connections are made through the solenoid coil (1) to the contact ring (4). From here the connection

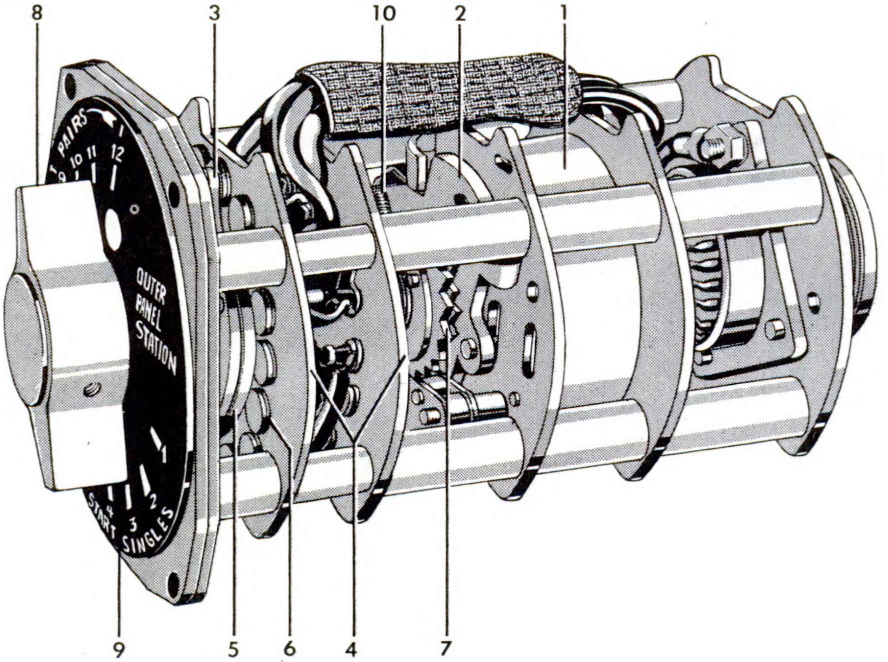


Figure 16-28.—Station Selector Mk 2 Mod 0 (cover removed).

is completed to any one or pair of contact terminals. Electrical impulses received from the firing key or intervalometer energize the solenoid (1). This causes the armature (2) to be cocked and ready for advancement of the contact arm assemblies (3). These arm assemblies are mounted so that electrical contact is established between the contact ring (5) and the terminals (6).

As soon as the impulse ceases, the instrument advances itself to the next position automatically. This action is accomplished by armature and pawl assembly (2) acting on the ratchet and detent assembly (7). The movement to the next position is the direct result of the armature spring (10) tension. This spring pulls the armature and its pawl to the normal, or inoperative position. Operation of the device is provided by setting the index knob (8) to the desired position on the dial (9) and introducing an electrical impulse from either a firing key or intervalometer.

K-2 INTERVALOMETER

The K-2 intervalometer is an electrically operated device which times the release of a group of bombs so that they will strike the ground at evenly spaced intervals. The intervalometer is placed in the electrical release system at a point between the power source and the other operating units in the system, and is set in motion when the pilot's control switch in the bomb release circuit to the intervalometer is closed.

Operating on a capacitor charge-discharge principle, the intervalometer alternately connects and disconnects the power source to and from the electrical bomb release system, thus sending out timed impulses. These impulses are distributed throughout the electrical bomb release system by the distributing units of the system. Each impulse operates a bomb rack or shackle release unit, thus releasing a bomb from the aircraft. The number of impulses sent out by the intervalometer and their frequency (releases per second) may be varied as desired by the pilot.

Intervalometer Type K-2 when used on P-2 or P-5 type aircraft is located on the pilot's control panel. It has provisions for automatically computing the number of releases per second in relation to the ground speed of the aircraft and the desired spacing between bombs. Electrical impulses are initiated to the release units at the rate of from 2 to 20 per second.

The intervalometer may be used for either "selective" or "train" bomb release by setting the TRAIN-SEL. Toggle switch. When it is set for selective release, only one impulse is produced by the intervalometer each time the bomb release switch is closed. When set for train release, the number of impulses produced is determined by the setting of the counter knob and pointer.

The counter unit knob and pointer can be set to any position on the counter dial from 0 to 50, depending upon the number of single bombs to be released in each "train." As the intervalometer sends out impulses, the counter knob and pointer will move counterclockwise around the dial until they reach 0, moving one position on the dial with each impulse. When 0 position is reached, the counter switch inside the unit opens, disconnecting the circuit.

The interval control switch determines the number of impulses per second that are produced by the intervalometer during a "train" release of bombs. It is automatically removed from the circuit during "selective" release. The pilot, knowing the groundspeed of the aircraft in knots, sets the corresponding marking on the groundspeed dial opposite the desired ground spacing of the bombs on the stationary bomb spacing dial.

The pilot light, with barrel turned to the right, glows when the intervalometer is set for "selective" release. When set for "train" release, it glows only when the counter is set to any position above zero.

Intervalometer K-2 is regarded as a "single wire" type since all impulses are sent out through a single wire.

ORDNANCE RELEASE INTERVALOMETER AERO 3A

The Ordnance Release Intervalometer Aero 3A (fig. 16-29) is a timing device that will supply 28 volts d.c., tripping pulses to ordnance release mechanisms. The number of releases or rounds expended and the spacing between them may be selected by the operator. All units and controls are made in one assembly, which mounts in the cockpit or navigator's compartment.

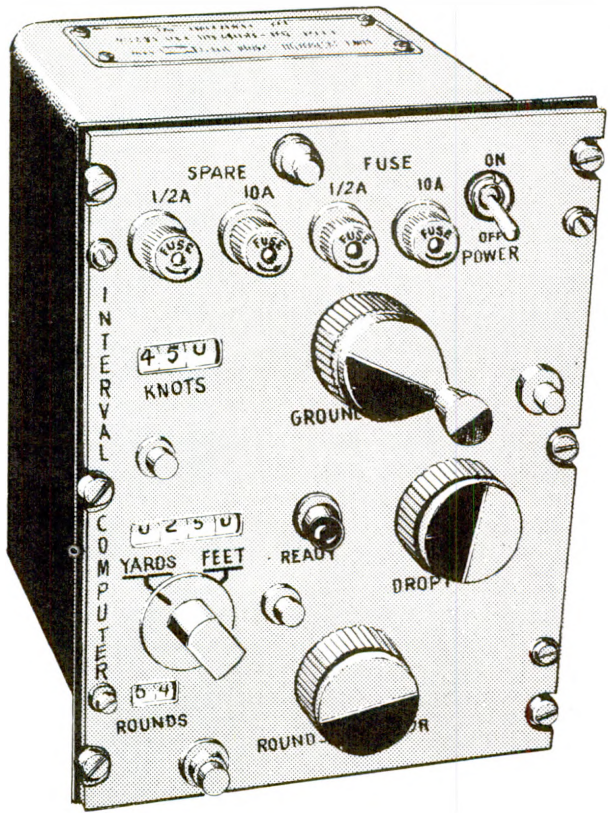


Figure 16-29.—Ordnance Release Intervalometer Aero 3A.

The external controls of the intervalometer consist of a power ON-OFF switch to turn the power on to the intervalometer, a groundspeed control knob with an odometer type dial with settings from 1 to 640 knots in 1-knot increments, a bomb drop interval selector knob with an odometer type dial which reads in yards or feet and can be set from 25 to 3,200 yards or feet, a round selector knob with an odometer type dial that can be set from 0 to 64 rounds, and a start switch that actuates or starts the unit.

To operate turn the power ON-OFF switch to the ON position, set the groundspeed knob to the desired groundspeed, set the drop interval knob to the desired distance between the bombs (yards or feet), and set the round selector knob to the desired number of rounds to be dropped. When the aircraft reaches the target, depress the start switch and the unit will then operate.

The extent of repair that can be accomplished by operational maintenance personnel is limited only by the tools and test equipment available. However, it is not anticipated that organizational maintenance will extend beyond replacing complete plug-in assemblies, fuzes, bulbs, and switch knobs.

After each 300 hours of operation, the intervalometer should be checked for operational accuracy by completing the accuracy test, pulse width test, low voltage test, and high voltage test. Conduct these tests as outlined in NavWeps 11-5-107.

At the same time the operational accuracy tests are run, inspect the unit for frayed or worn cables and loose or corroded terminals and connectors. Remove dust from the intervalometer subassemblies and parts with a soft hairbrush. Do not use compressed air. If there is any evidence of internal moisture, air dry or bake the unit, but in no event should the temperature applied to the equipment exceed 71°C (159.8°F). Check the set screws in each of the switch knobs to see that they are tight. Replace all defective panel light bulbs. The intervalometer requires no lubrication.

TD-441/A INTERVALOMETER

The TD-441/A Intervalometer, as currently used in the P-3A aircraft, is a special purpose electronic digital computer which is used in dropping a selected number of stores at selected intervals. The intervalometer output consists of a number of electrical pulses which are used to actuate the stores release mechanisms. The number of output pulses is equal to a selected number preset by the operator. The time spacing of the output pulses is inversely proportional to the aircraft velocity, and directly proportional to the selected distance spacing of the stores (preset by the operator). In performing its intended function, the intervalometer solves either of the following two equations:

$$(1)\ T = \frac{D1}{(V)\ (K1)} \qquad (2)\ T = \frac{D2}{(V)\ (K2)}$$

where

T = Time interval (in seconds) between output pulses.

V = True aircraft velocity (in nautical miles per hour) relative to the surface of the earth.

D1 = Selected distance spacing (in feet) between output pulses, relative to the surface of the earth.

K1 = 1.6878064—constant of conversion for converting nautical mph into fps.

D2 = Selected distance spacing (in yards) between output pulses, relative to the surface of the earth.

K2 = 1/3 K1—constant of conversion for converting nautical mph into yards per second.

The intervalometer is capable of performing the above computations for a range of aircraft velocities from 1 to 640 knots in 1-knot increments, and for a range of distances from 150 to 3200 feet or yards in 25-unit increments. The number of output pulses (rounds) may be selected from 1 to 64. The sequence of output pulses will follow the application of a single start pulse to the intervalometer initiated by a stores release switch.

For further information on the TD-441/A Intervalometer refer to the Armament and Photographic Systems Section of the Maintenance Instructions Manual for the P-3A aircraft, NavWeps 01-75PAA-2-5.

SAFETY PRECAUTIONS

The Aviations Weapons Officer should always be conscious of safety concerning suspension, arming, and releasing systems. It is doubtful that there is a weapons officer in the Navy that has not witnessed a minor mishap with a suspension, arming, and releasing system. The majority of accidents could possibly have been prevented by rigid adherence to the pertinent safety precautions, maintenance instructions, and the use of an effective educational program for all personnel not familiar with the equipment on which they may be required to work.

A few safety precautions though not all conclusive, that summarize this chapter are as follows:

1. All components of the various systems must be kept clean, well adjusted, and lubricated as prescribed.

2. Wiring and electrical fittings must be checked regularly; frayed or broken wiring replaced and plugs checked for condition and proper installation.

3. Operational check or periodic inspections of the system must be under the direct supervision of fully qualified personnel.

4. Safety circuits or devices must never be bypassed or otherwise rendered inoperative.

5. When loading stores, inspect all handling gear carefully. Do not use doubtful gear.

6. Do not place parts of the body under stores being loaded or unloaded it if it possible to accomplish the job without doing so.

7. When loading stores, insure that the store is in position and the rack is securely locked before removing hoist.

8. Insure that only the prescribed cartridges are installed in ejector devices.

9. When stores are loaded, safety pins or other safety devices should be installed as prescribed while the aircraft is on the ground.

10. When installing suspension equipment, torque all installation bolts or screws to the torque value prescribed.

11. All final work performed on the armament system should be thoroughly inspected by quality control personnel or other personnel who are familiar with the system. Operational tests should be made on repaired systems where necessary.

NOTE: Safety precautions for handling aircraft stores are covered elsewhere in this text.

CHAPTER 17

AMMUNITION HANDLING AND STOWAGE METHODS

Afloat or ashore, the control of aircraft ammunition from its arrival, into stowage, and through the assembly and arming areas remains much the same. However, this requires a high degree of proficiency and the coordinated effort of reliable trained personnel. Ammunition handling crews should be thoroughly familiar with all types of ammunition/explosives being handled and the equipment used in the handling or stowing operation.

In many cases, the mechanical equipment used to handle aircraft ammunition is identical whether afloat or ashore. However, differences in stowage accommodations, fixed installations, working areas, and space allowances sometimes require ordnance handling equipment and procedures specially designed for the job. This chapter discusses some of the prescribed ammunition handling and stowage methods.

GENERAL CONSIDERATIONS

The handling procedures described in this chapter are not to be considered as the only permissible ones. They are suggestions for methods of performing the necessary operations without violating safety requirements and official handling instructions. It is not to be assumed that other properly authorized methods may not be equally safe and efficient.

DIVISION AND RESPONSIBILITY

As defined in BuWeps Instruction 5450. 27 of 12 October 1961, technical control of ammunition material is vested in BuWeps. However, certain functions and tasks have been reassigned to other bureaus, offices, and to the Marine Corps in specific instances. Commanding officers of naval ammunition depots, naval magazines, and other like activities are under the direction of BuWeps. Further delegation of responsibility and authority for handling and stowage of ammunition is also in effect to each individual activity ashore and afloat. Within the individual activity, responsibility and authority for handling and stowage of ammunition are delegated by the commanding officer down the chain of command, to eventually become a matter within the scope of the Aviation Weapons Officer.

Responsibilities for handling and stowing ammunition are outlined in great detail in publications such as Bureau of Naval Weapons Instructions, (including Bureau of Ordnance Instructions that have not been canceled), Navy Regulations, OP 4, Ammunition, Instructions for the Naval Service Afloat, OP 5 Ammunition, Instructions for the Naval Service Ashore, and others prepared by district commandants, fleet commanders, and even duly authorized ones prepared at local levels. They are all regulatory along certain basic lines which deal with supply, procurement, accounting, allowances, expenditures, recordkeeping, safety in handling and stowage, maintenance, inspection, and surveillance.

PERSONNEL AND ORGANIZATION

A qualified officer should supervise the receipt, transferring, stowage or preparation of ammunition or explosives. It should be his responsibility to see that all personnel engaged in this work are properly impressed with the necessity for utmost care. Familiar work, no matter how dangerous, is apt to lead to carelessness; therefore, close and intelligent supervision is necessary to prevent accidents. The paramount considerations are safety and reliability; ammunition handling should never be allowed to degenerate into a contest between rival groups in speed and efficiency of methods.

General instructions for the proper handling of ammunition and components are included in the publications listed earlier in this chapter. These publications contain the basic regulations necessary for general instructions of personnel but do not list specific regulations or precautions applicable to particular marks and modifications of equipment; neither do they contain regulations governing equipment recently procured by the Navy. Therefore, it is the responsibility of all officers concerned with ammunition handling to see that operating and maintenance personnel have access to, and are familiar with, all special ordnance publications dealing with specific types of ordnance material with which they work.

The handling and stowage of ammunition are arduous and tiring operations, usually requiring large numbers of personnel for many hours at a time. It therefore is extemely important that detailed plans for personnel, organization, routing, and equipment be prepared and distributed for study well in advance. All supervisory personnel should be familiar with the work to be accomplished in order that the operations may proceed with safety and a minimum of delay.

Before loading or unloading ammunition, a preliminary conference of the weapons officer and other supervisory personnel should be held with regard to shipment orders, methods and locations of deliveries, availability of equipment (fixed and mobile), tabulation of procedures to be employed, routing to stowages, communications, officer supervision, working parties, special crew feeding, and other matters of joint concern.

The movements of aircraft ammunition and explosives between the magazine and aircraft arming areas involve handling and assembling functions that are sometimes under different commands. It is important that definite and clear understandings be reached as to the areas and the limits of responsibility for each crew.

AMMUNITION AREAS

For purposes of regulating ammunition movements, both afloat and ashore, the five following control areas are distinguished:

1. Ammunition arrival area.
2. Ammunition receiving area.
3. Magazine or stowage area.
4. Delivery assembly area.
5. Aircraft arming area.

The ammunition arrival area may be a station dockside or a railway siding, a barge or lighter, or a revetted area or siding used by motor trucks or railway cars.

The ammunition receiving area ashore is the transfer location within the magazine area where inspection, inventory, and unloading are accomplished prior to delivery to the magazines. This area must comply with all regulations governing dispersal of units and permissible distances between buildings and magazines. Aboard carriers, the ammunition receiving area is the flight or hangar deck, or possibly the fantail.

The magazine or stowage area, afloat or ashore, is the location with fixed installations, designed for stowage of all the various types of aircraft ammunition.

The delivery assembly area is the location to which the various components and details of ammunition are delivered for assembly into complete rounds for use in aircraft. For reasons of safety, this area ashore is remote from the magazines and from the aircraft arming area. Aboard carriers, the approved spaces may be below decks or on the hangar deck level.

The aircraft arming area is the location where aircraft are parked for operational servicing prior to launching. Ashore, this may be the hangar apron operations line or, for seaplanes, it may be a rearming boat over a water area or on the hangar ramp. Aboard carriers, this location is normally the flight deck. The location is a matter of task force directive or operating doctrine; the arming, however, should always be performed at the last moment and in a location consistent with operational schedules and the safety of the ship and its personnel.

RECEIPT AND SHIPMENT OF AMMUNITION

Handling of ammunition whether in receipt, shipment, transshipment, or other transactions in which ammunition is actually moved, involves great potential dangers. Therefore, safety is the prime consideration in any such movement.

Before taking aboard ammunition received in any conveyance, an inspection is made of the condition and security and the contents checked against the invoiced quantities. A report of any shortage, error, defect, or discrepancy is made. Ship and shore stations receiving ammunition in leaky containers or ammunition showing evidences of rough or improper treatment, should investigate the circumstances immediately and submit a complete report to BuWeps.

A copy of the completed invoice accompanies every delivery or shipment of ammunition. When explosives and ammunition are shipped, the material is carefully identified on bills of lading or shipping ticket by shipping name, caliber, mark and model number, manufacturer's name or initials, lot number, and such other information as may be required by other instructions.

OP 2165, Navy Ordnance Shipping Handbook, contains complete instructions for transportation of ammunition and explosives.

When shipment of ammunition is made which must cross state boundaries, the regulations of the Interstate Commerce Commission must be met with few exceptions. These regulations are spelled out in several publications issued by the Commission. The military is permitted to make shipments which do not comply strictly with the Commission's regulations. However, such shipments are held to an absolute minimum and every possible effort is made to actually be in compliance with the Commission's regulations in each such shipment. Prior to packaging and packing, all ammunition is laid out, counted, and checked. A packing slip showing the date and names of the packer and checker is placed in each case. Heavy articles are separated from light ones and not packaged or packed together. Articles of different freight classifications should not be packed together as all articles in the same case will take the classification of the article classified the highest.

When a shipment of ammunition is received, by any mode of transportation, a working party of sufficient size should be duly organized to properly handle the contents of the shipment. If, after commencing the job of handling the ammunition, it is seen that all of the personnel in the working party are not needed to effectively carry on the work, all excessive members of the party should be promptly assigned elsewhere. This safety precaution will prevail at all times that ammunition is being handled—only those actually needed should be allowed to remain in the area.

In many instances, personnel who are not familiar with the potential dangers involved in handling ammunition are assigned to working parties. These personnel should be briefed prior to receipt of the shipment.

COMMUNICATIONS

Reliable communications systems are necessary for ammunition handling and all phases of aircraft arming operations. It is important that all stations involved in the movement of ammunition (central control, magazine breakout, fuzing, elevators, assembly, arming, and other key points) be connected by telephone or some alternative method. The ability to increase or decrease, modify or reverse, the flow of ammunition and other materials can be accomplished only with an effective system of conveying orders. Circuits aboard ship must be properly manned and must be extended, when necessary, to cover all essential control and working points. Ashore, where instructions may have to pass through more than one activity or command, misunderstandings are likely to occur at the junction point where messages are transferred. Frequent checks of all equipment and rehearsals of communications procedures should be made.

RECORDS AND REPORTS

Commanding officers of ships and shore activities are required to make reports of all ammunition and ammunition details within their commands. These records show all receipts, transfers, expenditures, and quantities on hand. Also included in these records are complete ammunition identification data, including lot numbers and mark and modification numbers of all ammunition and ammunition components. Commands held accountable for ammunition are responsible for submitting reports regarding transactions, inventories, performance, and similar items in strict accordance with Navy Regulations and BuWeps Instructions, or other competent authority.

Daily magazine temperature reports are made by each command accountable for ammunition. These reports are compiled from the temperature readings taken at a specified time each day in each magazine, dump, or ready locker under the cognizance of the commanding officer of the activity. Copies of these reports are sent to BuWeps as per instructions. Temperature entries are made in rough and smooth magazine logs both ashore and afloat.

All ships, squadrons, and bases outside the continental U. S. are required to submit quarterly reports to the Fleet Ammunition Report Processing Center. This report contains information on the status of ammunition, amounts on hand, and cumulative expenditures during the fiscal year. This report, when processed, provides BuWeps with information concerning expenditure rates, ammunition availability, and facts from which fleet requirements can be determined.

There are numerous other reports that have to be made periodically concerning ammunition whether afloat or ashore. Some of these reports are as follows:

1. Available storage space at the activity.
2. Types and number of missiles used for training.
3. Performance of ordnance equipment.
4. Performance of pyrotechnics and other types of ammunition used.

TIME STUDIES

In the interest of efficiency, time studies should be made of all ammunition handling and aircraft arming operations especially when new equipment, procedures, weapons, or types of ammunition are involved. In planning complex aircraft arming schedules, supervisory personnel need accurate data on the following and similar factors:

1. The time required to convey original orders from control to magazines.
2. The arrival time of the first loads of ammunition requested.
3. Magazine loading times for single loads and various multiple-load combinations.
4. Loading times for singles and multiples of various aircraft types.
5. Handling times in the magazines.
6. Assembly times for components.
7. Delivery times.
8. Round-trip times for hoists, elevators, or other conveyance equipment.

A forecast, taking all these factors into consideration, should be available for estimated loading times of one, six, or a squadron of aircraft. Such a forecast should make some allowance for crew fatigue and for unforseen interruptions.

ORGANIZATION AND PROCEDURES AFLOAT

Organizational procedures for the handling and stowage of ammunition afloat should be carefully formulated in advance, giving thought and planning to all details regardless of how small and insignificant they may seem on the surface. Due to the many hazards connected with handling ammunition, no factor must be overlooked in establishing the organization and performing the work. Responsible officers should insure that personnel selected for key positions (crew leaders, safety inspectors, equipment operators, etc.) are qualified for the job they are assigned. Personnel in supervisory positions especially have to know all the details of the entire task at hand and ascertain how to coordinate their work with other area supervisors.

PERSONNEL ORGANIZATION AFLOAT

In order for the Aviation Weapons Officer to better understand the factors involved in the receipt and delivery of ammunition aboard ship, it will be helpful to review chapter 7 of this text.

AMMUNITION RECEIPTS AND DELIVERIES AFLOAT

In preparation for handling ammunition from ship to lighter, or the reverse, or when ammunition is being moved aboard ship from one place to another, certain preparatory steps are necessary. The BRAVO flag is hoisted to the mainmast, except in battle, and remains there while ammunition/explosives are being received or discharged.

Red flags must be flown from the bows of all small craft loaded with or transporting any type of explosive materials.

Prior to moving ammunition aboard ship, the word is passed, "The smoking lamp is out throughout the ship (except for designated areas as defined by the commanding officer) while handling ammunition." This also applies to the lighter, the dock, and all areas immediately adjacent.

Lighters or other conveyances for ammunition must have convenient placement with respect to cranes, gangways, or other handling facilities. If the ammunition is being transported from ships to shore, this placement should be at the best possible area for unloading.

Before ammunition movements are begun, an effective communications system must be worked out for the area involved in the loading or unloading operations.

Dunnage mats and chafing gear must be carefully placed aboard ship, so that the knife edges and decks may have protection from cargo damage, and so that handling gear may not be damaged by contact with the ship.

All slings, tools, and handling gear should be available at the proper locations and in quantities large enough to accommodate ammunition movements safely and promptly. The proper use of handling gear is essential because small dents in ammunition may cause malfunctioning or even premature explosions.

All hoists, elevators, and other power equipment should be tested and alternate routes and equipment made available for use in event of failure of the primary equipment.

Stowage spaces to receive ammunition should be prepared by moving stanchions and battens to their correct positions, with saddles adjusted to the most advantageous positions for the type of ammunition to be received. Provision must be made for separate stowage of ammunition types and components wherever this is required by specific instructions issued by BuWeps or other competent authority.

It is particularly important that new supplies of ammunition be checked for imperfections and damage, and that any unsatisfactory conditions be noted in appropriate logs and reported immediately to BuWeps.

INSPECTION AND TESTS

Inspections, tests, and overhauls are required on many items related to ammunition. All places of stowage require regular inspections and tests. Ammunition details, which are accessories used in packing, handling, protection, and surveillance of ammunition, require frequent inspections.

Prior to taking ammunition onboard, a visual inspection should be made to determine the condition of containers, security of containers, and completeness of the ammunition material invoice.

A report is required to be made of any shortages, errors, defects, and other discrepancies. Ships receiving ammunition in leaky containers, or ammunition showing evidence of rough or improper handling, are required to immediately investigate the circumstances fully and submit a full report to BuWeps.

The primary purpose of ammunition inspections is to detect deterioration, thereby reducing hazards, to detect and correct defects, and to maintain all ammunition and ammunition components in a safe and serviceable condition. Surveillance is close observation, rigid inspection, careful examination, and thorough testing of ammunition. Surveillance applies not only to the ammunition itself, but also the methods of handling, packing, stowing, segregating, and shipping, and to precautions and instructions tending to protect property and personnel against hazards inherent in all explosives.

Officers and men charged with the responsibility of magazines and the examination of ammunition should thoroughly familiarize themselves with the practical methods of making such examinations and tests. They are held responsible for the accuracy of these tests, the correctness of the official reports concerning them, and for the proper instruction of those who actually conduct the tests and inspections.

In order for the tests and inspections to be of value and a true indication of the condition of the ammunition under surveillance, it is essential that the methods in all details be uniform and those performing the testing scrupulously follow the prescribed methods. BuWeps records all tests reported from the various sources and keeps careful accounts of the disposition and condition of ammunition. Thus, BuWeps is enabled to dispose of any and all ammunition which is unsafe and unserviceable. It may be seen that accurate and timely reporting from the activities and fleets is necessary to assure correct and prompt action by BuWeps.

Magazines

During the daily inspections, the magazines are carefully examined for cleanliness, ventilation, temperature, and the general condition of their contents. Upon entering a magazine, a deep breath should be taken to detect the presence of any excessive ether-alcohol fumes. Should such fumes be present, it means that containers are leaking. These should be removed or replaced immediately. The temperature and the moisture content of the magazine's atmosphere (hydrometric condition) must be constantly watched. Temperatures are read daily and the maximum and minimum figures are recorded in the Magazine Temperature Record Book. If one thermometer is allowed for a particular magazine, it is placed in the hottest portion of the space. If two are allowed, one is placed in the hottest part and the other in the coolest part of the magazine.

A magazine is considered to be in a normal condition when the following set of conditions prevail:

1. Magazines and magazine area are well guarded and protected from fire.
2. Magazine is in good repair, dry, and well ventilated.
3. Interior is neat with contents arranged in orderly units which do not exceed the prescribed height or quantities.
4. Atmosphere in and around the magazine is free of ether-alcohol fumes.
5. Visual testing equipment (violet paper, etc.) indicating correct conditions.
6. Temperature not exceeding 100° F, and no evidence of local heating of smokeless powder containers.
7. Boxes and containers securely closed.
8. Contents of magazine properly identified by lot number and piled with not more than one lot in each pile.
9. Loose rounds, damaged containers, empty containers, paints, oils, rags, dunnage not in use, and other prohibited articles not present in the magazine.
10. Magazine properly placarded inside and out.
11. Only the ammunition types designated for the particular magazine stowed in that magazine.
12. Fire- and lightning-protection equipment maintained in efficient operating condition, and magazines (ashore) properly grounded.

The magazine sprinkler system has to be inspected and tested weekly and monthly, following the specified procedure for this work. Powder samples have to be taken as prescribed in OP 5. Magazine flooding controls and valves have to be inspected. Electrical continuity has to be tested within the magazines to insure no dangerous conditions exist in wiring and grounding circuits. Inspection of installed ammunition handling equipment for security, safety, and operation is necessary continually. In addition other types of surveillance tests and inspections are necessary on the ammunition, its components and details, and the stowage areas in general.

ORGANIZATION AND PROCEDURES ASHORE

In general, all naval shore activities have a continuing responsibility for the safe storage, maintenance, operation, use, and protection of their assigned ordnance equipment, ammunition, and ammunition components.

PRACTICAL CONSIDERATIONS

Aviation Weapons Officers assigned to air stations are confronted with a variety of duties and problems in connection with ammunition handling and stowage. Many events that arise in their daily work are not specifically covered in official Navy publications. Some of the practical aspects which are more or less typical of the duties and problems of the Aviation Weapons Officer are discussed in the following paragraph.

Local air station instructions pertaining to the WAR PLAN ANNEX should be thoroughly studied and periodically reviewed. All departments/divisions/branches, etc., concerned with handling ammunition or the loading of retaliatory missioned aircraft should hold periodic meetings to work out various problems to insure maximum flexibility and still guarantee completion of the local assigned mission. Among other things, provisions should be made for sufficient types and quantities of ammunition and ammunition accessories, tools, nonmobile and mobile handling equipment, and, of course, experienced personnel to carry out the plan. A workable system necessitates frequent inventories and inspections and training lectures to keep the plan current. The Aviation Weapons Officer should also schedule rearming drills to bring out deficiencies in this important work, and provide competent observers to cover these drills. The station's disaster plan should also be studied and procedures should be set forth to encompass this situation.

INSPECTIONS ASHORE

Personnel responsible for ammunition ashore should be aware of and familiar with pertinent instructions and procedures governing the inspection and maintenance of all ammunition, magazines, and magazine areas. The inspections afforded magazines ashore are basically the same as for magazines afloat. However comparison of inspections of magazines ashore and afloat will show many physical differences and dissimilar stowing procedures.

All magazines should be inspected in detail every day. Where this is impossible due to lack of personnel, one or more magazines which are representative of each group or type of magazine must be inspected daily. The results of any and all inspections are recorded in the magazine logs (also recorded in the rough and smooth OOD logs) over the signature of the person making the inspection.

There are several matters which are not common to shipboard magazines, but which do apply to magazines ashore. One is that a definite firebreak is necessary around all the magazines. It must be of prescribed width and should be kept free of rubbish and other flammable materials at all times. Another is that all ammunition, explosives, and components thereof must be stowed in the designated and appropriate magazines. They cannot be stowed in buildings used for other purposes. The requirements for normal magazine conditions for magazines ashore are the same as those for aboard ship except that the above two details are added to the conditions for magazines ashore.

Magazine Symbols

Ammunition depots and other shore activities number their magazines in accordance with certain specifications. These numbers are assigned so that inspecting officers and others concerned may at a glance be able to tell how much ammunition can be safely stowed therein, if the magazine is standard, or if it is a nonstandard magazine. Being nonstandard, he will further know that a check is necessary to determine if the amount stowed therein can be safely carried as marked on the magazine.

There are 16 standard types of magazines. The nonstandard magazines have a separate listing with the letters X, Y, and Z added to their designators. In addition, the standard magazines, which have less than the prescribed safety distance from other magazines or inhabited areas, carry the above letters in their designators. Numbers are added to the letters to indicate the location of the magazine. The numbers and letters are painted on a colored background to indicate the nature of the hazard.

Each magazine displays a three-group symbol consisting of one number, one or more letters, and a number painted on a colored background. The letter T indicates that the magazine is earth covered and barricaded. The letter C indicates that the magazine is covered with earth, but that the doors are not barricaded. The colored backgrounds indicate what the buildings are used for and the nature of the hazards, and are as follows:

High explosives	Yellow
Black powder	Yellow
Projectiles	Green
Fixed ammunition	Red
Separate loading cartridges	Blue
Smokeless powder	Blue
Bag charges	Blue
Small arms and pyrotechnics	White
Chemical ammunition and smoke drums	White and yellow diagonally striped
Fuze and detonator	Red and yellow diagonally striped
Inert, combustible	Brown
Inert, noncombustible	Black
Filling house and loading plants	Orange

The letter X on the nonstandard magazine stands for explosive hazard magazine; the letter Y for fire hazard magazine; and the letter Z for missile magazine. As an example, a magazine designated 7AT28 on a yellow background would convey the following information: Magazine located in Group 7; is of the 80-foot arch earth-covered barricaded type, located at least 3,150 feet from the boundary, and at least 400 feet from the nearest magazine; is number 28 in that group; and contains high explosives. Distance from the station boundary or the nearest inhabited building, public railway, or public highway is another of the factors governing magazine designations. All ammunition is grouped for stowage purposes under one of three nonstandard types of hazards (explosives, fire, and missile) and is stowed in the appropriate magazine type.

Essential Magazine Data

Certain data concerning magazines are retained by all activities responsible for stowage and handling of ammunition. These data include copies of corrected blueprints, maps, and drawings of all explosive and ammunition stowage, showing the location of all magazines and magazine areas. It also includes the type and construction of the magazines; permissible stowage; maximum permissible quantities; actual contents, and distances to inhabited buildings (off naval reservation); and public railways and highways. Each activity supplies to BuWeps periodically corrected charts and other source materials which keep the Bureau current on all stowage problems and facilities at the activity.

Quantity-distance tables, reflecting how much ammunition of what types may be stowed at what distances from specified structures (private and military) and other features, are published by BuWeps. The Bureau bases these tables on data concerning fires and explosions involving naval explosives and ammunition, reports covering a comprehensive series of tests conducted at the Aberdeen Proving Grounds, and from other factual and regulatory sources. These tables, which reflect the quantity-distance specifications, are published in Volume 1 of OP 5, Ammunition Ashore.

STOWAGE REQUIREMENTS

As a general rule, stowage facilities ashore (an air station, for example) will include provisions for high explosives, fuzes and detonators, JATO, rockets, small arms ammunition, pyrotechnics, fixed ammunition (20-mm and larger), inert materials, and smokeless powder. The location and capacity of the magazines will depend on the type of stowage involved. For some explosives, this is in terms of net pounds. In others, it is based on the use of 70 percent of the gross floor area and a stowage height of 6 feet. For inert storehouses, the same floor area regulation applies, but the height may be greater. The overhead in a standard storehouse is 14 feet. Regulations for the stowage of special weapons are not considered in this chapter.

In order to better illustrate stowage requirements, it might be well to consider a specific example. The requirements for small arms ammunition and/or pyrotechnics are cited as the example. In general, these types of ammunition, and all others classed as non-mass-detonating, are each stowed in separate arch-type, earth-covered magazines, without a barricade at the door end. The standard size for such a magazine is normally 25 feet by 50 feet. When stowage space for any one type of ammunition is greater than the capacity of this size magazine, additional magazines of the same capacity are required.

Minimum safety distances for small arms ammunition and/or pyrotechnics have been established as follows:

1. Between magazines containing these types—200 feet.
2. Away from high explosive groups—1,900 feet.
3. Away from single high explosive magazine—500 feet.
4. Away from other types of magazines—200 feet.
5. Away from station boundary, inhabited buildings on and off the station, public highways and passenger railways—400 feet.
6. Away from centerline of runways and/or taxiways—750 feet.

An exception to both (1) and (4) above occurs when the "triple-arch" magazine is used. Then the minimum spacing between two adjacent magazines of the same type and between the triple-arch and the other magazines, except high explosives and fuze and detonators, must be 300 feet.

Small arms ammunition is stowed in separate magazines of the type used for projectile smokeless powder. It is not classified as an explosive hazard, but rather as a fire hazard. High temperatures and dampness are detrimental to this ammunition. It should be stowed by lot number and type, with each pile placarded to show readily all pertinent information. Tracer ammunition should be segregated.

Inert components and nonexplosive details not assembled with ammunition should not be stowed in magazines with live ammunition or explosives. They should be stowed in packing boxes and placed on dunnage for protection from dampness.

Rocket components offer particular hazards in stowage. Rocket heads loaded with TNT, Composition B, or HBX are stowed in high explosive magazines. The rocket fuzes, however, are stowed in regular fuze magazines. The motor itself presents only a fire hazard and may be stowed with fixed ammunition. A limited number of assembled rockets and missiles may be stowed in ready-service lockers, at a point physically convenient to the aircraft arming area.

Pyrotechnics should not be stowed with other ammunition. They should be stowed in a dry, well-ventilated place out of the direct sunlight, and should be protected from excessive and variable temperatures. The distance requirements for pyrotechnics are the same as for smokeless powder.

Bomb type ammunition is usually regarded as the most hazardous type of ammunition because of its tendency to detonate "en masse" if exposed to fire or shrapnel which may enter the magazine where stowed. It has to be stored in a fireproof high explosive magazine on noncombustible dunnage. Arch type, earth-covered magazines have to be used to stow this type ammunition. The detonators for this type ammunition have to be stowed separately in standard detonator magazines.

Fuzes, tracers, primers, boosters, and detonators not assembled in ammunition should be stored in standard earth-covered detonator or fuze magazines.

ADVANCED BASE AMMUNITION HANDLING

It is only natural to suppose that in advanced areas there will not be the opportunity to afford ammunition proper stowage—stowage that is in accordance with doctrines established for ammunition depots and shore stations where permanent magazines are available. It is likewise reasonable to suppose that certain measures have to be taken to assure maximum protection to ammunition and personnel alike, even in advanced areas.

Certain elementary precautions must be observed in these areas in order to afford an adequate and dependable supply of ammunition. If possible, ammunition to be stowed in advanced areas at bases should at least have the protection of a cleared area. A firebreak 50 feet wide should surround the depot or dump. It is possible that this firebreak will have to be constructed prior to the arrival of the ammunition due to the fact that it may have to be burned off for lack of proper tools for clearing purposes.

There are other factors involved. It may be highly undesirable to clear vegetation around such a dump because it would spoil the natural camouflage. Smoke resulting from burning in a firebreak might disclose an otherwise well-hidden position. Those in charge will have to meet the demands of the area and the urgency of the situation with a great deal of commonsense and a basic understanding of the potential dangers inherent in ammunition.

COVER AND PROTECTION

When selecting stowage facilities in advanced areas, it is important to take every possible advantage of natural cover for the protection of ammunition from the elements. In so doing, the extreme need for artificial cover is thereby lessened considerably. Ammunition necessarily stowed in the open requires certain precautions be taken in order to insure that it will perform satisfactorily at some subsequent date. It should be raised on dunnage at least 6 inches off the ground and the pile covered with tarpaulin of double thickness. For ventilation an air space should be provided for between the tarpaulin and the ammunition.

Lacking sufficient tarpaulins to completely cover the ammunition to be stowed, use should be made of vegetation, broken packing cases, burlap bags, or any other materials which may serve the purpose of keeping the direct rays of the sun off and affording as much protection from rain as possible. Suitable trenches should be dug around each stack. This will serve to prevent runoff rainwater from seeping underneath the dunnage. The nearest thing approximating a magazine for advance base stowage of ammunition is a revetment or earth barricade. This device not only serves as a firebreak, but also as a shield against shrapnel from enemy bombs and, in case of explosion of the dump itself, serves to deflect and absorb shrapnel which might otherwise set off a nearby dump.

In subtropical and tropical areas it may be impossible to maintain temperatures of the ammunition below the normal limits required. In this event it is imperative to make frequent inspections of the ammunition. Inspecting personnel should carefully test for excessive ether-alcohol fumes from smokeless powder tanks, look for TNT exudate on bombs and mines, and note any deterioration of pyrotechnic materials.

SEPARATE STOWAGE

So far as possible, various ammunitions should be stowed separately. Further, sufficient distance should be left between adjacent piles of different types to prevent danger to one pile from destruction of another. There should always be sufficient space between stacks to provide walkways during inspections.

At advanced bases it is highly desirable to stow various calibers and types of ammunition together. However, the entire supply of each type or caliber should never be placed in the same stowage position for obvious reasons. The different types should be distributed between various stowages in such a manner that in no case will the entire supply of any one type or caliber be exposed in the event of fire or other hazard. Therefore, none of these, or any other instructions relative to segregation of ammunition, are to be so interpreted as to exclude the necessary dispersion of ammunition. They are held applicable to individual stacks in any one magazine or any one of several stowage areas existing at any one activity, not the entire supply at such activity.

BOMB TYPE AMMUNITION

Adequate stowage facilities are not available at most advance bases for bomb type ammunition, as well as other types. It will nevertheless have to be stockpiled because of its importance to military operations. Since this is the case, it is necessary to observe certain precautions relative to exposed storage. At permanent stowage facilities, forklike trucks, cranes, and other related handling equipment make easy work of moving and stacking ammunition. At advance bases, handling equipment is usually scarce. Most likely bombs will have to be moved about or stacked manually. The bombs that are stacked by hand will normally be 500 pounders or under. Heavier stores will have to be rolled into position in lines leaving enough space between rows in which to walk and work.

It is possible to store general-purpose, fragmentation, semi-armor-piercing, demolition, and depth bombs in the open, unprotected from the elements, for short periods of time without major impairment of their operational efficiency. The inventory of ammunition at an advance base may include various stores containing batteries. This type of ammunition cannot be exposed to the direct rays of the sun. It must be covered with anything available to keep the items shaded. It is also imperative to protect from the sun's rays all incendiary bomb clusters in containers.

Time should be taken during inspection of bomb ammunition at advance bases to tighten all caps, plugs, and other attachments found to be loose. This especially applies to fuze cavities in the bombs. A coating of grease should be placed at the junction of the fuze-hole plug and the bomb body after tightening the plug to keep out moisture. Ammunition received at advanced bases will quite often be found with loose fuze-hole plugs; even missing in some instances. Every effort should be made to procure and install these plugs where missing. If this is impossible, wooden plugs should be cut to fit and installed until standard plugs are obtained. All threaded sections of the bombs should be coated with grease. Nose and tail fuzes and suspension lugs will screw in smoothly if grease is used to protect threads from corrosion. Bomb fuzes and boosters must not be allowed to become adrift and abused. This may render them unreliable and unsafe, creating an explosive hazard in the area. With the nonstandard stowage methods to be found at advanced bases, it may be expected that ammunition components may more easily become adrift than at permanent magazines. Consequently, a closer watch should be maintained to guard against such possibilities.

Stowage of bombs in the open necessitates that they be piled or lined up horizontally on level dunnage to prevent their falling or rolling and striking others nearby. They should never be stood on end or leaned against any form of support. Storing bombs on ground areas requires that they be supported by relatively thick dunnage to form an adequate airspace between them and the ground. Logs may be split and used for dunnage. Where the ground is soft, it may be wise to use the whole log (not split) to minimize settling of the dunnage. Bombs of different types held in reserve should be stowed in separate revetments or dumps if at all possible. Completely assembled bombs should never be stowed with unassembled bombs. However, it is a good idea to stow crated tail vanes for any stock of bombs with the bomb bodies. This will facilitate supply of both items.

Shipping bands (lug guards) should not be removed from the bomb bodies until just prior to assembly and/or use. Bombs returned unused from missions, or those assembled and not used, may be left assembled, but they must be defuzed. These should then be stowed one layer deep on dunnage, with tails alternately pointing in opposite directions, near the aircraft loading area. Tail vanes, due to their sheet metal construction, are more susceptible to damage than bombs themselves. Therefore, it is best to leave them in their crates until they are needed.

ROCKET TYPE AMMUNITION

Most aircraft rocket type ammunition (rockets and missiles) is shipped disassembled. Warheads, motors, guidance systems, and fuzes are shipped separately. One fundamental rule in rocket and missile handling and stowing is that they should never be fully assembled except just prior to issue for use. Their components are placed in segregated stowage and, as far as practicable, separate from other types of ammunition. At advanced bases where space may be limited, it is permissible to stow rockets and missile motors with smokeless powder charges, the warheads with projectiles, and the fuzes with bomb type fuzes. In this event, all other safety precautions must be observed and care is to be exercised in issuing these components. Rocket fuzes are issued in metal containers and the same precautions should be observed as with bomb fuzes.

Rocket and missile motors require special handling not afforded any other type of ammunition. They might even be called delicate and sensitive in the extreme. Ignition of their propellent charge, or grain, is accomplished by an electrical impulse transmitted through wires to their igniters through the surface of the motor. Corrosion cannot be allowed to build up on these surfaces. In cleaning off any corrosion, sandpaper (fine) may be used, but not wire brushes or emery cloth. The last two items might possibly cause production of sufficient static electricity to set off the black powder igniter squib. Rigid precautions have to be taken to insure that rocket and missile motors are not stowed or allowed to be passed near such energy producing components of electronic gear as antenna lead-in wires, high voltage electric circuits, and radar magnetrons. These components may cause the motors to ignite through radiated electrical energy.

Contact surfaces and threaded sections of rocket components should be preserved with a light coating of mineral grease to prevent corrosion, especially while stowed at advance bases. Any component that has been corroded, damaged, or dropped forcibly enough to possibly break the propellent grain should be set aside and not used. The motors are highly sensitive to moisture. As a result, they should at all times be stowed under cover upon suitable dunnage.

Stowing a completely assembled rocket or missile unless designated to be so stowed is the same as stowing a loaded gun. As a consequence, they are normally never assembled into complete rounds until immediately before use unless the tactical situation dictates otherwise. When assembled, complete rounds should be stowed only in ready service lockers or in revetments, behind shields and barricades, and other equally safe locations. Unassembled motors are chiefly fire hazards due to the relatively unconfined condition of the propellent grain. They would be classified as smokeless powder rather than explosives.

Missiles and rockets may not be fired if the propellent temperature is below or above the temperature limits stenciled on the motor. In temperatuve extremes, the motors will have to be stowed in proper locations for 6 or more hours for the propellent temperatures to stabilize within these two figures. A temperature insensitive motor propellent is now replacing present inventories and should simplify the handling and stowage problems connected with missiles and rockets.

SAFETY PRECAUTIONS

In the handling and stowing of all types of ammunition, a need for rigid adherence to all safety precautions is mandatory. Although safety precautions have been written on almost every apparent situation dealing with all types of explosives, ammunition, and handling equipment, the Aviations Weapons Officer will undoubtedly be faced with new and unwritten experiences each time ammunition is handled or stowed.

One of the first general precautions to be remembered is that when there is the slightest doubt as to the exact meaning of a particular safety precaution, an interpretation should be requested from BuWeps. The method of communicating with the Bureau is determined by the seriousness of the situation. If unsafe conditions or unusual situations are encountered, for which no safety precautions are written, the commanding officer will find nothing in any of the safety precautions or regulations which may be construed as authority to continue operation under the existing situation. He must either cease operations entirely, or hold further operations in abeyance until advice can be received from BuWeps.

Safety devices provided for handling and stowage of ammunition are to be used consistently without fail. These devices must be kept in good order and operative at all times. They are there for the protection of all hands. Further, all operating instructions for such equipment must be diligently followed.

Changes, modifications in, or additions to ordnance material are not made without explicit authority from the bureau or bureaus concerned. No ammunition or explosive assembly will be used in any gun or device for which it is not designated.

Familiarity with any line of work, no matter how dangerous, is apt to lead to carelessness. Personnel supervising or performing work in connection with the inspection, care, preparation, use, or handling of ammunition and explosives must exercise the utmost care that all regulations and instructions are rigidly observed. Inexperienced personnel require close supervision and should be frequently warned of the necessity of using the ultimate precaution in the performance of their work. No relaxation of vigilance should be permitted.

All ammunition, explosives, and powder should be protected from abnormally high temperatures. If so exposed to abnormal temperatures they must be handled in strict accordance with the latest BuWeps Instructions. The Bureau prescribes the maximum allowable storage temperatures for all types of ammunition.

Smokeless powder which has been wet from any cause whatever must be considered dangerous and is handled as prescribed by BuWeps. Also, smokeless powder which shows unmistakable signs of advanced decomposition is disposed of according to current instructions.

In order to minimize the dangers of fire, explosion, and damage to ammunition and its containers from accidental causes, ammunition is handled as little as possible. Denting of thin-cased high explosives has caused detonation of the explosive in some instances.

Any fuzed projectile dropped from a height of 5 feet or over must be returned, if practical, to the nearest naval ammunition depot. If not, it should be dumped overboard as prescribed in current instructions.

Magazines must be kept scrupulously clean and dry at all times. Explosives, containers, and authorized magazine equipment only should be stowed in magazines. The removal and/or disposal of oily rags, waste, or other foreign materials susceptible to spontaneous combustion in magazines is mandatory.

Naked lights, matches, or any other spark or flame-producing device must never be taken into magazines or other spaces used primarily as magazines as long as the spaces therein contain explosives. Before performing any work which might cause either an abnormally high temperature or intense local heating in a magazine, all ammunition must be removed to safe storage until normal conditions have been restored.

Black powder is one of the most dangerous of explosives and must be kept by itself. Only such quantities as are immediately needed should be broken out of the magazine. A container of black powder should never be opened in any magazine, nor in the vicinity of a container in which there is any explosive.

Ammunition must not be altered, nor should fuzes or any other parts be disassembled without explicit instructions from BuWeps.

Ammunition must be handled under the direct supervision of qualified personnel who understand thoroughly the hazards and risks involved. Personnel handling ammunition must be impressed with the fact that their safety, as well as that of others, depends upon the intelligence and care exercised by themselves and their shipmates.

The handling of ammunition should always be conducted so that a limited number of personnel are involved—the smallest number compatible with the work to be accomplished.

Charges of static electricity can be accumulated on a person and on explosive materials such as smokeless powder. The discharge of static electricity is a serious hazard in the presence of certain exposed explosives, dust and air mixtures, and flammable vapor and air mixtures. Processing equipment for such materials subject to static discharge should always be grounded.

Workbenches should be covered with electrically grounded conductive materials as should be the decks wherever possible. Safety shoes which will not cause sparks should be issued to all personnel performing certain types of ammunition overhaul and maintenance work. Cushioned metal chairs may generate static electricity under certain atmospheric conditions; they should not be used around ammunition and explosives.

Drivers, both Navy and civilian, engaged in the operation of Navy vehicles carrying explosives must understand that, during the time they are operating such vehicles, they bear responsibility and personal liability as agent of the Navy for any damages resulting from their negligence. This applies both to their driving and improper operation of their vehicles.

The driver is required to carry with him, while driving, his medical certificate (or photostat of same), and is responsible for keeping his certificate current by submitting to reexamination at specified intervals appropriate to his age group. It is the duty of the driver of a truck loaded with dangerous cargo to be certain that proper dangerous cargo placards have been affixed to his vehicle in the specified locations prior to his departure for an off-station trip.

Carbon tetrachloride must not be used for cleaning purposes except by express authorization by the commanding officer or executive officer. The fumes are highly toxic even in moderate concentrations. Carbon tetrachloride is frequently the cause of skin troubles if used in excess. When heated above a specific temperature, phosgene gas is formed as a byproduct. This is the same poisonous gas that was used in World War I.

PUBLICATIONS CONTAINING SAFETY PRECAUTIONS

It would not be practicable to mention all of the safety precautions connected with the stowage and handling of ammunition in this chapter. It would require too much space. However, all safety precautions are important because most of them were written as the result of some damaging or fatal incident. No safety precaution should be overlooked or slighted. With this in mind, the latest revision of the following publications, or sections thereof pertinent to the work being conducted, should be studied prior to commencement of the actual work.

1. OP 4 Ammunition Ashore Handling, Stowing, and Shipping.
2. OP 5 Ammunition Afloat.
3. OP 1014 Ordnance Safety Precautions.
4. OP 2173 Handling Equipment for Ammunition and Explosives.
5. OP 2210 Aircraft Rockets (rocket safety precautions).
6. OP 2216 Aircraft Bombs, Fuzes, and Associated Components (bomb and fuze safety precautions).

NOTE: Publications dealing with guided missile safety precautions are listed in chapter 19 of this text.

The above list of publications is not to be construed as an all conclusive list of published safety precautions. The Aviation Weapons Officer must constantly be on the alert to acquire and maintain as complete a file as possible and to obtain current directives that alter any procedures or safety precautions listed in the basic publications.

CHAPTER 18

AERIAL TARGETS AND ASSOCIATED EQUIPMENT

Aerial targets and their associated equipment are used in naval aviation in gunnery, rocketry, and missile practice by ships and shore installations, and in air-to-air firing exercises. Firing at targets that simulate moving aircraft improves battle efficiency of the Navy and is a valuable aid in evaluating armament control/ weapons systems under development for operational use by the fleet.

TRAINING TECHNIQUES

Various training techniques are currently used by the Navy in the training of pilots in firing weapons and launching missiles. Previously, synthetic training devices provided practice in elementary gunnery training for both the pilot and gunner. However, at the present time there are no current synthetic training devices available for the ground training of pilots in the firing of air-launched missiles. A device that simulates the firing of the Bullpup is currently under evaluation for the Navy.

The responsibility for securing any device that will aid pilots either as a refresher or as indoctrination, rests with the Aviation Weapons Officer. The U. S. Naval Training Device Center can furnish, through appropriate channels, the necessary devices for any needed training.

Aerial targets are classified as towed targets and powered targets. This chapter discusses primarily towed targets and their associated equipment. However, a brief coverage of powered targets currently used and now under development is included.

TOW TARGETS

There are two basic classes of tow targets—textile tow targets and rigid tow targets. Textile tow targets are flexible targets woven from a synthetic fiber, such as rayon, nylon, or polyethylene. Metallic film or metal ribbon materials are added to the basic target fabrics for radar reflectivity. There are two major types of textile tow targets: Banner targets and sleeve targets, both of which are always radar reflective.

Rigid tow targets are made of a rigid material such as plywood or metal. They are shaped and constructed so that they will offer little drag and withstand severe airloads when towed at high speed. There are two major types of rigid targets: Solid shapes, which are streamlined in construction and normally fin stabilized; and plane shapes, which normally consist of thin wings or fins intersecting without a fuselage section. All rigid targets provide an auxiliary aid for the radar fire control system in the attacking aircraft.

BANNER TARGETS

Banner targets are large slow-speed textile targets used chiefly in air-to-air gunnery. (See fig. 18-1.) A banner target is a rectangular fabric panel which may vary in size from 6 feet by 30 feet, to 7 1/2 feet by 40 feet. A steel tow bar, located on one of the short sides, and a safety webbing which extends from the tow bar to a shackle, "U" bolt, or eye, provides the necessary means for attaching the towline.

A safety webbing is in essence a 100-foot bridle consisting of three or more strong nylon straps. It prevents gunfire that falls forward of the target from parting the towline and setting the target adrift and becoming a menace to the firing aircraft. Each strap of the safety webbing is capable of holding the target. Thus each strap would have to be cut by gunfire before the target could be set adrift.

Banner targets have two disadvantages. One is the high turbulence created by its tail whipping violently during flight. This whipping action

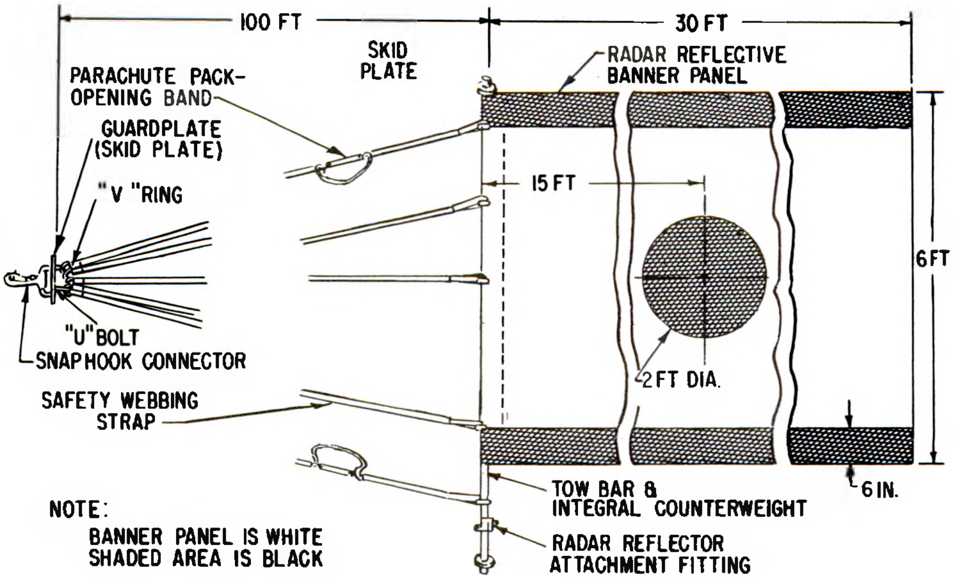


Figure 18-1.—Aero 26C aerial banner target.

increases with speed, causing the target to rip or disintegrate if towed too fast. The second disadvantage is that the banner is not realistic in shape or size.

These disadvantages become advantages for some types of training. Since banner targets are large, are towed at slower speed than that of the attacking aircraft, and maintain their position in flight, a pilot who is learning to use a new fire control system can hit a banner target when he would probably miss a high-performance type. Thus, his performance can be measured, because an examination of the target after the towing flight will show both the number of hits and the approximate angle from which they are made. In addition, the cost of banner targets is only a fraction of the cost of some high-performance targets.

Banner targets currently used by the Navy are the Aero 26C and the Aero 35B. The Aero 26C (fig. 18-1) is a radar-reflective vertical tow target used exclusively in air-to-air gunnery exercises with radar fire control systems. It consists of banner panel, tow bar with integral counterweight, and safety webbing. The banner panel is a rectangle, 30 feet long and 6 feet wide, consisting of nylon leno interwoven with aluminum foil and polyethylene. The aluminum foil makes it possible to track the target by radar. A radar reflector, with swivel, can be attached to the tow bar for improved radar reflectivity in the aft 30° cone of the target.

Aerial Banner Aero 26C may be launched from a runway by using the drag takeoff launching techniques.

The Aerial Banner Target Aero 35B is also a radar-reflective tow target used exclusively in air-to-air gunnery. Its construction is similar to the Aero 26C. However, it is larger with a banner panel 40 feet long and 7 1/2 feet wide.

SLEEVE TARGETS

Sleeve targets are radar-reflective textile targets used in surface-to-air gunnery exercises. (See fig. 18-2.) The sleeve is about 15 inches in diameter at the throat, 30 inches at the trailing end, and normally about 20 feet long. When towed, the sleeve target has the shape of an elongated cone with the apex removed. A bridle is attached to the smaller end, or throat of the sleeve, and the towline is attached to the bridle. Sleeve type targets are made of red, black, or white rayon.

Wire-bearing cloth panels are sewed inside the sleeve targets to make them radar reflective. Sleeve targets are also equipped with flotation pads, which cause them to float if dropped at sea, thus making them recoverable. The sleeve targets may also be equipped with lights (battery-powered) for night towing and firing exercises.

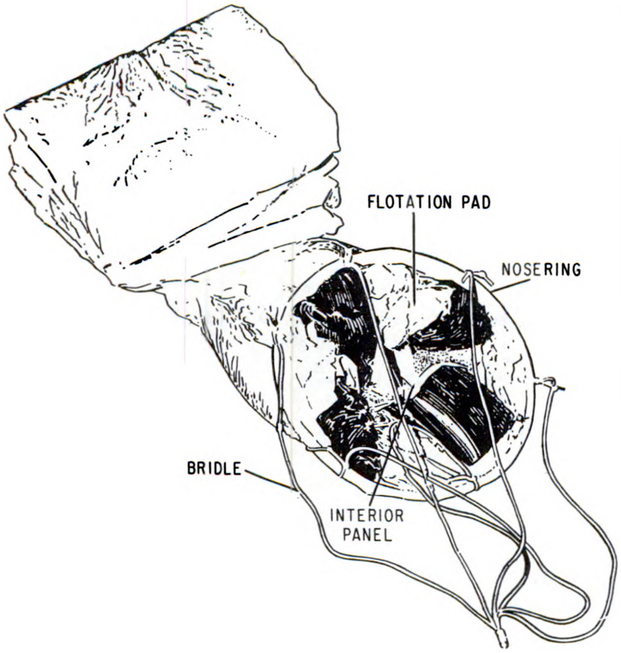


Figure 18-2.—Sleeve target.

When the sleeve is inflated in flight, it assumes an aerodynamic shape that enables it to be towed at airspeeds up to about 260 knots. Sleeve targets are less suited for air-to-air gunnery than a banner target for two reasons: They tend to disintegrate when penetrated by gunfire, and to rotate about their long axis in flight. For these reasons, examination of the target after the firing exercise often fails to show the number of hits or the angle of approach of the firing aircraft when a hit was scored.

In surface-to-air gunnery with heavier guns (40-millimeter and above), a burst near the target destroys it. Hits—that is, a burst near enough to be effective—can thus be scored by the number of targets destroyed.

Sleeve targets can be launched and exchanged in the air from a reel-equipped aircraft, or they can be launched from the ground by the air pickup or snap takeoff method. They cannot be launched by the drag takeoff method, because they are likely to tear when dragged over the ground.

RIGID TOW TARGETS

Rigid targets are designed to simulate high-speed aircraft in speed and maneuverability. They can be towed by jet aircraft at speeds within the attacking range of jet fighters. Rigid targets present less area at which to shoot than banner targets, but normally somewhat more than sleeve targets.

Plane Shapes

Rigid targets of the plane shape type consist of thin wings or fins intersecting without a fuselage section. The large fins provide stability in high-speed flight and surfaces for scoring projectile hits. The low drag of this type target minimizes the danger of collision with the attacking aircraft if the towline is severed.

The plane shaped targets currently used by the Navy are the Aero 40 and Aero 40A dart (fig. 18-3). They are constructed of sheet aluminum and employ a honeycomb-like material between the layers of the aluminum for increased strength and rigidity. A kit is also supplied to make repairs when direct hits are made on the target.

The target may be launched by using the snatch pickup technique or may be air launched from the Aero 44 reel-launcher. The Aero 44 provides a means of launching the target, but the target and tow cable is cut free to be parachuted to the ground prior to landing.

Solid Shapes

Rigid targets of the solid shape type consist of a streamlined body or fuselage which is stabilized by small wings or fins. The target may or may not be designed to rotate in flight. Because of their small size as compared to the plane shape type of rigid target, scoring of hits is not possible unless an auxiliary scoring system is included in the target or attacking aircraft. Although destruction of the target is possible, it is not required to obtain a firing score.

RADOP WEAPONS TRAINING SYSTEM

The RADOP weapons training system is the outgrowth of the need for a realistic radar target for rocket and missile firing practice involving high-speed, high-performance jet aircraft. It consists of a rigid type aerial tow target (radar reflective), a tow reel, a launcher, a control box, and a scorer. With the exception of the scorer, which is carried on the attacking aircraft, the RADOP units are carried by the towing aircraft. The RADOP weapons training system is actually a combination radar system

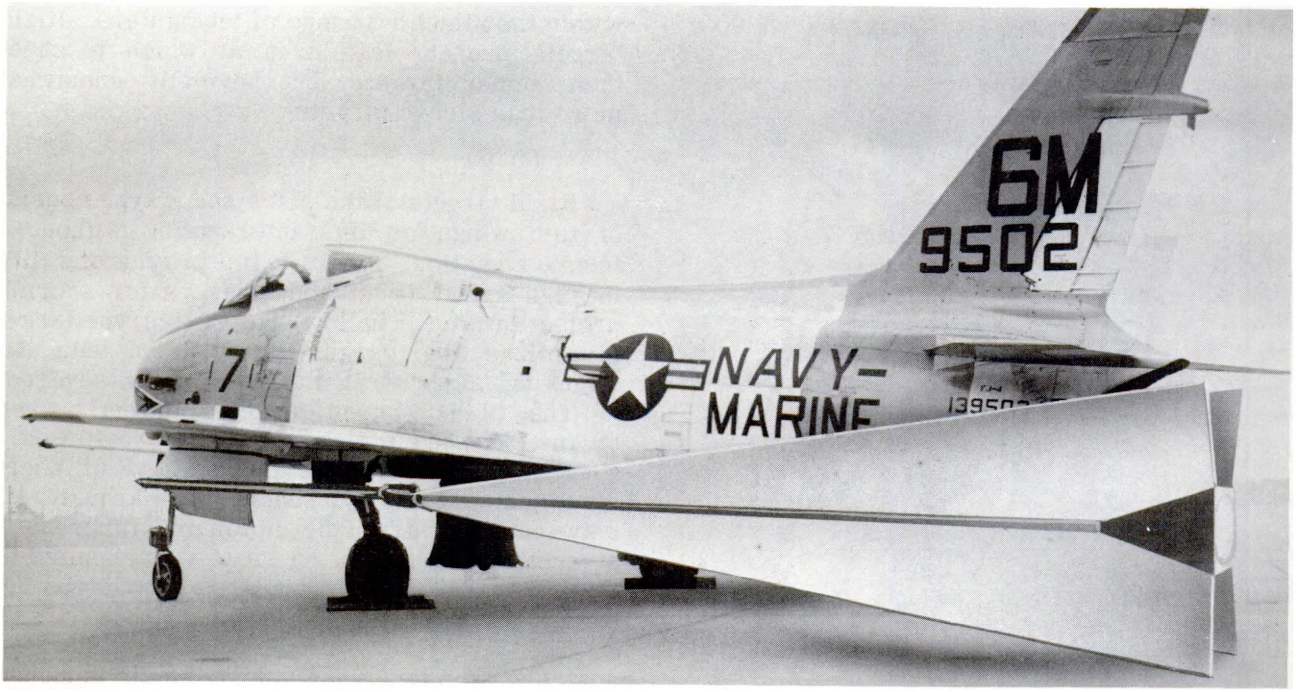


Figure 18-3.—Aero 40 dart target.

and an optical system, each used simultaneously to record the firing error when firing either rocket or guided missiles. The units of the system are discussed separately.

Targets

Targets currently used by the Navy in the RADOP weapons training system are the Aero 36, Aero 36A, Aero 42, Aero 42IR, and the TDU-21/B Supersonic Radar Reflective Aerial Tow Target.

The Aero 36 and Aero 36A are identical in outward appearance and differ only in the construction of the radar reflector. Essentially they consist of a cluster of eight corner reflectors mounted within a streamlined radar-transparent shell of styrofoam covered for towing at high speeds. The construction of the reflectors is illustrated in figure 18-4. Spin stabilization is accomplished by the trim of the four fins, the swivel point being at the nose of the target. The target weighs 17 pounds. The corner reflectors are positioned to provide maximum target return for a lead collision attack—the attack flightpath for an intercept mission employing rockets or missiles.

As with any radome, it is necessary to keep the surface of the target reasonably clean. Only paints approved for radome use are safe; since many types will introduce considerable attenuation to the radar signal. Thus, the effective range of the scorer would be reduced.

The Aero 42, which is similar in appearance to the Aero 36A, utilizes flares to attract infrared seeking missiles. It also contains a spherical radar reflector similar to the Aero 36A. The target is equipped to carry four infrared flares, each being housed in a flare holder located at the base of the fins and attached to the target shell. (See fig. 18-5.)

The target contains a UHF receiver, located just aft of the forward reflector, which is powered by self-contained batteries. The flares may be ignited by a signal from a UHF transmitter located in either the attack or chase aircraft. (NOTE: Current naval jet aircraft are normally equipped with a UHF transmitter.)

The output of the receiver is fed to a stepping relay which fires the flares singly, in pairs, or in a four-flare salvo as preselected prior to the flight.

NOTE: Information on the flare may be found in NavWeps OP 2944.

Unlike the other targets, the Aero 42 must be checked and alined prior to use. A detailed

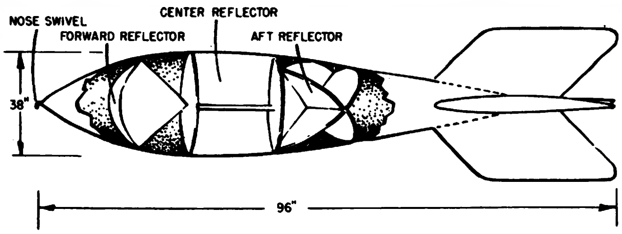


Figure 18-4. —Aero 36A tow target.

test procedure may be found in the Overhaul Instruction Manual with Parts Breakdown, Aero 42 Aerial Towed Target, NavAer 28-10A-7.

The Aero 42 IR Aerial Flare Tow Target Model DF-4MFC is similar in appearance and has the same capabilities as the Aero 42. The Aero 42 IR has an additional feature in that the target incorporates provisions and controls for a visual augmentation system. The Operation and Service Instruction Manual with Illustrated Parts Breakdown, NavWeps 28-10A-10, should be consulted for a detailed coverage of this target.

The TDU-21/B Supersonic Radar Reflective Aerial Tow Target is the newest of a long line of aerial tow targets.

This target is an expendable component of a system for air-to-air weapons training at both subsonic and supersonic air speeds. The components used in conjunction with the target are a tow reel, a pilot's control unit, towline, and a launcher equipped with a Del Mar Model DL-6 series launcher subassembly. These components provide the means of towing the target at distances of several miles and of launching and jettisoning or recovering the target by the tow aircraft.

The external configuration of the target is made up of a tubular aluminum probe nose bonded to the target body. The target body is made of bonded overlapping sections of internally reinforced molded fiberboard shell and four fins of Fiberglas-reinforced polyurethane foam. The fiberboard surfaces are treated to withstand normal storage and operating conditions.

The leading particulars of the TDU-21/B target are as follows:

Weight . . . . 26 lb (approx).
Length . . . . 121 in.
Diameter . . . . 15 in.
Fin span . . . . 24 in.

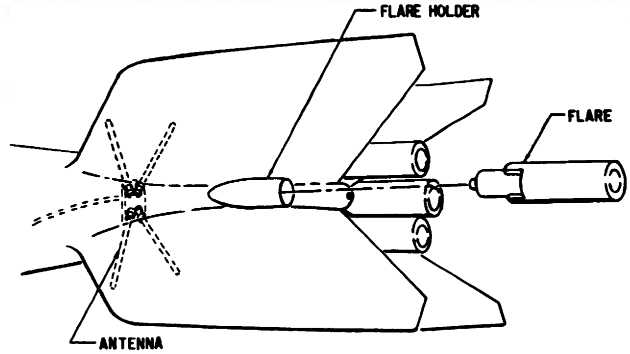


Figure 18-5. —Aero 42 tow target.

Flight rotation . . . 0.5 rpm (approx) per knot true airspeed up to 1.2 Mach, then constant beyond.
Radar reflective source . . . . . 3 passive reflectors with multiple corners.
Airspeed limitation . 630 knots equivalent airspeed.
Mach number limitation . . . . 1.5.

For detailed information on the TDU-21/B Supersonic Radar Reflective Aerial Tow Target, refer to the applicable Operation and Service Instruction Manual with Illustrated Parts Breakdown, NavWeps 11-55BA-2 (September 1963 or later revision).

The Aero 36 and Aero 42 type tow targets are carried and launched by an external launcher (Aero 38 series) mounted on the towing aircraft. This launcher is discussed in the following paragraphs.

Aero 38 Launcher

The Aero 38 series target launcher (fig. 18-6) is designed to function as a support for a target and to establish a means of release, inflight towing, and recovery of the target. The launcher consists of a steel boom and launcher frame bolted together to form a tubular unit. The launcher assembly is approximately 15 feet long and 4 inches in diameter with a 17-inch ring at the aft end for supporting the target in the stowed position. The boom is 11 feet long and comprises approximately three-fourths of the total length of the unit. The frame is the aft portion of the unit and consists of a 3-foot tubular extension of the boom, the support ring, and a spring-loaded receptacle, which receives the nose of the target in the stowed position. Two shackle plates on the forward end of the boom, together with a small elevated platform in the middle of the boom, establish

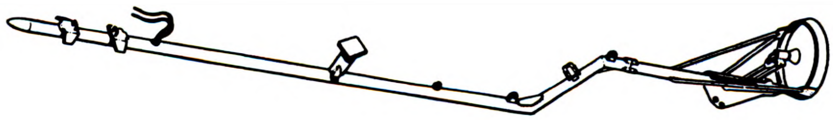


Figure 18-6.—Aero 38 target launcher.

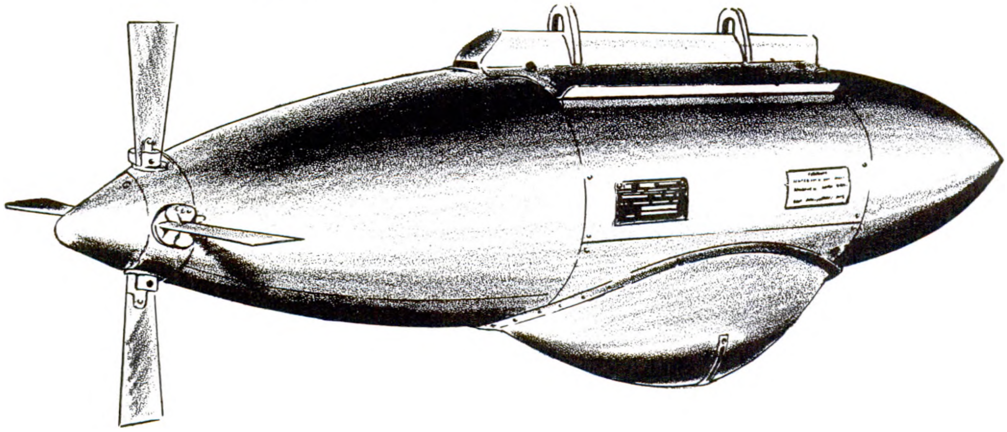


Figure 18-7.—Aero 43 tow reel.

the necessary mounting provisions for fastening the launcher to the aircraft wing.

The launcher provides for stowage, release, and recovery of the target without interference to, or from, the aircraft. Three pulleys near the aft end of the launcher serve to guide the towline from the tow reel through the cable cutter to the target receptacle assembly. The cable cutter is mounted on the angular bend in the boom and consists of a squib-operated cutter and an anvil. If it is desired to jettison the target, the squib in the cutter assembly is detonated when the cable cutter switch on the pilot's control unit is actuated. The receptacle assembly is suspended in an elevated position on two pivoted arms so that it can move forward and backward on the centerline vertical plane of the launcher. The forward end of the receptacle assembly contains a pulley which guides the towline through the receptacle assembly to the nose of the target. A tension spring within the launcher frame is connected to the pivoted arms by means of a wire cable so as to apply a continual spring load to the receptacle assembly. This spring loading on the receptacle assembly is used to absorb the impact against the receptacle assembly which is created at the time the target enters the support ring during recovery. It also maintains cable tension in the stowed position and throws the target clear of the aircraft turbulence at the moment of launching.

The reeling in or reeling out of the tow cable automatically governs the operation of the spring-loaded receptacle which is the only moving part on the launcher. The operation of the tow cable cutter assembly is the only function of the launcher that is controlled by the pilot's control unit.

NOTE: The cutting of the tow cable is an emergency procedure performed only when the target is damaged beyond reuse or when a malfunction of the towreel prevents the recovery of the target after it has been reeled out.

Two inspection periods are required on the launcher—the preflight and postflight. An additional 60-hour inspection of the launcher is recommended, but not required. This 60-hour inspection should be performed at the same time the 60-hour inspection of the tow reel is performed.

The preflight and postflight inspections consist of checking the security of the launcher to the aircraft, free movement of pulleys, tightness of bolts and nuts, lubrication of pulleys if necessary, condition of spring and connecting cable in frame, and testing the firing circuit of the cable cutter squib.

Although only one model of the Aero 38 series target launcher is discussed in this

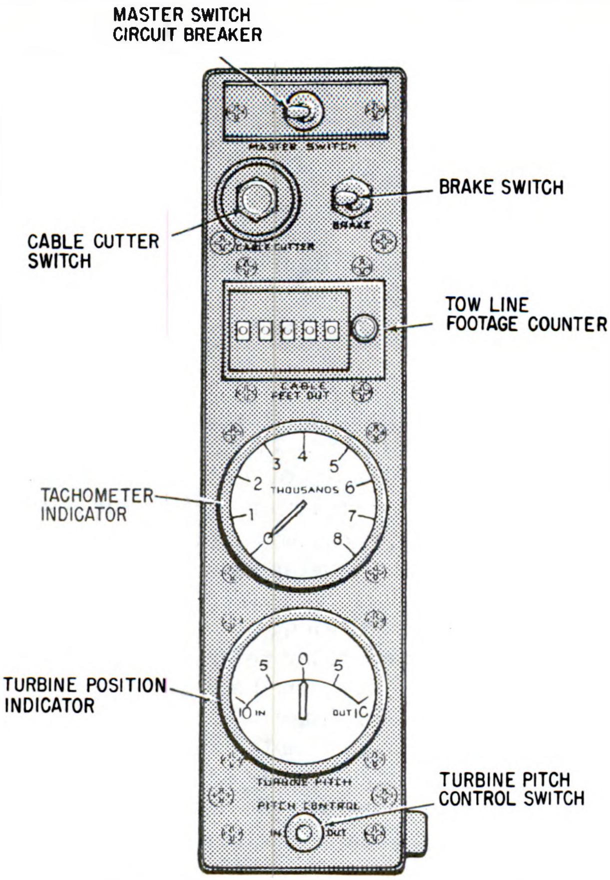


Figure 18-8.—Aero 43 operating controls.

text, the Aviation Weapons Officer will undoubtedly encounter other models in different types of operational squadrons. However, all models of the Aero 38 target launcher are basically the same. Complete coverage of the various models of the Aero 38 target launcher can be found in the Operation, Service, and Overhaul Instruction Manual with Illustrated Parts Breakdown, NavWeps 28-10A-3.

Aero 43 Tow Reel

The Aero 43 tow reel (fig. 18-7) is a component of the RADOP weapons training system. It is capable of extending and recovering 32,500 feet of tow cable. Power required to operate the reel is provided by the airstream acting against a four-blade variable-pitch turbine on the nose of the reel. The reel turbine is coupled to the reel drum through a planetary gearbox. Operations are electrically controlled at the control box within the aircraft pilot's compartment.

A discussion of the detailed mechanical mechanisms contained in the reel is beyond the scope of this chapter. This information may be found in the Operation, Service, and Overhaul Instruction Manual with Illustrated Parts Breakdown Aero 43 Tow Reel and Shackle Assembly, Model DX-4A, NavWeps 28-10A-9.

OPERATION.—In the reeled in position, the target is nested in the launcher basket, held against launcher spring compression by the tension of the towline. All slack in the towline is taken up by the reel drum, and the drum brake is engaged to prevent rotation of the drum and unreeling of the towline.

In order to launch the target, when airborne, the operator actuates the control box switches (fig. 18-8) to feather the tow reel turbine blades and to release the tow reel brake. The compressed launcher spring ejects the target from the launcher basket clear of the aircraft, and the target is pulled into the airstream, reeling out the towline. After the target is definitely clear of the launcher, the operator actuates the turbine pitch control switch to permit turbine blades to be spun by the airstream rather than the drag of the target, accelerating target reel out. At the required reel out distance as indicated on the control box towline footage counter, the operator may stop the target from further reel out by actuation of control box switches to reverse the turbine blade pitch until the reel drum stops, and then engage the tow reel drum brake and feather the turbine blades.

In order to recover the target, the operator returns the turbine blade pitch to the position required to stop target reel out during the launching procedure. Then the reel brake is released, and the turbine blade pitch changed to the reel in position and adjusted to obtain the desired reel in speed. As the target enters the launcher, entry impact is absorbed by the launcher spring. As the launcher spring compresses, tension on the towline increases which in turn slows the rate of rotation of the reel drum. When the target is nested in the launcher basket, the operator engages the tow reel brake and feathers the turbine blades.

The towline passes through a cable cutter which is provided as an integral part of the launcher to sever the towline and jettison the target if malfunction of the tow reel prevents recovery of the target, and to cut off the trailing end of the towline if the target is shot away. If cable cutting is necessitated, the operator feathers the turbine blades, engages the tow reel drum brake, and depresses the cable cutter switch button to energize and fire an explosive squib in the cable cutter. Detonation of the squib actuates a plunger which severs the towline.

MAINTENANCE.—Maintenance for the Aero 43 tow reel consists primarily of daily, periodic, and major inspections. However, any defects or malfunctions found during any inspection or operation will necessitate troubleshooting to locate the defective part or component. A troubleshooting chart is normally included in the manual for the particular equipment.

Aero 37 Tow Reel

The Aero 37 tow reel, which may still be used by some units of the Navy, has been replaced by the Aero 43 tow reel. Operation and maintenance information on the Aero 37 tow reel may be found in the Operation, Service, and Overhaul Instruction Manual with Illustrated Parts Breakdown Aero 37 Tow Reel, NavWeps 28-10A-2.

Aero 39 Scorer

The Aero 39 scorer (fig. 18-9) is a component of the RADOP weapons training system. The scorer, carried by the attacking aircraft, provides miss-distance information to permit scoring of interceptor aircraft firing runs against high-speed targets. The scorer can be used with missiles and standard or flash-head rockets. It is an externally stored training device, which provides a three-dimensional photographic record of the distances between the target and the weapons fired from the aircraft on which the scorer is mounted. The measurement of the miss distance, both direction and magnitude, is determined from the resulting motion-picture film of the attack situation, which is combined with a record of radar range data.

When the weapon is fired, a motion-picture photographic record is taken of the target and the weapon as it travels toward the target. At the same time, a radar subsystem within the scorer obtains range information on both the target and weapons, and the resulting display (an A-type presentation, range only) is also presented on the exposed motion-picture film. Thus, each frame of exposed film has a picture of the target and the weapons fired, and, on that same frame, is radar range data corresponding to the time at which the optical portion of that frame was taken. With this visual and radar range data on each frame of film, assessment can be made of the weapon firing mission. Procedure for assessing the firing run is covered later in this chapter.

DESCRIPTION OF EQUIPMENT.—The scorer is completely self-contained and requires only control (on and off signal from the fire control system) and operating voltages (28-volt d.c. and 115-volt 400 cps a.c.) from the aircraft on which installed. The complete scorer is contained in a streamlined housing (fig. 18-9), which consists of a spun aluminum shell, installed over cast aluminum structural members. The components of the scorer comprise two systems—the radar subsystem and the optical subsystem.

The RADAR SUBSYSTEM (fig. 18-10) is an X-band ranging type, operating at a frequency of 9,375 megacycles. Peak power output of 6,000 watts is developed by the transmitter magnetron. The pulse repetition frequency (PRF) is 2,000 pulses per second; pulse width is 0.15 microsecond. The developed pulses are radiated by a pyramidal horn type antenna. The antenna is directed forward along the longitudinal axis of the scorer. The radar returns from the target, and the weapons fired are received by the same antenna, then mixed, amplified, detected, and finally displayed on the cathode-ray tube (CRT) in an A-type display (range only). This radar presentation is photographed by the motion-picture camera in the scorer, and appears in the lower portion of each frame of exposed film.

The OPTICAL SUBSYSTEM (fig. 18-11) uses a 35mm motion-picture camera, which works into a dual lens system. This special lens system consists of a strike lens and an oscilloscope lens. The strike lens covers an 8-degree field of view ahead of the scorer (in the same direction in which the radar subsystem is directed); this strike lens views through the lens window in the bottom of the scorer. A reversed image is produced by the strike lens and a prism, and is directed to the focal plane of the motion-picture camera. The oscilloscope (CRT) presentation is directed to the focal plane of the motion-picture camera by double reflex mirrors. The oscilloscope presentation is magnified 1 1/2 times between the face of the cathode-ray tube and the motion-picture camera focal plane.

LOADING THE CAMERA.—The camera has a capacity of 100 feet of standard 35mm motion-picture film spooled for daylight loading. Film prepared for daylight loading should have about 6 feet of leader to protect the unexposed film from the light while threading the film, and

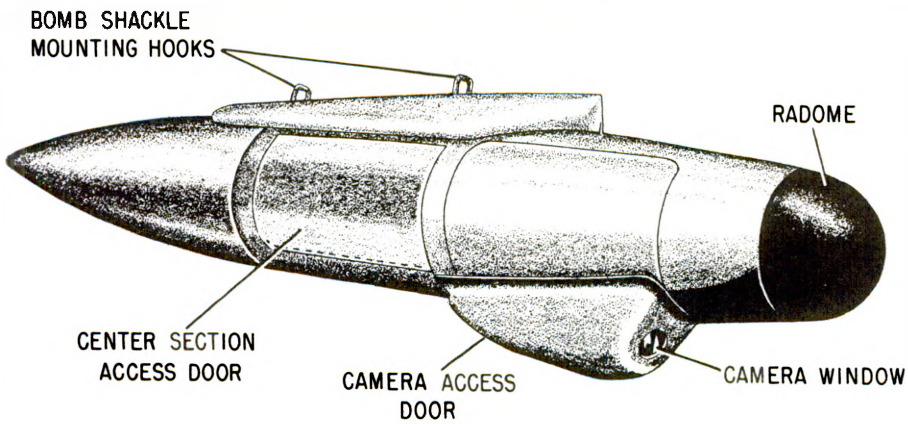


Figure 18-9.—Aero 39 scorer.

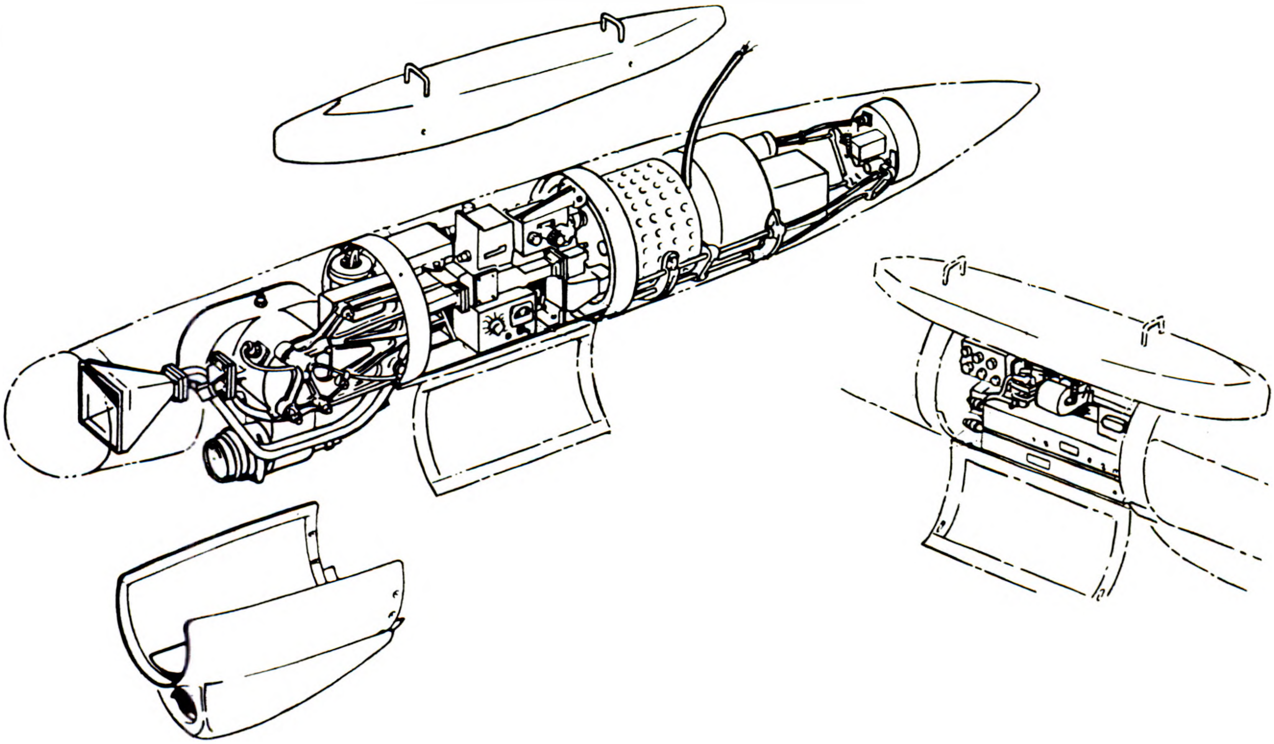


Figure 18-10.—Cutaway view, general arrangement, Aero 39 scorer.

about 6 feet of trailer to wrap around the film when the entire roll has been exposed. Although the film is termed daylight loading, do not load it in the glare of bright sunlight. This precaution will prevent any possible edge fog caused by light filtering in between spool flanges and the film roll.

The film is loaded as follows:

1. With the film gate in the open position (fig. 18-12), insert a full spool of film on the feed spool spindle located in the center of the aft spool cavity.

2. Unreel about 1 foot of leader.

3. Engage the leader perforations with the teeth of the aft sprocket, and rotate the spool in a counterclockwise direction to insure that the film is tightly wound.

4. Form a loop, extending from the aft sprocket to the aft end of the spring-loaded film channel backplate. NOTE: The aft film loop must show exactly 11 perforations when the film gate is closed.

5. Engage the leader perforations with the shuttle teeth projecting through the aperture

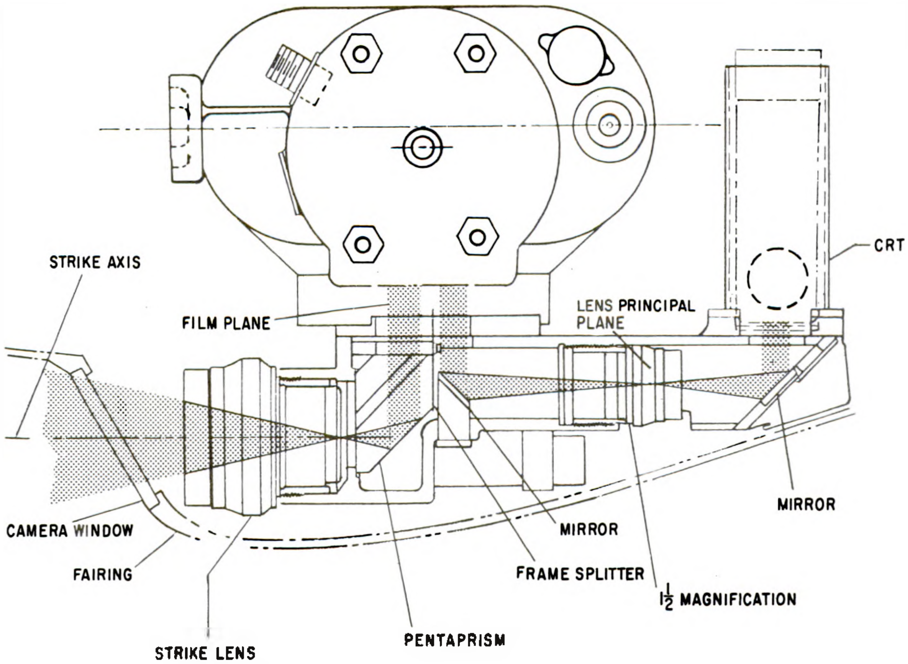


Figure 18-11.—Camera and optics, simplified cross section.

plate. NOTE: The forward film loop must show exactly nine perforations when the film gate is closed.

6. Close the film gate by pushing downward on the gate-arm knob. Be certain that the shuttle teeth properly engage the leader perforations. NOTE: This can be accomplished by gripping the film on each side of the film gate and move the film back and forth until the teeth engage.

7. Insert the end of the leader as far as it will go into the hub slot of the takeup spool, then wind one full turn of leader around the spool to prevent the leader from slipping out of the hub slot.

8. Place the spool on the takeup spindle located in the center forward spool cavity, and rotate it in a clockwise direction until all of the slack is wound on the spool hub. CAUTION: Make sure the film is seated on the spindle by turning the spindle with a screwdriver and pressing in on the spool. Failure to do this will cause the film to jam.

9. Press the CAMERA TEST switch momentarily to observe the behavior of the film, and to be sure that the loop sizes do not change when the camera is in operation.

10. Replace the loading door on the camera. NOTE: The loading locks will not engage unless the film gate is fully closed.

UNLOADING THE CAMERA.—After the return of the aircraft to the flight line or ordnance unloading area, the camera is unloaded as follows:

1. Open the camera access door.

2. With the aircraft d-c electrical system energized, hold the camera TEST switch in the ON position long enough to wind any unexposed film onto the takeup spool in the motion-picture camera.

3. Remove the takeup spool from the camera.

4. Place the takeup spool (which contains all the exposed and any remaining unexposed film) in a lighttight container.

5. Turn the film in for processing.

ASSESSING THE FIRING RUN.—With the use of a film readout unit or other similar device, scoring of the firing run is accomplished by selecting the frame of motion-picture film at which the target echo and weapons echo on the radar presentation are in coincidence.

Figure 18-13 is a sample of a typical strip of scorer film. Note that the range information appears as a horizontal trace at the bottom of each frame (A-type presentation). The target return appears at the right side of the CRT trace, and moves to the left (decreasing range).

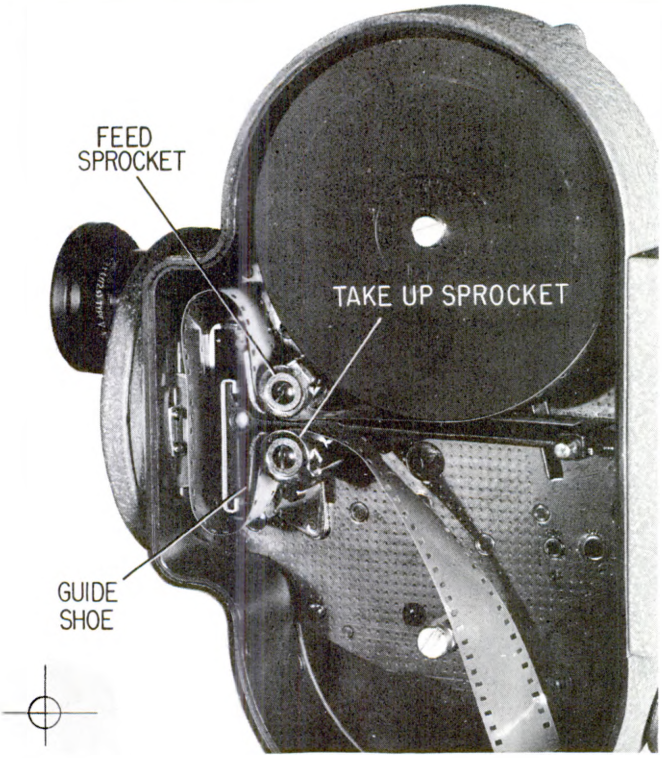


Figure 18-12.—Scorer camera.

The weapon return appears initially inside the transmitter pulse, and moves from left to right (increasing range). During the period of exposure of the film clip shown in figure 18-13, the aircraft-to-weapon range increases in a nearly linear rate, while the aircraft-to-target range decreases in a nearly linear rate. Therefore, if a straight line is extended along the leading edges of the weapon return pulses on each frame, and another straight line is extended along the leading edges of the target return pulses, the frame of film on which these lines intersect is the frame of coincidence (frame at which both the target and fired weapon are at the same range). With the frame of coincidence obtained, proceed as follows to determine the accuracy of the firing:

1. Divide the length of the target image into the length of a line drawn between the target and the weapon centroid.
2. Multiply the result obtained in step 1 by 8 feet (actual target length). The answer is the true miss distance, except that the image will be reversed on the film from right to left and left to right due to the action of the optical prism.

MAINTENANCE.—Maintenance of the scorer at the organizational level consists of minimum performance checks, inspections, trouble analysis, removal and replacement, and lubrication. These are discussed in the following paragraphs.

Minimum performance checks are those visual and measured indications at the various test points and at the meter box which indicate that the total equipment and the various components of the scorer are functioning properly. The minimum performance standards, listed in the scorer's Operation and Service Instruction Manual with Illustrated Parts Breakdown, NavWeps 28-10A-4, consist of adjustments to the CRT sweep, meter box indications, motion-picture camera operation, and a general test of the various scorer components. Failure of the equipment to meet all the requirements stated in the service manual does not necessarily mean inoperability of the equipment, but such indications do indicate a trend towards inoperability which must be corrected by replacement of the defective part or component.

The schedule recommended for testing the scorer, and the type of tests to be performed are listed in the equipment's manual. As the using organization accumulates experience with the scorer, these recommendations may be modified to meet necessary requirements or unusual conditions. Preventive maintenance consists of periodic inspections aimed at discovering conditions which, if not remedied, may lead to malfunctions requiring major repair, or aborted missions. Thus, inspections fall in two categories: (1) regular visual inspection of the mechanical parts of the equipment for dirt, corrosion, loose connections, mechanical defects, and other sources of trouble; and (2) the functional inspections, accomplished through bench tests.

The scorer has been designed for modular (standard measurement) servicing techniques. The meter box (fig. 18-14) provides means for checking each of these modules individually, with the meter indications being of the GO/NO-GO type. When NO-GO indications are obtained during the various checks, this will usually mean that the component being checked is malfunctioning and should be replaced. Based on this modular type service technique, the following scheme is to be followed when troubles are encountered in the equipment:

1. When a NO-GO indication is obtained at the meter box, first check that the related fuse in the fuse box is not blown; replace as necessary.

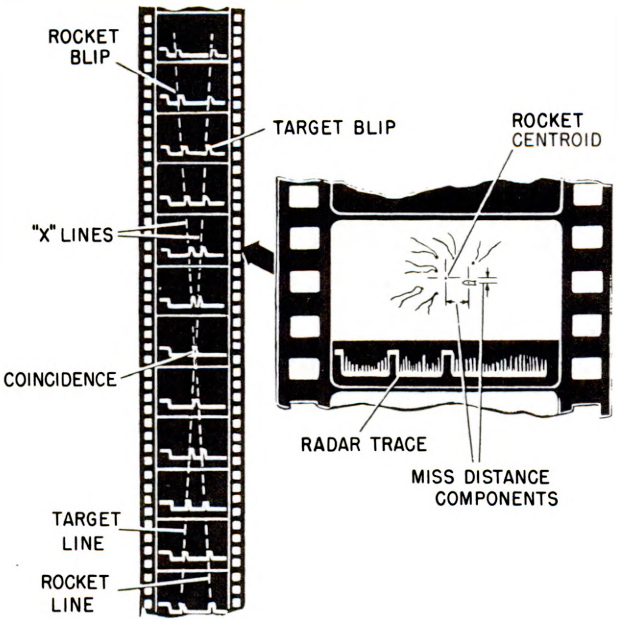


Figure 18-13.—Typical film run.

2. If the fuse is serviceable, check that all connections to the component and related components are tight and secure.

3. If everything is satisfactory up to this point, replace the component being checked (IF amplifier, AFC unit, modulator, etc.).

4. If replacing the component in step 3 does not repair the faulty condition, try replacing the meter box.

5. If replacing both the component and the meter box does not repair the faulty condition, replace the interconnecting cabling to the component under test.

6. If replacing the component, meter box, and cabling does not repair the malfunction, no further repair must be attempted; return the scorer to a depot for repair.

No special procedures are necessary for the removal and replacement of any of the components of the scorer. The Illustrated Parts Breakdown section of the Service Instruction Manual illustrates the details of attaching parts and locations of the various components of the scorer. The exploded views use a system of index numbering which indicates the normal order of disassembly or removal of any component. Normally, the various components are replaced as complete units and should not be further disassembled, but sent to a repair activity for maintenance.

The motion-picture camera is the only component of the scorer requiring lubrication. A lubrication kit is provided with the camera for this purpose. The kit contains the necessary lubricants for all eight lubricating points on the camera. Seven of these lubricating points are accessible when the film loading door is removed. The eighth is located in the camera head. Camera lubricants must be used sparingly. Lubrication is performed as follows:

1. One drop of oil is inserted in each sprocket shaft and cover plate hole (as marked on the camera) every time 10 reels of film have been exposed.

2. A small amount of camera grease is applied to the exposed teeth of the drive gear every time 100 reels of film have been exposed.

3. The black pin which caps the camera head lubricating point is pried out and two drops of oil are inserted after every five reels of exposed film.

INFLIGHT OPERATION.—Operation of the scorer in flight is completely automatic. No scorer power switch is provided and no adjustments or changes in setting are possible in flight. The radar subsystem is energized, and begins operation as soon as the aircraft's d-c and a-c electrical buses are energized. The motion-picture camera optical subsystem commences operation upon receipt of the firing pulse from the aircraft fire control system, and continues to operate for 3 seconds to cover the run of the fired

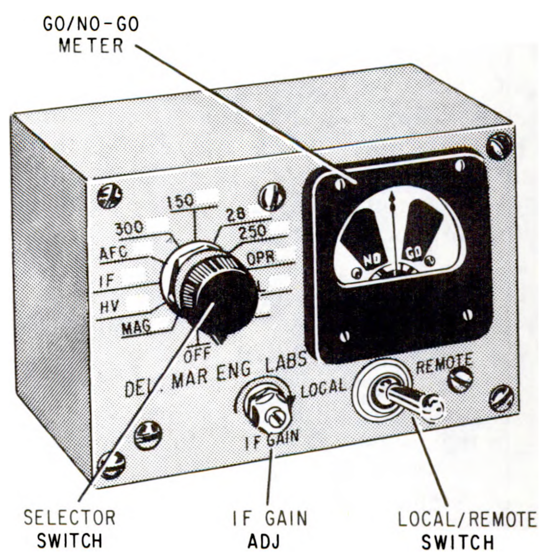


Figure 18-14.—Meter box.

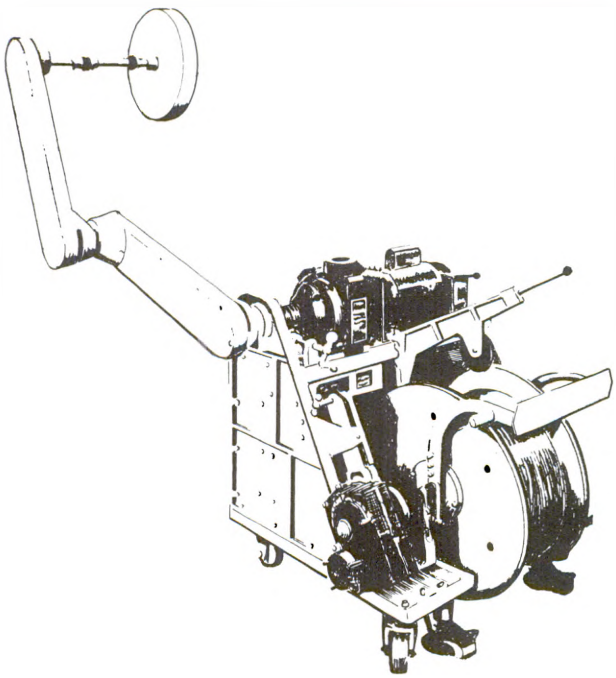


Figure 18-15.—DX-4PW Portable Wire Winder and Spool.

weapons at normal firing ranges. No modification of the accepted "lockon" steering procedures (flying with dot centered) is necessary.

GROUND REWIND EQUIPMENT

Numerous types of ground rewind equipment are used by naval activities. The type of equipment may vary in size and complexity from expensive huge rewind trucks and trailers to locally (or contract) manufactured inexpensive portable rewind units. (See fig. 18-15.) However, rewind units all have one main objective, to wind or unwind wire cable from a standard spool onto a tow reel mounted on an aircraft in a safe, efficient, and rapid manner.

ANTIAIRCRAFT TARGET REEL MK 8 MOD 0

The Antiaircraft Target Reel Mk 8 Mod 0 has been used for many years by utility squadrons in performing their assigned towing missions. This tow reel is normally mounted on slower speed prop type aircraft such as the A-1, and is used mainly for towing targets for antiaircraft exercises.

The Mk 8 Mod 0 reel (fig. 18-16) is a hydraulically driven unit designed to hold, reel in, store, and reel out a maximum of 12,000 feet of 1/8-inch diameter, 7 x 19 or 1 x 19 steel tow cable.

Antiaircraft Target Reel Mk 8 Mod 0 consists of a drum assembly mounted between two frames that are held in place by tie rods and spacer tubes. Other components of the reel are screens that enclose the front, top, and ends of the reel; the freewheeling assembly; and the level-wind assembly.

For detailed operation and maintenance information on the Antiaircraft Target Reel Mk 8 Mod 0, refer to Chapter 3, Section III of the Operation and Service Instruction Manual Aerial Targets and Associated Equipment, NavAer 28-10A-501.

SAFETY PRECAUTIONS

There are many safety precautions associated with the target towing service. The more pertinent ones are discussed in the following paragraphs.

It is essential that a tow reel operator and a safety towman be assigned to each towing aircraft having tow reels in a tow compartment. It is the duty of the safety towman to aid the tow reel operator, and to constantly check for incipient dangers while the tow reel operator is otherwise engaged.

Preservatives and lubricants may not be used on tow cables. High-speed reeling out generates heat caused by friction. This heat might generate explosive vapors from the lubricants in the tow compartment.

A cable should be uncoiled by standing the coil on its edge, holding the end, and unrolling the coil. Do not attempt to take cable from either a coil or roll by pulling the cable when the coil or roll is lying flat. The cable will snarl and kink.

When cutting nylon towline, the ends have to be bound or heat applied to the cut ends to melt the nylon to prevent raveling.

Safety tow webbing must be used between the target and the end of the towline. This webbing will prevent many of the fatal accidents caused by the pilot shooting off the towline and becoming entangled in the target. Multistrand safety webbings (100 feet long) will be supplied for use with banner targets.

The snarl catcher must not be used during air-to-air gunnery exercises. It may clamp on

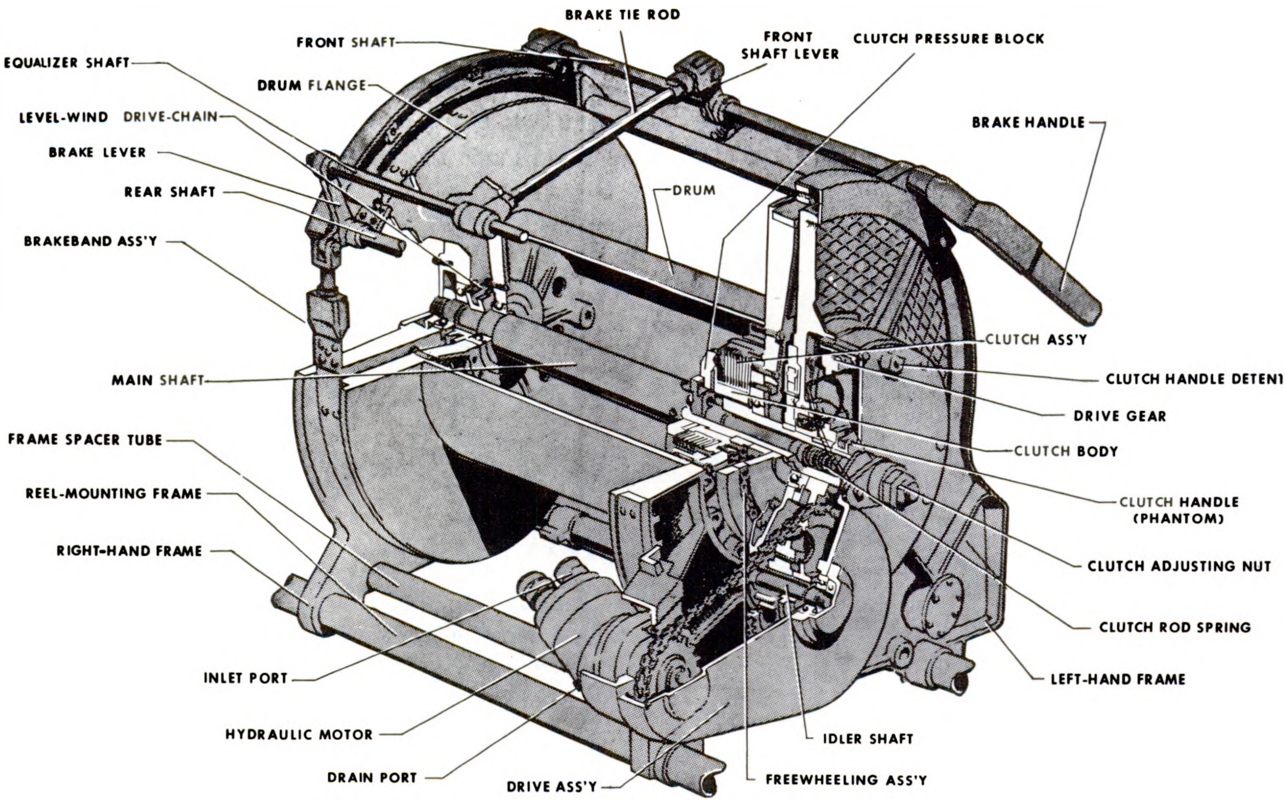


Figure 18-16.—Cutaway view of Antiaircraft Target Reel Mk 8 Mod 0.

the towline before it reaches the end of the cable. This means that there will be a long free section of the cable whipping about behind the target.

All personnel involved in target towing operations must know the standard hand signals for controlling aircraft on the ground.

Perform a preflight inspection of all tow equipment.

Keep wirecutters ready for instant use while towing.

Stand by tow reel brake while reeling out and reeling in.

Make sure you are clear of the cable when launching a target.

There are many do's and don'ts for the pilot, tow reel operator, safety towman, ground crew, and others involved in target towing missions. They are all common-sense items, and have been prepared as a result of bitter experiences. They must be learned thoroughly by all concerned. Each squadron or unit conducting towing operations has its own set of safety precautions and regulations, and its own set of tricks of the trade which, if observed, will greatly reduce the hazards of towing and insure smooth operation of the mission. The Aviation Weapons Officer should be thoroughly familiar with all facets of safety involved in towing. One of his primary duties will be to insure that all safety precautions are observed by personnel engaged in towing operations.

POWERED TARGETS

Powered targets are used for training and weapon evaluation and development. However, the Aviation Weapons Officer is primarily concerned with training uses of powered targets.

There are several powered targets currently used or under procurement by the Navy. It is beyond the scope of this chapter to discuss these complex devices in detail. Therefore, two are briefly mentioned in the discussion that follows.

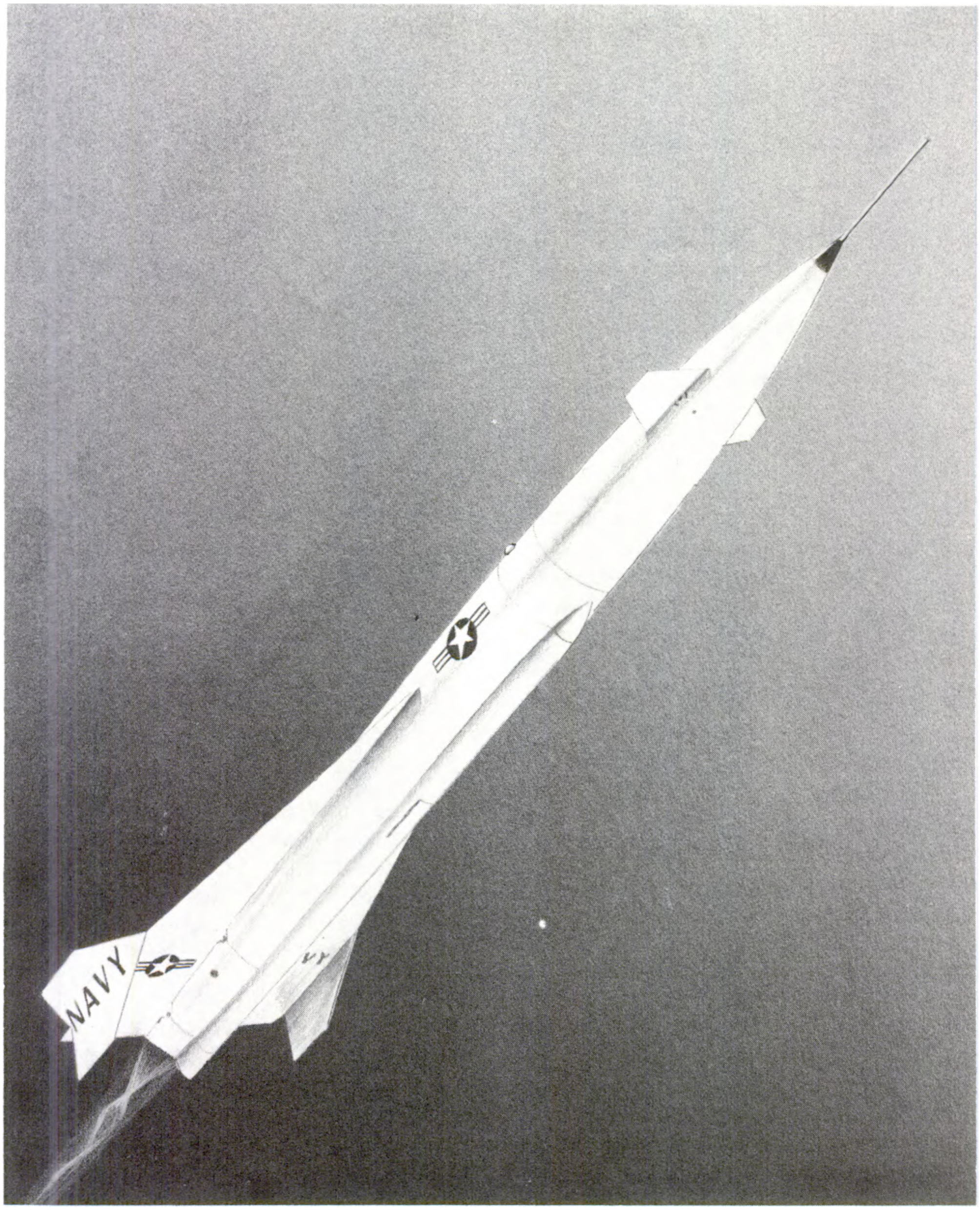


Figure 18-17.—AQM-37A missile target.

AQM-37A

The AQM-37A missile target (fig. 18-17) is the newest Navy powered target in production and available to the fleet. This high-performance expendable target, previously known as the XKD2B-1 is air-launched from carrier aircraft and flies a preprogramed flight profile selected during target checkout. A selection of flight profiles ranging from Mach 0.9 at 1,000 feet to Mach 2.0 at 70,000 feet is available.

The "round of ammunition" concept is stressed in the design of the AQM-37A target which accounts for the ability to store the target

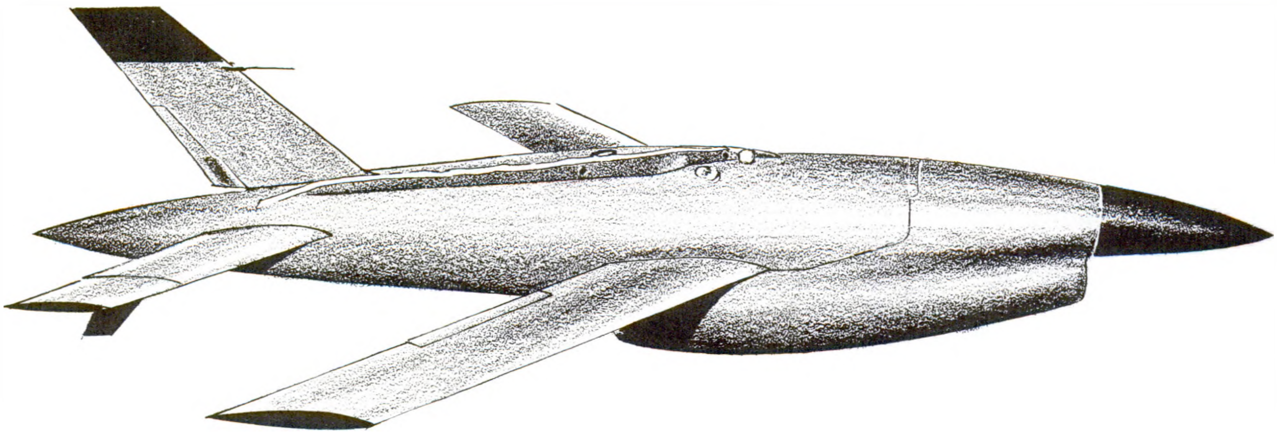


Figure 18-18.—Q-2C target.

aboard ship in modular stowage magazines configured for liquid Bullpup missiles. The prepackaged, liquid-rocket propelled target requires only a minimum of preparation for launching. Within an hour the target can be quickly readied. Several direct hits have been scored on the target with both Sparrow III and Sidewinder missiles.

The Q-2C "Firebee" (fig. 18-18) is a recoverable jet-powered target having a service ceiling of 55,000 feet and a maximum speed of 600 knots. Unlike the AQM-37A, this target requires extensive ground support equipment and preparation prior to launching.

In addition to its air-launch capabilities, this target has also been successfully ground launched. This additional launching technique is expected to increase the operational availability of the target. Previously the Firebee had been limited to air launching by P-2 mother aircraft.

Designed and built by the Ryan Aeronautical Company, San Diego, California, the Firebee target is used for the Navy's most modern surface-to-air and air-to-air missiles.

The Q-2C target is considered to be the most sophisticated reliable powered target in daily use by the Navy.

RECENT TOWING DEVELOPMENTS

The fleet may soon obtain a new space age tow target system on which to test missile-shooting proficiency. It is the first major development in this line in many years. The tow system was designed by the engineering development laboratory at the Naval Air Development Center, Johnsville, Pennsylvania.

The main parts of the system to be used by both the Navy and Air Force are the Aero RMU-8/A tow reel and Aero 47 target. The system has been successfully used on the F-4B type aircraft.

The new system is designed to replace the old, slow towed sleeve target, the banner target, and possibly the far more expensive and complex powered targets (drones) for missile firing exercises.

The tow reel mounted under the towing aircraft's wing can store up to 70,000 feet of towline. It can let out and recover the target at speeds up to 5,000 feet per minute.

The target can be equipped with passive or active radar gear, infrared devices, and a scoring system for different missions.

This new target system has completed flight testing and now holds these records: highest tow target speed, 1,000 miles per hour; longest cable and target in tow, 51,000 feet (more than 9 miles); highest deployment speed, 5,400 feet per minute; and highest recovery speed, 5,300 feet per minute.

This means the target can be used in conjunction with the most advanced air-to-air and surface-to-air missile weapons system.

CHAPTER 19

AIR—LAUNCHED GUIDED MISSILES

As a result of man's ingenuity, the pace of modern warfare has been accelerated to a point where concepts of time, space, and speed must be revised. Aircraft missiles have been developed which travel at velocities of two, three, or even five times the speed of sound. Missiles, to be effective, must be capable of destroying the enemy's aircraft, missiles, or installations as quickly as possible. This can be accomplished by using weapons superior to those of the enemy.

GUIDED MISSILES

A guided missile is defined as an unmanned, self-propelled vehicle designed to move in a trajectory or flightpath all or partially above the earth's surface and whose trajectory or course, while the vehicle is in motion, is capable of being controlled remotely (by the launching or homing systems) or by inertial and/or programed guidance from within. (This term does not include space vehicles, space boosters, or naval torpedoes, but it does include target and reconnaissance drones.)

This definition is broad enough to include many possible variations in design and tactical applications. The operation of guided missiles involves the fields of aerodynamics, radar, infrared techniques, propellants, radio-wave propagation, telemetry, automatic control, and specialized ordnance applications. Effective use of the guided missile as a part of a weapons system requires qualified personnel for its handling and use.

Guided missiles have been developed to overcome the limitations of conventional weapons and offer the following advantages:

1. Increased range from the point of release to the target.
2. Decreased susceptibility to countermeasures.
3. Increased destructive effect resulting from improved accuracy and a larger destructive load.

CLASSIFICATION

BuWeps Instruction 8800.2 issued 27 June 1963 (DOD Directive 4000.20) establishes a uniform designation system for classifying and naming all military rockets and guided missiles with combat or combat-related missions.

All missiles used by the Navy have been redesignated to conform to current standard policies. However, the popular names such as Bullpup, Sidewinder, etc., remain unchanged and should be valuable identification aids during the transition period. Table 19-1 lists the current and former designations of air-launched guided missiles currently used by the Navy.

Table 19-1. —Missile designations.

Current designation	Former designation	Popular name
AIM-7C	AAM-N-6	Sparrow III
AIM-7D	AAM-N-6A	Sparrow III
AIM-7E	AAM-N-6B	Sparrow III
AIM-9A	AAM-N-7	Sidewinder I
AIM-9B	AAM-N-7	Sidewinder IA
AIM-9C	AAM-N-7	Sidewinder IC-SAR
AGM-12A	ASM-N-7	Bullpup
AGM-12B	ASM-N-7A	Bullpup
AGM-12C	ASM-N-7B	Bullpup
AGM-45A	ASM-N-10	Shrike

An analysis of the current designation system is as follows:

1ST LETTER—LAUNCH ENVIRONMENT

A—airborne.
B—launched more than one way.
C—horizontal coffin (ground).
H—silo stored, raised for launch.
L—silo launched.
M—soft pad.
R—surface ship.
U—submarine.

2ND LETTER—MISSION

D—decoy.
E—special electronic.
G—surface attack.
I—intercept.
T—training.
U—underwater.
W—weather.

3RD LETTER—TYPE SYMBOL

M—guided missile.
N—probe.
R—rocket.

4TH NUMBER—DESIGN NUMBER

5TH LETTER—MODIFICATION SERIES LETTER

CURRENT AIR-LAUNCHED GUIDED MISSILES

Although missiles have been operational for several years, research on current missiles as well as missiles involving new theories is continuously producing changes in the missile field. Therefore, missiles that are operational today may be obsolete tomorrow. The missiles discussed in this chapter are presently current. Although changes may be made in these missiles, they contain most of the basic components of any air-launched missile system.

Sparrow

The Sparrow is a supersonic air-to-air guided missile system currently used by carrier- and land-based aircraft for fleet and continental air defense. Although two earlier models of the Sparrow were produced, the most successful (and currently used) model is the Sparrow III (fig. 19-1). It is a semiactive homing missile with a range of over 6 miles; its speed is in excess of Mach 2.5 with respect to the launcher.

The Sparrow III (designated as either AIM-7C, 7D, or 7E) is used in conjunction with an armament control system such as the Aero 1A. The combined capabilities of the missile and the armament control system permit an attack on an enemy aircraft from any direction (including head-on) in all types of weather. Later versions of the missile have a higher capability and are designed to be launched from supersonic, all-weather, jet aircraft of the Navy and Marine Corps.

Sidewinder

The Sidewinder missile (fig. 19-2) was designed for use by high-performance fighter and interceptor aircraft (in tail chase attacks) against jet and reciprocating engine aircraft having unshielded exhausts. It is the most widely used air-to-air guided missile in the U.S. Fleet and the U.S. Marine Corps.

There are at present three versions of the Sidewinder missile—designated AIM 9A, 9B, or 9C. All three versions of the Sidewinder are operational and are presently being utilized by the fleet.

The Sidewinder 9A is this country's first passive infrared-homing air-to-air guided missile. It requires no guidance radar or fire control system, but radar does assist the pilot in locating the target. Sidewinders 9A and 9B are best suited for daytime attack; however, they may be used effectively under visual night conditions. Since the Sidewinder 9A and 9B missiles depend on infrared rays for guidance, they are not effective in bad weather. (The Sidewinder 9C (SAR) is now operational in the fleet for all-weather use.)

The Sidewinders 9A and 9B are inexpensive and reliable weapons which have very few moving parts and utilize less electronic components than an ordinary radio. Personnel require no specialized technical training to handle and assemble the missiles. Developed by the Naval Ordnance Test Station (NOTS), China Lake, California, the missiles became operational in July 1956.

Sidewinder missiles are also being produced for use by foreign countries and were the first guided missiles to destroy an enemy aircraft under actual combat conditions. Chinese

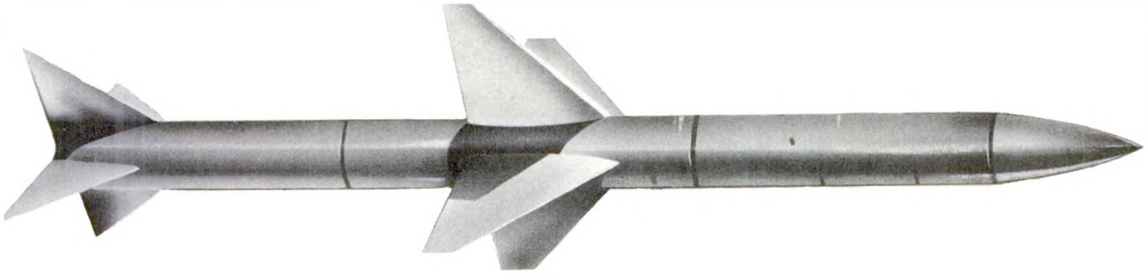


Figure 19-1.—Sparrow missile.

Nationalists successfully employed the weapons during the Quemoy crisis in 1958.

Bullpup

The Bullpup missile (fig. 19-3) is relatively inexpensive, highly accurate, and simple in design. It is a short-range, supersonic air-to-surface guided missile, and was designed for use in close air support of ground troops. It is also used against small tactical targets ashore and afloat.

The Bullpup is guided to the target by command signals from the pilot. Target tracking is by visual means and radar. Current Bullpup missiles can be launched at night and guided by radar to the target. This has given the Bullpup an all-weather capability. During daylight operations, the pilot can guide the Bullpup by radar or visual means. The pilot launches the missile while in a dive toward the target, maintains the dive until impact, and then pulls out.

A new improved Bullpup with a prepacked liquid fuel motor is in production and is presently replacing the solid fuel type.

The liquid fuel propulsion system makes the Bullpup a missile that requires no checking from factory to firing; it operates as a round of ammunition. Other features include a more powerful warhead and an improved guidance package. The cost is less than the solid fuel missile and is more effective in overall destruction and penetration capability.

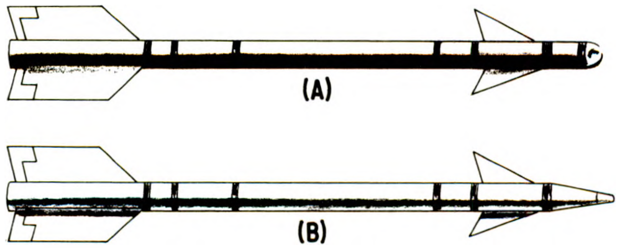


Figure 19-2.—Sidewinder missile family. (A) Sidewinders 9A and 9B; (B) Sidewinder 9C.

Anti-Radiation Missile Weapon System

For many years a simple, inexpensive air-to-surface missile capable of neutralizing enemy radar has been needed. Various systems were considered, but the only acceptable system to date is the Shrike (AGM-45A) developed by the Naval Ordnance Test Station (NOTS), China Lake, California. (See fig. 19-4.) The system,

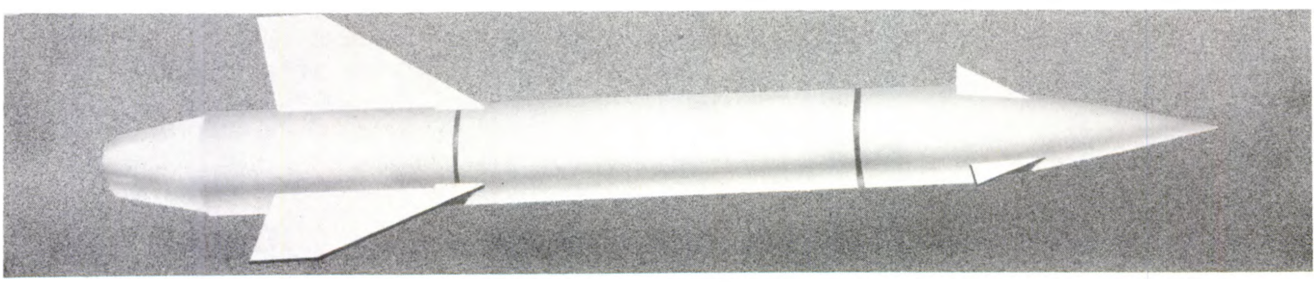


Figure 19-3.—Bullpup guided missile, AGM-12B.

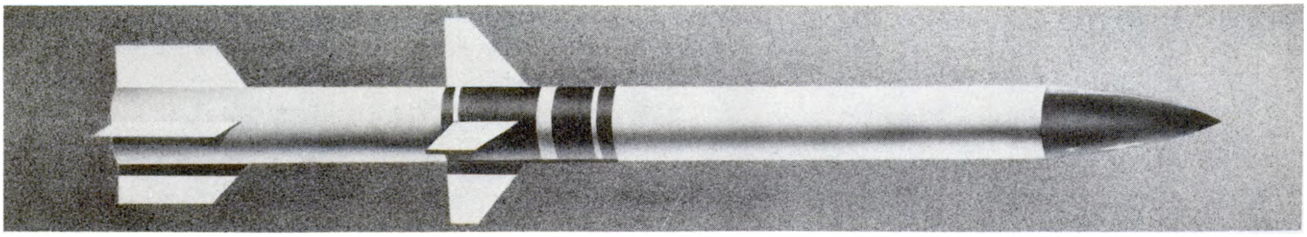


Figure 19-4.—Shrike anti-radiation missile, AGM-45A.

patterned after the Sidewinder, utilizes "off-the-shelf" components to a maximum extent. Most of the information pertaining to the Shrike is classified and is not discussed in this text.

MISSILE COMPONENTS

All guided missiles must contain certain components in order to perform their mission. A guided missile contains all or most of the following components:

1. Airframe.
2. Propulsion system.
3. Warhead and fuzes.
4. Guidance system.
5. Control system.

The preceding components are discussed in this chapter.

AIRFRAMES

The term airframe has the same meaning for guided missiles as it has for conventional aircraft. It serves as a vehicle to carry all the other parts of the missile, and it provides the aerodynamic characteristics required for successful flight. However, since an air-launched guided missile is a one-shot weapon, the body structure required may be simple in construction.

There are certain requirements in aerodynamic configuration that the airframe must satisfy. Among these requirements are the following:

1. The body and airfoils must be aerodynamically suitable for the speed at which the missile will fly.

2. The airframe must be light in weight, yet sufficiently strong and rigid to withstand the enormous shock loads, vibrations, and accelerations encountered in high-speed flight.

3. The airframe must be easy to assemble and to disassemble, and it must be designed so that the inner components are readily available for removal and repair. (The major components should be mounted so that they form independent units. The missile body should contain adequate room to permit slack in the electrical cables and harnesses so that the inner sections can be removed easily during field maintenance and repair operations.)

The main body is normally a slender cylindrical structure and may utilize any of several types of nose configurations. However, since all current air-launched missiles are supersonic, they generally use a forward section that has a pointed-arch profile. (NOTE: The Sidewinders 9A, 9B, and 9C (SAR) are the exception.)

The basic types of designs which are employed in missile airframes are distinguished principally by the location of the control surfaces with respect to the missile body. They are the canard and the wind-control designs.

Canard airframes, such as that used in the Bullpup and Sidewinder, utilize small control surfaces which are placed forward of the center of gravity. (The center of gravity may be defined as the point at which the total mass of the body can be considered as being concentrated.) Fixed fins (known as wing and rolleron assembly on the Sidewinder) are larger than the control surfaces and are mounted on the tail section to increase flight stability.

In the wing-control design (Sparrow III), the control surfaces are mounted at or near the center of gravity. Larger than in the canard arrangement, the controlling surfaces also provide considerable lift. Fixed fins are mounted on the tail section to increase flight stability.

In air-launched missiles (particularly in the air-to-air weapons), the missile body is generally composed of several sections.

Sectionalized construction has the advantage of strength with simplicity and allows ease of handling, replacement, and repair of the components since the shells are removable as separate units. (Each unit normally composes one complete component such as the guidance system, etc.) The sections are joined by connectors which can be easily engaged or separated. An example in the breechblock connection, in which the shells contain machined, interrupted threads, allowing the body sections to be joined by making an eighth of a turn. Access ports are usually provided in the walls through which adjustments of the inner components can be made prior to loading the missile on the aircraft.

The body sections, the fins, and the wings of air-launched missiles are constructed from materials which have high ratios of strength to weight in order to insure the necessary strength and rigidity. The airfoils must be thin structures which are required for supersonic flight; and in order to secure the necessary rigidity, these parts are generally machined from solid blocks of metal. Materials frequently used are alloys of aluminum and magnesium.

In the assembled missile, many of the component sections are joined by electrical cables. The connections are made by means of harnesses which run through tunnel assemblies. In some of the sections, the tunnels are routed internally; and in others, for example, those which house rocket motors or some part of the propulsion system, the tunnels are faired onto the outer skin of the body section.

One or more special connectors called umbilical plugs are secured to the missile body flush with the skin. These plugs mate with connectors through which electrical connections are made between the missile components and the launching equipment.

PROPULSION SYSTEMS

In order to be an effective military weapon, a guided missile must move at a high speed. It must do so in order to better its chances of intercepting enemy missiles or aircraft when used defensively, and to decrease its chances of being intercepted when used offensively. Missiles are moved in a desired direction and at a desired speed in response to applied forces. These forces are produced by the propulsion system (powerplant).

The most frequently used missile propulsion systems are those making use of either liquid or solid-propellent rocket motors. Rocket motors consist of three major parts—propellant, combustion chamber, and nozzle. The propellant is the combination of fuel and oxidizer necessary for the chemical reaction which generates the gases that are accelerated to high velocity and pass through the exhaust nozzle. Propulsion systems are classified according to the state of the propellant used—solid or liquid. For more information concerning rocket motors, refer to the applicable ordnance pamphlets.

WARHEADS AND FUZES

The guided missile must carry some form of useful burden if it is to accomplish the intended objective. In missile terms, the useful burden is called the payload. Physically, the payload merely occupies one or more of the sections of the airframe, and it contributes nothing to the functions of the vehicle, such as guidance, propulsion, or control. But in the total system, it is the component of greatest value, since all the actions of the missile serve as the means for insuring the effective delivery of the payload.

In research and test missiles, the payload often consists of telemetering units, which collect data during flight, convert the information into radio signals, and transmit them to receivers at a recording site. In some test missiles, dummy payloads are carried which have the same physical characteristics as the corresponding devices the missile will carry as an operational weapon. But in its military role, the guided missile is launched with a payload composed of one or more warheads and one or more fuzes.

Types of Warheads

Many of the warheads developed for other types of weapons can be modified or adapted for use in guided missiles. Some of these may present special problems to the missile designer, but almost any sort of destructive device employed in conventional weapons may also be carried by guided missiles. Among the types of warheads which might be used are external blast, fragmentation, shaped charge, explosive pellet, chemical, biological, nuclear, and continuous rod.

Types of Fuzes

The missile warhead is activated by the actions of one or more fuzes, which release the destructive forces after certain conditions have been fulfilled. The type of fuzing employed determines whether the warhead is detonated at a distance from the target, upon impact with it, immediately following penetration, or at some fixed time after penetration of the target skin.

The radio proximity fuze is employed in naval air-launched guided missiles. This device transmits high-frequency radio waves which are reflected from the target as the missile approaches it. Because of the relative motion of missile and target, the reflected signal, as received at the missile, is of a higher frequency than the transmitted signal. The two signals, when mixed, produce a difference frequency which is a function of the target relation. When the difference frequency reaches a preset value, the fuze operates and detonates the warhead.

GUIDANCE SYSTEMS

The guidance and control component of any guided missile determines the proper flight-path to hit the target, and controls the missile so that it follows this determined path. It accomplishes this "path control" by the following processes:

1. Tracking, in which the positions of the target and the missile are continuously determined.
2. Computing, in which the tracking information is used to determine the directions necessary for control.
3. Directing, in which the directions are sent to the control units.
4. Steering, which is the process of using the directing signals to move the missile control surfaces by power units.

The first three processes of path control are performed by the guidance system, and steering is performed by the control section.

In order for these processes to be accomplished, the missile must be in stable flight; that is, the missile must be capable of developing forces which restore it to straight and level flight when it is disturbed by some outside influence, such as a gust of wind. The control of missile stability is called attitude control, and is usually accomplished by an autopilot, which is a part of the control system.

Missile guidance may be divided into three phases—launching, midcourse, and terminal. In the launching phase, the missile is brought to the proper speed and position so that the midcourse or terminal guidance processes can assume control. The midcourse phase is the major part of the guidance cycle in that here most of the corrections are made for changes in course. The terminal phase, which occurs as the missile approaches the target, requires very high accuracy since the missile may have to make sharp turns and undergo high accelerations, especially against moving targets.

In some missiles a single guidance and control system may be used for all three phases; in others a different guidance system may be used for each phase in conjunction with a single control system. Also, a separate guidance and control system may be required for each phase. A single missile may utilize one of many combinations of basic guidance systems. The most common basic types of guidance systems are as follows:

1. Homing.
2. Beam-rider.
3. Command.
4. Self-contained.

Each of these basic guidance systems is discussed in this chapter.

Homing

Homing systems operate by detecting some distinguishing emission from the target, such as radiant heat, radar or radio waves, or visible light. The guidance equipment carried by the missile may or may not originate the emission by which the target is detected. In semi-active homing, the target is illuminated by some type of energy (usually radar) originating at the launching aircraft, and the missile homes on the echoes returned by reflection. In active homing, the illuminating source is carried in the missile; while in passive homing, the missile receives natural radiations from the target and is independent of any other source of signals.

ACTIVE HOMING.—Active homing systems illuminate the target and obtain the guidance information from the reflected signals by means of equipment located entirely within the missile. The type of equipment used in any particular system will depend largely on the location, speed, and maneuverability of the intended target. Active homing guidance may be used against both aerial and surface targets, and usually employs radar techniques to obtain the guidance information.

The general method employed by an active homing radar system is shown in figure 19-5. Radar pulses originating in the missile strike the target and are reflected back to the missile radar receiver. The latter is equipped with a gyroscopically stabilized dish antenna, which is adjusted by the control system so that it remains focused on the target. The position of the dish antenna provides guidance information concerning target location which is applied to the control components in the form of steering signals.

The arrangement of the components of a typical active homing missile is illustrated in figure 19-6. A homing radar is located in the nose section, and the antenna assembly is covered by a radome. The autopilot section contains the stabilizing devices, such as gyroscopes and accelerometers, and the electronic circuits that generate the signals which move the wings. The wing section consists of four movable wings and a hydraulic system for controlling their movement. The hydraulic oil is stored under high pressure in the accumulator and is supplied to the control linkages by electrically operated valves. The propulsion section contains a solid-propellent rocket motor, and supports four stabilizing fins.

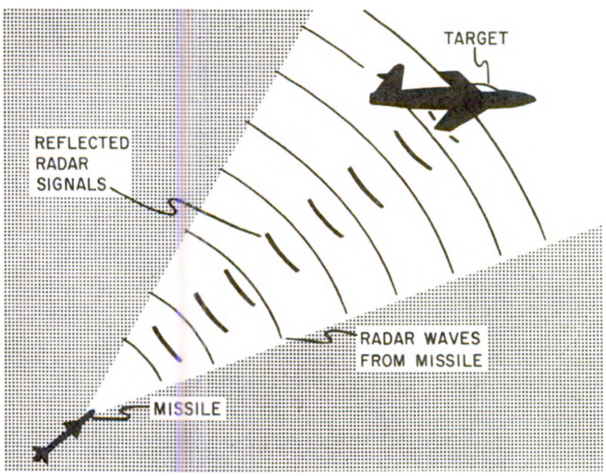


Figure 19-5.—Active homing.

SEMIACTIVE HOMING.—A missile employing semiactive homing guidance receives radiation reflected from the target, which has been illuminated from a source outside the missile. A receiving antenna in the nose of the weapon intercepts the reflected energy; and the guidance and control components cause the missile to home in on the object returning the echoes. The source of illuminating waves is usually a radar transmitter which, in the case of the air-launched weapon, is located in the parent aircraft. Thus, it is unnecessary that the missile carry the heavy, complex transmitting equipment required in the active homing weapon; while at the same time, it retains the principal advantage of homing guidance, that is, its accuracy increases during the final phase of the attack while closing on the target. It is required, however, that the launch aircraft illuminate the target with AI (air intercept) radar until target intercept.

The essential features of semiactive homing are indicated in figure 19-7, which shows the radar waves originating in the launching aircraft and the reflections from the target returning to the missile.

The guidance and control equipment carried within the semiactive missile consists principally of a target seeker and an autopilot. The

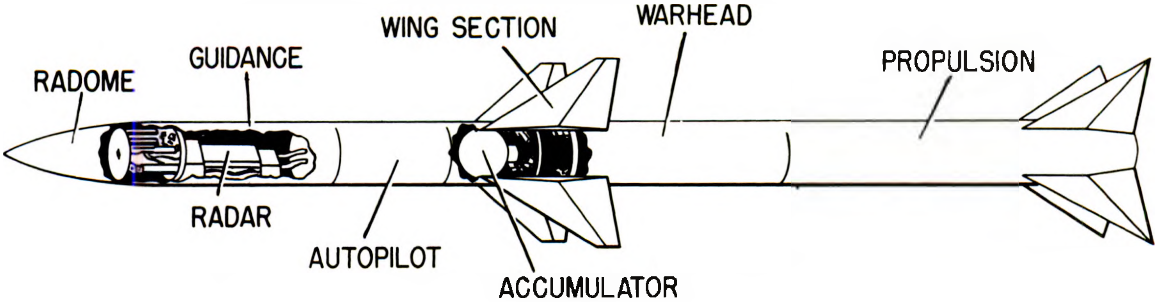


Figure 19-6.—Components in an active homing missile.

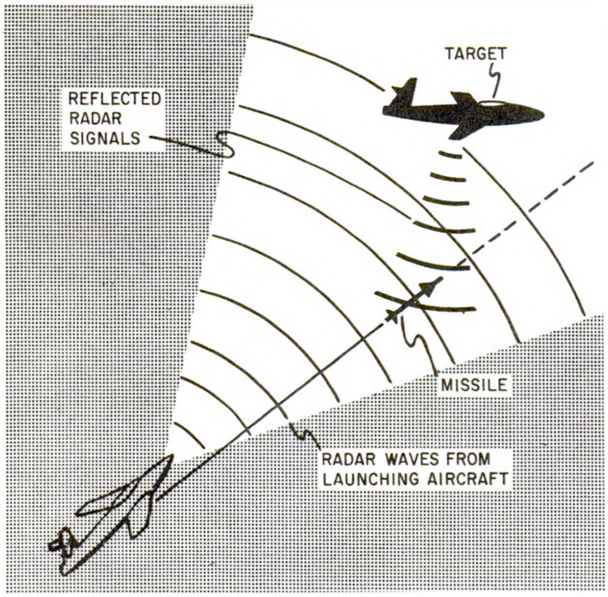


Figure 19-7.–Semiactive homing.

CW (continuous wave) target seeker, a special type of radar receiver, develops the signals required for steering the weapon. It searches for the reflected target signal, locks on the target signal, and tracks the object to produce the steering error voltages. In addition, it measures the closing speed of the missile and target, and provides a voltage proportional to its value. The signals thus derived are applied to the units of the autopilot, which adjust the missile wings to bring about the necessary changes in course for steering the missile to collision. The major components of a representative target seeker employing Doppler operation are shown in block diagram form in figure 19-8.

The RF (radiofrequency) section (fig. 19-8) contains a forward-facing and rear-facing antenna. The forward antenna receives echoes reflected from the target; the rear antenna receives signals directly from the launching aircraft. These signals are applied to two mixers and combined with the output of a klystron local oscillator. The outputs of the RF section are two independent IF (intermediate frequency) signals, which are applied to the Doppler section.

In the Doppler section (fig. 19-8), the IF signals are amplified and mixed to produce a difference frequency, the Doppler signal. The frequency of the Doppler signal is proportional to the closing speed of the missile and target. After amplification, the Doppler signal is passed on to the gating and error-detector section, which locks on the signal and

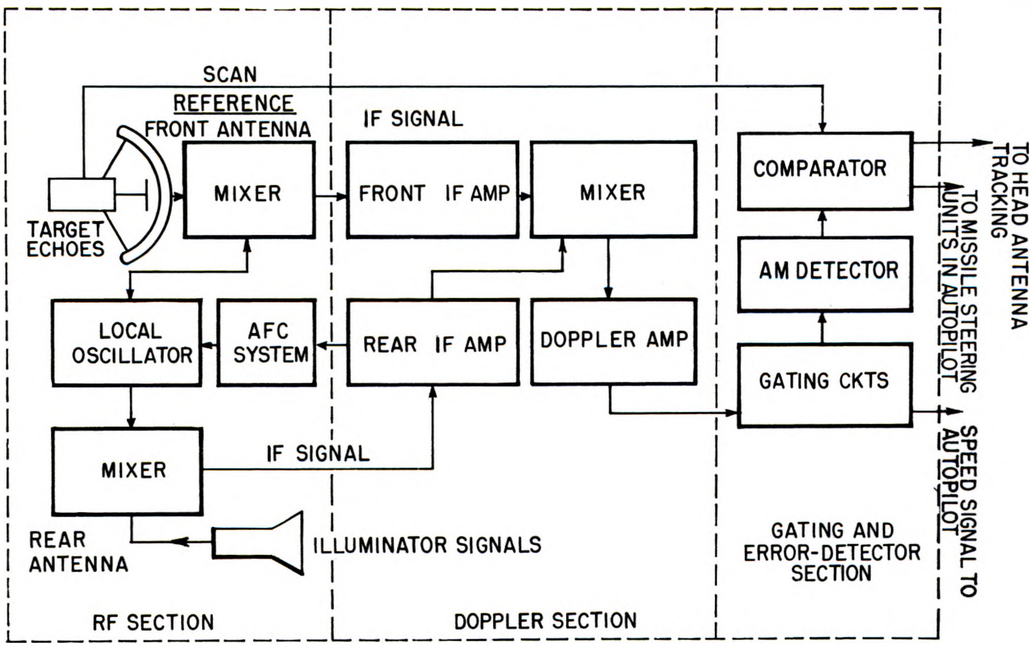


Figure 19-8.—Block diagram of a CW target seeker.

produces an output for the control system. The action of the latter steers the missile by means of the wing servo units (not shown in the diagram) and also governs an antenna servosystem which adjusts the position of the front antenna so as to track the target automatically.

PASSIVE HOMING.—Passive homing equipment detects and tracks a target by sensing some type of radiation that the target emits. A passive homing system, like an active system, is completely independent of the launching aircraft, thus allowing the aircraft to maneuver immediately after firing the missile. Unlike the active method however, the operation of the passive equipment cannot be detected by the enemy since the target is supplying the guidance signals.

The most common type of radiation used for passive homing is infrared, which is produced largely by propulsion systems. However, in order to utilize infrared radiation as control information, there must be a distinct contrast between the target and the background; and the background must be reasonably uniform in temperature so that the target will be the only "hot spot."

The infrared homing missile operates in the manner indicated in figure 19-9. Many military targets such as ships, factories, aircraft, and guided missiles are warmer than their surroundings and may be detected by missile guidance equipment because of the large amount of heat they emit. Homing guidance equipment, usually located in the nose of the missile, gathers this radiation from distant objects which lie in its field of view, and transforms it by optical and electrical processes into voltage signals. These signals are then used by the autopilot in the same manner as signals from radar guidance equipment to control the flightpath of the missile.

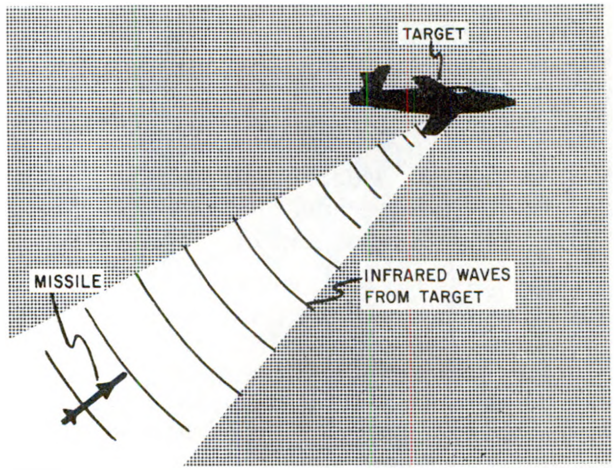


Figure 19-9.—Passive homing.

Beam-Rider

The beam-rider system now employed in some types of air-launched and surface-launched guided missiles bears a close resemblance to a method for controlling rockets first proposed as long ago as 1925. At that time it was suggested that a rocket could be made to climb the beam of a searchlight by the use of a simple control system containing four selinium cells. The light-sensitive cells were to be attached to the tail assembly of the rocket in a symmetrical arrangement; and after launching, the rays of the guided searchlight would fall equally on the four cells as long as the projectile remained in the center of the illuminated path.

If the rocket should stray from the desired track, the four cells would then intercept different amounts of light. Since the electrical resistance of a selenium cell is a function of the intensity of the light falling upon its sensitive surface, the unequal responses of the four units could be converted into corresponding electrical signals. The signals were to be applied through amplifiers to a transmission system which would in turn act upon the rudders and steer the rocket back toward the center of the beam.

While this early scheme was never developed in exactly the form first proposed, it is nevertheless interesting and noteworthy since the modern beam-rider guided missile works on exactly the same general principle, although with numerous refinements and variations. Instead of a light beam, the missile system employs the beam of a fire control radar for guidance; and the modern technique of automatic tracking in range and angular position increase the accuracy of the guidance process. Instead of selenium cells, the missile carries microwave antennas which are used as sensing elements. With these it receives special guidance signals emitted by the parent equipment; and by means of electronic circuits; gyroscopes, and servomechanisms included in its control system, it locates the center of the radar beam and follows it to the target.

The guidance signals in the system illustrated in figure 19-10 consist of coded pulses arranged in pairs. The aircraft radar emits a circularly scanning beam which encloses the target. The guidance pulses are emitted at 90° intervals on the circle. These are received by the missile with amplitudes which vary in accordance with the position of the missile with respect to the center of the scanning circle.

Consider the case shown in figure 19-10 when the missile is at position (a) and flying along the scan axis. It is then equidistant from the beam positions at which all guidance signals are transmitted, and all four are received with equal strength. The guidance circuits produce no wing command in this case since no correction is necessary or desirable.

When the missile swings from the proper course, as shown at position (b) in the figure, it is then nearer the beam when the fly down pulses are transmitted than when the fly up signals occur; hence the former are received in greater strength. Also, the fly right pulses are stronger than the fly left pair. After comparing the opposite sets, the guidance circuits respond to the inequalities by developing two wing-command voltages which mean "fly down" and "fly right" to the servosystem. They are put into effect by the wing-actuator units until the guidance pulses are again received in equal strength. This signifies that the missile has regained the course and is following the scan axis to the target.

Command

A command guidance system is similar to a beam-rider system in that the missile is controlled by the launching aircraft. In a command system however, the missile does not develop the steering commands but receives them directly from the parent aircraft. The command receiver merely converts the signals into the proper form to energize the servomechanisms which move the wings. A typical command system used for air-launched missiles is that in which a control operator in the launching aircraft visually tracks the missile and transmits control signals to keep the weapon on the line of sight to the target.

The control signals are usually conveyed to the missile by a radio command system employing FM (frequency modulation), the principal components of which are shown in figure 19-11. (The principles of frequency modulation are discussed in Basic Electronics, NavPers 10087-A.) The missile is guided by the operation of switches located on the control unit in the aircraft. Each switch corresponds to a particular command, such as fly down, fly up, fly left, or fly right; and when operated, it connects power to one of several audio oscillators in the modulator unit. Each oscillator generates a signal at a frequency chosen for a particular command, and the signal is applied to the input of the transmitter. Thus, the output of the modulator will be a different frequency for each command.

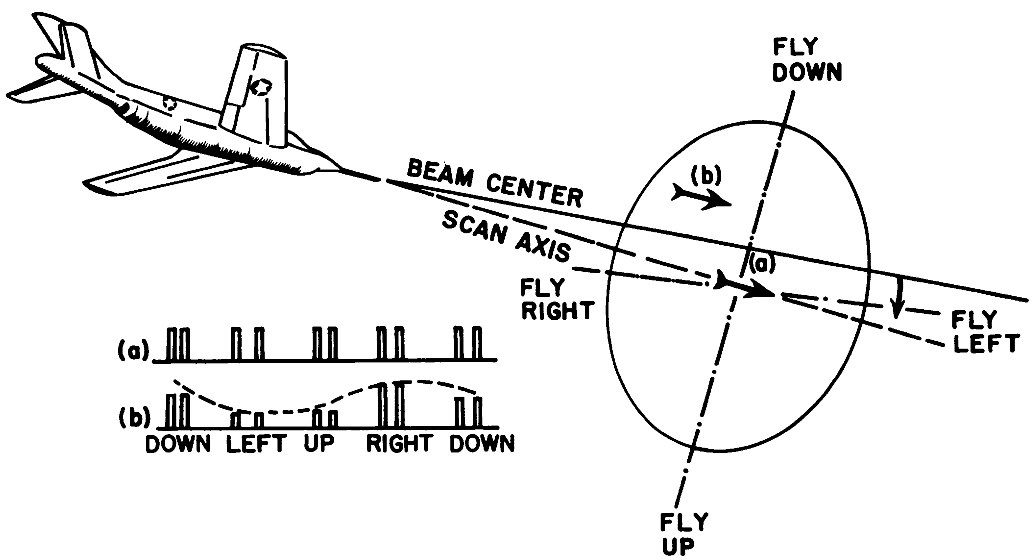


Figure 19-10.—Guidance by coded pulses.

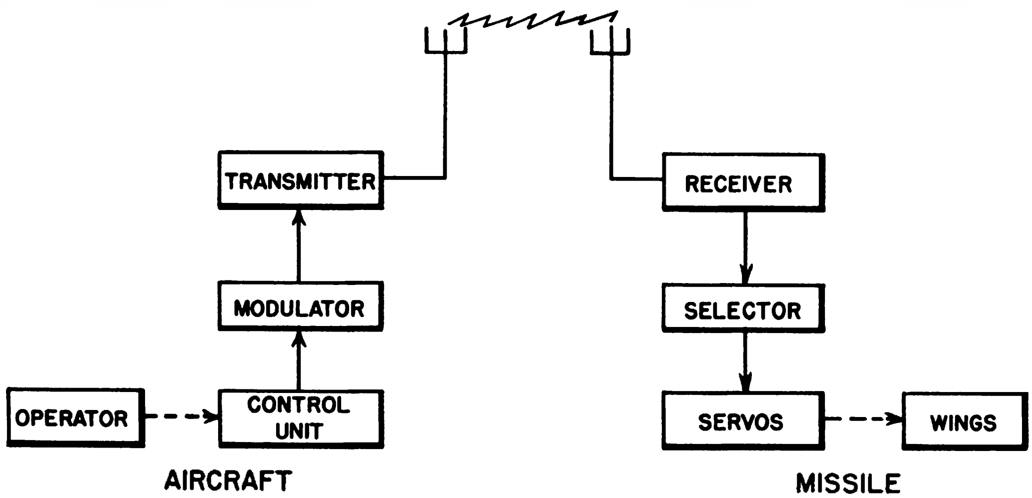


Figure 19-11.—Radio command system.

The signal from the audio oscillator modulates an RF signal which is generated in the transmitter and the modulated signal is fed to the antenna where it is radiated to the missile. The frequency-modulated carrier is picked up by the missile antenna and coupled to the receiver where it is amplified and demodulated so that the audiofrequency is separated from the RF. The audio command signal is then fed to the selector.

In the selector section, the audio signals are separated by filters. Each filter is tuned to one of the audio command frequencies; and because of the selective nature of the filters, each audio signal will pass through only one of them. When a command signal has passed through the corresponding filter, it energizes a relay which activates a wing-control servo, thus causing the desired maneuver.

Self-Contained Guidance Systems

The self-contained group consists of the guidance systems in which the intelligence is entirely within the missile. Some of the systems of this type are as follows: preset, terrestrial, inertial, and celestial-navigation. These systems are most commonly applicable to surface-to-surface missiles. Countermeasures are usually ineffective against them.

PRESET SYSTEM.—A missile equipped with a preset guidance system follows a predetermined flightpath which is controlled by a mechanism within the missile, and which cannot be corrected after launching. This mechanism, usually a clockwork device, is set according to calculations of range and wind drift made from the known location of the target with respect to the launching point. A typical example of the preset system was that of the German V-2, where range and bearing of the target were predetermined and set into the control mechanism.

The preset system is relatively simple compared to other types; it is dependable, and does not require tracking or visibility. But, because of its poor accuracy due to the fact that conditions along the flightpath are not always the same as estimated, and since the flightpath cannot be corrected after launching, the preset system has limited application in current guided missiles.

TERRESTRIAL SYSTEM.—The terrestrial or magnetic guidance system is similar to the preset system in that a predetermined course is set into the missile prior to launching. In addition, a magnetic device in the missile, such as a magnetic compass, monitors the flightpath and initiates corrections if the missile deviates from it. The German V-1 used this type of guidance in conjunction with a barometer to control altitude, and an airlog (similar to the milage section of an automobile speedometer) connected to a propeller to control range. The accuracy of the magnetic system is greater than that of the preset system, but wind drift can cause large error because the missile can maintain the same heading and still be blown off course.

INERTIAL SYSTEM.–In the inertial guidance system (this type is used in the Polaris missile), a predetermined path is adjusted after launching by devices within the missile which make use of Newton's second law of motion. This law, which relates acceleration, force, and mass, states that the acceleration of a body is directly proportional to the force applied, and inversely proportional to the mass of the body. These devices, usually three double-integrating accelerometers, continuously measure the distance traveled by the missile in three directions–range, altitude, and azimuth. Double-integrating accelerometers are devices which are sensitive to acceleration, and by a double-step process they measure distance. These measured distances are then compared with the desired distances, which are preset into the missile. If the missile is off course, correction signals are sent to the control system.

The three accelerometers are usually setup with the sensitive axis of one of them vertical, and the other two in the horizontal plane—one along the flightpath, and the other at right angles to it. The output of the one along the flightpath is the distance traveled in range. If the output of the one at right angles to the flightpath is maintained at zero by controlling the missile, then the missile is maintained on the desired path in azimuth. In some systems the function of the vertical accelerometer, which keeps the missile at the desired altitude, is performed by a barometric altimeter.

Accelerometers are sensitive to the acceleration of gravity as well as missile accelerations. For this reason the accelerometers which measure range and azimuth distances must be mounted in a fixed position with respect to the pull of gravity. This can be accomplished in a moving missile by mounting them on a platform which is stabilized by either gyroscopes or star-tracking telescopes. This platform, however, must be moved as the missile passes over the earth to keep the sensitive axis of each accelerometer in a fixed position with respect to the pull of gravity. These requirements cause the accuracy of the inertial system to decrease as the time of flight of the missile increases.

CELESTIAL-NAVIGATION SYSTEM.–In this system celestial observations are used to navigate the missile along a predetermined path. These observations are made by a device in the missile, such as an automatically positioned telescope, and the measured readings are compared with preset values to determine whether the missile is on course. The accuracy of this system is independent of range, thus making it desirable for long-range missiles. In the missile system, some device must sight the stars and calculate positions continuously and automatically. This requirement means that the missile must carry complicated equipment, and must fly above the clouds to assure star visibility.

CONTROL SYSTEMS

The missile guidance system senses the position of the missile with respect to the target and develops the necessary commands, or "error signals" to keep the vehicle on the proper flightpath. The missile control system executes the commands by adjusting the wings, canards, or fins to steer the vehicle toward the target; and it also plays an important part in stabilizing or maintaining the proper flight attitude.

The control section contains wing actuator units, amplifiers, and attitude-sensing instruments such as gyroscopes and accelerometers. When the system determines that a change in missile attitude is needed, or that the response to the guidance signals is too fast or too slow, signals are developed within the control section which correct the undesired condition by readjustment of the control surfaces. In general, it can be said that the guidance section is responsible for missile path control and produces the signals applied to the control section. The control section, in turn, carries out the commands and also is responsible for attitude control and stabilization of the vehicle in flight.

MISSILE MAINTENANCE (AIR-LAUNCHED)

Since air-launched missiles are a specialized type of military aircraft and depend on complex guidance systems which contain electrical, electronic, hydraulic, pneumatic, and mechanical units, frequent and accurate maintenance and testing must be performed to insure adequate reliability.

Although the Aviation Weapons Officer is concerned with many factors associated with guided missile maintenance, his main responsibility concerns supervision of aviation ordnance personnel within the scope of their respective field. Therefore, missile maintenance, as discussed in this chapter, consists primarily of the proper use of test equipment and of testing missile units and components.

To better understand the various aspects of missile handling, it is deemed appropriate to review the background organization in which the functions of testing, maintenance, and supply are accomplished.

HANDLING

The term handling, when applied to the missile field, refers to all of the procedures and steps taken with missile components from original issue through assembly and ultimately the expenditure of the weapon. The principal steps are receipt of the various sections, inspection, stowage, testing of system operation, assembly of the sections to form an operational missile, and the loading of the weapon on the launching aircraft. Handling also includes procedures used with missiles not fired, which must be unloaded from the aircraft and disassembled.

The process of tracing a missile from the manufacturer to the expending aircraft can best be illustrated by a simple flow chart. Figure 19-12 depicts a composite of the major elements concerned with the missile handling organization.

In addition to the manufacturer, the elements include naval ammunition depots or other similar storage and issue activities that provide depot type functions, overhaul and repair activities, aircraft carriers, and aircraft squadrons.

LOGISTICS AND STOWAGE

Personnel assigned to naval ammunition depots (NAD's) or other similar storage and issue activities are responsible for the receipt, stowage, and issuance of complete guided missile assemblies. They perform systems tests and component checks, and inspect and make replacements of missile sections. They replace damaged structural parts of missiles and repair and maintain assigned missile systems and component test sets. The functions of area stock and issue control are carried out at NAD's or other similar storage and issue activities in response to orders or drafts from authorized commanders.

Overhaul and repair activities are parts of naval air stations; and as major shore-based organizations, they play a significant part in the missile logistic system. Personnel assigned to these activities perform necessary rework on "inert" or rejected guidance and control sections to make them ready for issue (RFI).

Personnel assigned to aircraft carriers or other support activities are required to be proficient in the following typical duties: performance of automatic checkout procedures, assembly and loading, and replacement of removable sections and components.

The duties of personnel assigned to aircraft squadrons include preflight checking and missile servicing, the latter term indicating the preparation of missiles for launching.

The Aviation Weapons Officer has several major areas of duties and responsibilities. In addition to supervision, he functions as part of the supply or logistic organization which insures an adequate supply of material to expending activities. He is also responsible for various training projects which require skill and experience in applying standard training procedures and, in addition, must be able to apply his knowledge in the utilization of special missile training devices.

The Aviation Weapons Officer is mainly concerned with correct missile assembly procedures, efficient use of support equipment, and proper techniques for servicing missile and electronic components. He is also responsible for the proper stowage of missiles and the organization of trained teams to perform breakout, assembling, testing, and loading of air-launched guided missiles.

Figure 19-13 is a flow chart showing the scope of responsibility of the Aviation Weapons Officer in the two areas of missile logistics afloat. The first area includes receiving, unpacking, inspecting, and stowing. The second area involves assembling and readying of operational weapons, aircraft testing, arming, dearming, and disassembly.

BREAKOUT AND ASSEMBLY

Due to the various factors encountered in the handling of missiles and the variety of missiles now operational, no standard procedure

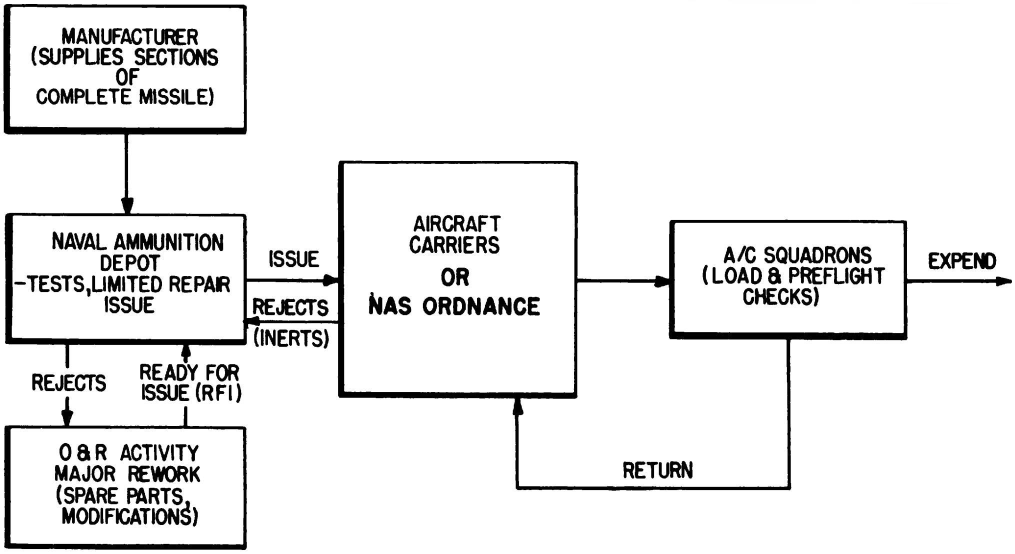


Figure 19-12. --Air-launched missile maintenance and logistic organization.

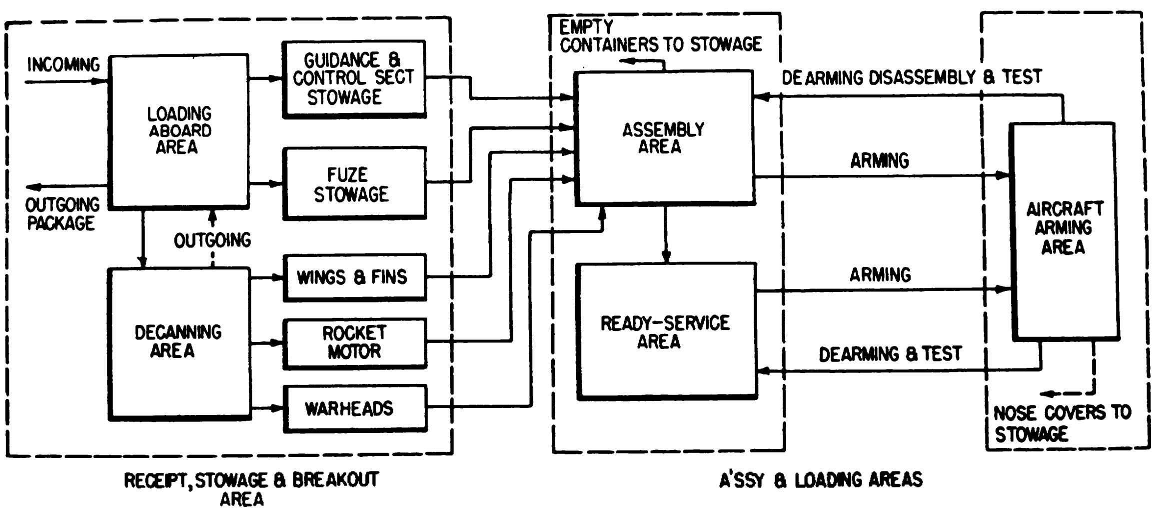


Figure 19-13. —Flow chart of missile components aboard ship.

for breakout, assembly, and disassembly is feasible in this text. However, a general review of the basic equipment requirements, and a list of publications that should be available for handy reference are included.

There are certain standard requirements that, if properly adhered to, will suffice for the breakout, assembly, and disassembly of most missiles. Personnel in charge should insure that the following requirements are fulfilled.

1. Proper support equipment is available, including electrical power, hydraulics, air, etc.
2. Proper handling equipment such as skids, assembly stands, slings, dollies, and other pertinent equipment is accessible.
3. Test equipment is available (and working properly).

Table 19-2. --Missile publications.

Missile/Equipment	Publication Number	Title	Classification
All current missiles	NW 00-120A-1	Naval Air-Launched Guided Missile, Volume 1.	Confidential.
Sidewinder	OP 2309 (Second Revision)	Mk 2 Mods 0 and 1-14, Description, Handling, and Operation.	Confidential.
Sparrow III	NW 01-265GMAA-11	Operational Checkout Instructions, AIM-7C Sparrow III Using Missile Test Set AN/DSM-32.	Confidential.
	NA 01-265GMAA-501	Operational Checkout Instructions, AIM-7C Sparrow III Using Missile Test Set AN/DPM-7.	Confidential.
	NW 01-265GMAA-501A	Supplemental Handbook Weapon System, AIM-7C Guided Missile (Issue Controlled BuWeps RM-372).	Confidential.
	NA 01-265GMAA-504	Illustrated Parts Break-down, AIM-7C, 7D Sparrow III.	Confidential.
	NA 01-265GMAA-509	Assemble and Dis-assembly Instructions, AIM-7C Sparrow III.	Confidential.
	NW 01-265GMAD-1	Operational Checkout Instructions, AIM-7D Sparrow III Using Missile Test Set AN/DPM-7.	Confidential.
	NW 01-265GMAD-9	Assembly and Dis-assembly Instructions, AIM-7D Sparrow III.	Confidential.
	NW 01-265GMAD-11	Operational Checkout Instructions, AIM-7D Sparrow III Using Missile Test Set AN/DSM-32.	Confidential.

Table 19-2. —Missile publications—Continued.

Missile/Equipment	Publications Number	Title	Classification
Bullpup	NW 01-35GMAA-501	Assembly Procedure With IPL AGM-12A, 12B.	Confidential.
	OR 142B	U. S. Navy Bullpup, Martin Orlando Pamphlet.	Confidential.
	OR 85B	U. S. Navy Bullpup, Martin Orlando Pamphlet.	Confidential.
	OR 713	U. S. Navy Bullpup, Martin Orlando Pamphlet.	Confidential.
	OP 3178	Bullpup Safety Handbook (AGM-12B, 12C Guided Missile)	Unclassified.
Handling equipment	OP 2173	Handling Equipment for Ammunition and Explosives, Vol. 1 and 2. (Mobile and Non-mobile).	Unclassified.
	NW 00-120A-4	Naval Air-Launched Weapons (General Information).	Confidential.

NOTE: Ordnance reports (OR's) are pamphlets issued by civilian manufacturers, with the approval of BuWeps, who have ordnance contracts with the Navy.

4. Correct publications are accessible.

5. Sufficient number of trained personnel are available. In addition to the above, practice, teamwork, and above all good judgment will guide the Aviation Weapons Officer through most missile handling situations.

The missile and associated handling equipment publications deemed helpful to the Aviation Weapons Officer are shown in table 19-2. This listing should not be construed as an all conclusive list.

AIR-LAUNCHED MISSILE TESTING AND TEST EQUIPMENT

Because of design characteristics, some air-launched guided missiles require a rather large amount of special support equipment; each unit performs a definite function in placing the missile into the air. Support equipment includes items such as air compressors, loading skids, launching racks, and handling tools of special types. It also includes systems test equipment used for performing electronic and electrical checks on the guidance-control section of the missile.

The term system, as used here, refers to the missile section containing those components which detect errors, determine courses, direct and perform all corrective actions, and which, in general, are required in the processes of guidance and control.

The effectiveness of an air-launched missile depends largely upon the operation of the guidance-control system, which must function perfectly if the missile is to achieve the high degree of reliability of simpler weapons such as the rocket. To insure this reliability is the primary function of the associated test set, which provides the means for subjecting the missile to a thorough confidence checkout before it is placed in ready storage or loaded on an aircraft.

Systems test equipments differ because of variations in the missiles for which they are designed; however, most perform the same basic functions and meet the same fundamental requirements. These can be summarized briefly by the following list:

1. Self-check. In order to make thorough confidence checks, the test set must contain provisions for making rapid checks of its own performance prior to running an acceptance test on the missile system.
2. Flight simulation. It is necessary to check the missile system under conditions that approximate those of actual operation. Hence, the test equipment must contain signal generating circuits for developing inputs that simulate normal, in-flight signals.
3. Provision of objective test results. One of the leading requirements is that test results be indicated in an objective manner and provide conclusive evidence concerning the condition of the missile section.
4. Isolation of malfunctions. In addition to making acceptance checks, the test set must be capable of indicating the location of circuit trouble as an aid in further casualty analysis and repair.

Test sets designed to meet these requirements can be grouped for convenience into two major classes: (1) automatic, or GO, NO-GO, and (2) semiautomatic, or manually operated equipments. These differ in the types of components contained and also in the amount of participation required by the operator. The automatic test set is characterized by almost complete objectivity.

Selection of the tests to be performed are programed into the test equipment, and the results of the separate checks are indicated as either GO or NO-GO. Hence, there is no "almost good" or "almost bad," depending upon how the operator reads a chart, meter, or other indicating device.

Most semiautomatic testers require manual selection of the various test sequences performed and permit the operator to repeat a particular test as many times as necessary. In some cases, test results are read out by means of cathode-ray indicators, in others by means of meters. As a result, the operator is required to interpret test results to a greater extent than is required with fully automatic equipment.

Some of the test equipment and procedures used with current operational air-launched missiles are discussed in this chapter.

SIDEWINDER

Fleet testing of Sidewinder missiles is a relatively simple job when compared to tests that must be performed on other types of missiles. The Sidewinder, by nature of its simple design, has a high degree of reliability and performance, but yet requires little more testing than an aircraft rocket. The simplified checkout and testing procedures are outlined in Sidewinder Guided Missile Mk 2 Mods 0 and 1-14 and Test Equipment; Description, Operation, and Handling, NavWeps OP 2309 (Second Revision) and in BuWeps Instruction 08811.1 of 21 March 1960. More sophisticated testing of the Sidewinder missiles is usually performed by personnel attached to depots. Missiles are turned into authorized depots once a year for a complete check.

Testing by squadron personnel is limited to a GO or NO-GO test of the launcher and the aircraft wiring. However, the missile must be thoroughly inspected before and after it is suspended on the launcher. The launcher and aircraft wiring is tested with the aid of the Test Set, Guided Missile Launcher AN/ASM-11.

After the missile has been properly positioned on the launcher and the umbilical plugs properly installed, power is applied to the missile for a preflight check of the complete system. This is accomplished by the pilot and an assistant (usually an Aviation Ordnanceman) working together just prior to takeoff.

The assistant is stationed from 6 to 10 feet to the front of the missile but not directly in the missile's path. Upon receiving a signal from the pilot the assistant moves a lighted flashlight up and down and then back and forth across the front of the missile. If the missile is functioning properly, the pilot should hear a 400-cycle tone in his headset with each pass of the flashlight in front of the missile.

If the pilot does not hear the 400-cycle tone and the missile is installed correctly, a heavy piece of steel, such as a crescent wrench, should be moved around the nose cone of the missile. Normally, this will induce the gyro to spin.

Test Set, Guided Missile Launcher AN/ASM-11

The AN/ASM-11 test set (fig. 19-14) is used to perform accurate and safe operational tests on the launchers which carry and launch Sidewinder missiles. The tester is a portable, lightweight, compact unit designed to have minimum test procedure and requires no periodic maintenance. The tester is housed in a waterproof and shockproof carrying case. The compactness and the portability of the test set provide field personnel a quick and efficient method of testing the aircraft and launchers with minimum transportation effort.

After ascertaining that all armament has been removed from the aircraft, the test equipment is set up as illustrated in figure 19-15 for testing the launcher. The following steps in testing the launcher are then performed:

1. Energize the aircraft circuit by using an auxiliary power unit.
2. The weapons selector switch is placed in the proper position for Sidewinder.
3. The station selector switch is placed in the station position corresponding to the launcher to be tested. See table 19-3 for the switch position numbers and the corresponding launcher circuit designations.
4. Starting with test position 1, the switch knob is cycled through the first 10 positions, stopping at position 10. As the switch is cycled through the first 10 positions, the knife edge pointer on the test set meter (M101) should indicate in the yellow area. A 400-cycle tone will be heard in the pilot's headphones with the switch in position 10. If the 400-cycle tone is not heard, the switch that controls the communications system should be located and turned on. Be sure that the gain (volume control) is high enough to hear the signal.
5. The master armament and safety override switches are turned on their ON position.

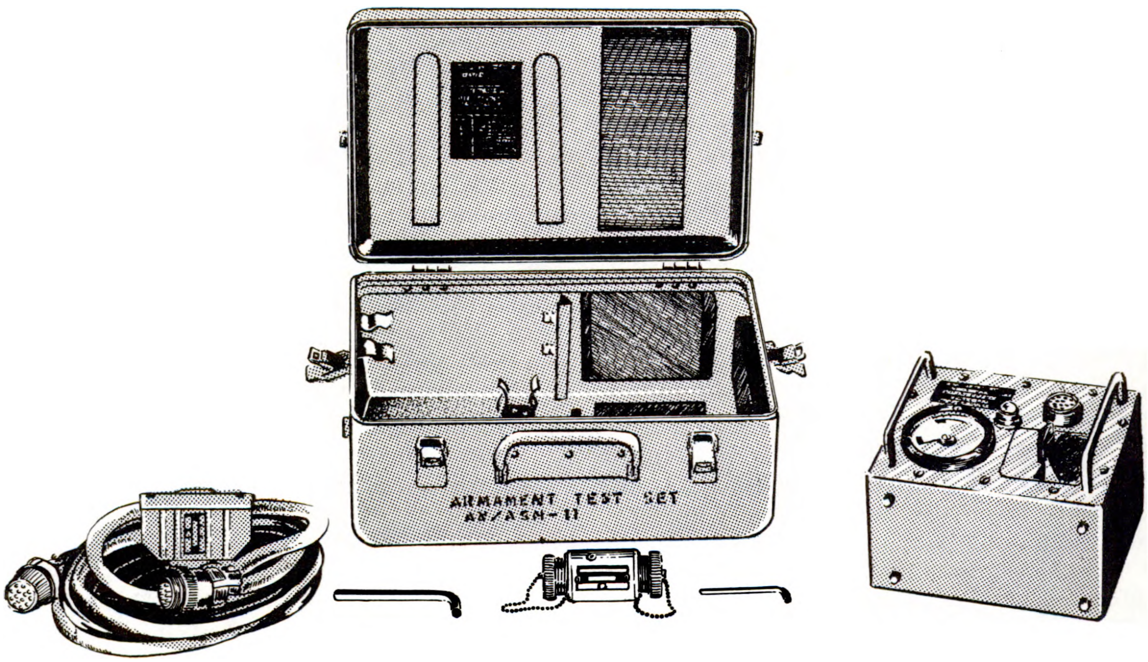


Figure 19-14. --Test Set, Guided Missile Launcher AN/ASM-11.

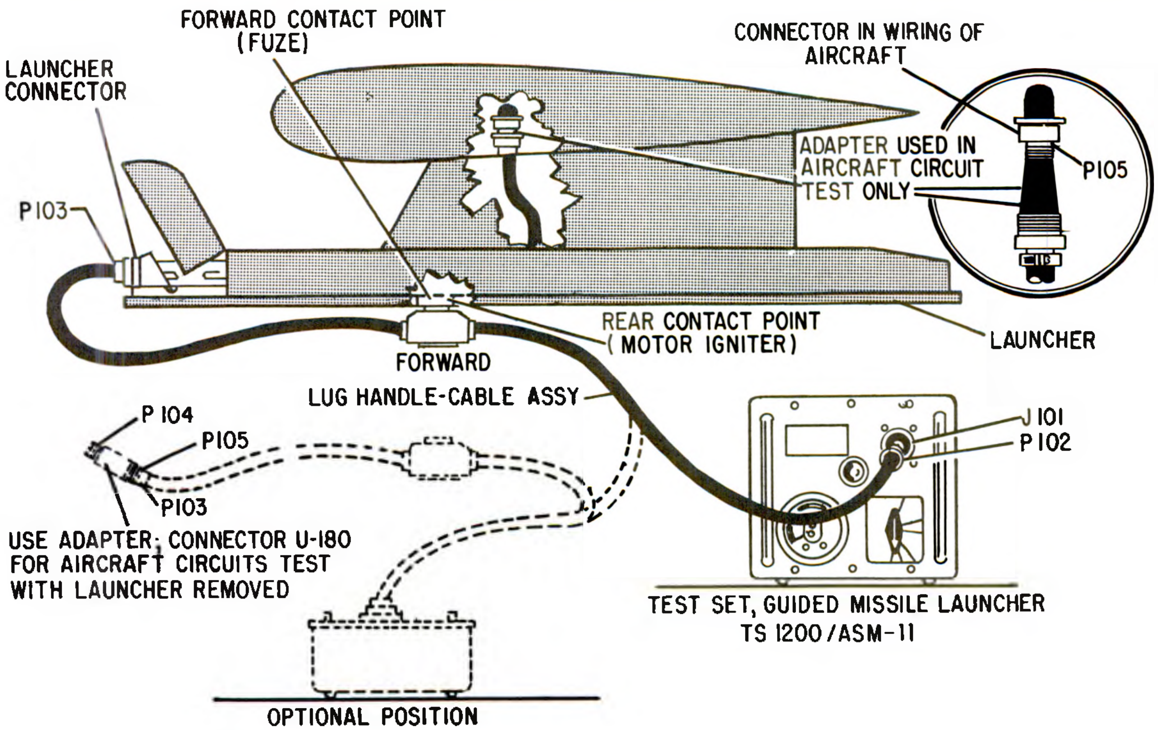


Figure 19-15. —Test Set, Guided Missile Launcher AN/ASM-11 test setup.

6. The firing switch is depressed and the switch knob cycled through positions 11, 12, 13, and 14. If the launcher circuits are functioning properly, the knife edge pointer will read in the red area for positions 11, 12, and 13. Position 14 should be in the black area. When the safety pin is pulled from the launcher, position 14 will read in the red area. The firing switch is released and the master armament switch is turned off.
7. The switch knob is cycled to position 15. The knife edge pointer will read 0 (black area), and the pilot light will go out.
8. With the safety pin removed as in step number 6, the switch knob is cycled through positions 16, 17, and 18. The knife edge pointer will read in the black area for these three positions.
9. The switch knob is cycled to position 19. The knife edge pointer will read in the yellow area. The switch knob is turned to the OFF position.

If the indications are not the same as listed in the above steps, study table 19-3 to localize the trouble.

NOTE: The above testing procedure is included as typical of those found in launcher testing. When performing any maintenance test, refer to the applicable equipment manual for the latest procedure. For example, current information on test procedures to be followed when using the AN/ASM-11 Test Set are contained in NavWeps OP 2309 (latest revision) and NavWeps 16-30ASM11-1 (latest revision).

In addition to the tests on the launcher, the test set has also been designed to provide a test of the aircraft circuitry. However, this test is made on the aircraft circuitry when there are no missile launchers on the aircraft wings.

The test set (fig. 19-15) provides a GO or NO-GO determination of the aircraft circuits as follows:

1. The power supplied to the Sidewinder missile, both standby and firing, is within voltage tolerances.
2. The missile firing sequence is operating satisfactorily.
3. The firing circuits are safe.

Table 19-3.—Sources of troubles.

Switch position	Launcher test	Aircraft test
1	Preamp fil	
2	Mtr dr fil	28 v a. c. or d. c.
3	Servo htr	Master arm.
4	Preamp B+	
5	Mtr dr B+	
6	Disabling B+	
7	A. G. C.	
8	Nonshort	
9	Uncage closed	
10	115 v a. c. pwr and pilots signal.	115 v a. c. pilots signal.
11	Uncage open	
12	Gas, gen, firing	Firing.
13	Fuze, firing	
14	Propulsion unit, firing.	
15	Pwr int	
16	Gas gen, stray voltage.	
17	Fuze, stray voltage.	
18	Propulsion unit, stray voltage.	
19	Meter check	
20	Off	

4. It also indicates if the aircraft launcher circuits are operational and that the jettison circuits will function satisfactorily.

For a complete description of the operation and use of the AN/ASM-11 tester (plus maintenance and calibration of the tester), refer to the Operation and Maintenance Instruction Manual, NavWeps 16-30ASM11-1 (or latest edition), or other appropriate publications. (NOTE: This is a launcher tester and not a Sidewinder missile tester.)

SPARROW III

Operational testing of the Sparrow III missile is usually confined to the guidance and control section. The AN/DSM-32 or AN/DPM-7 guided missile test sets are used to perform these tests. Tests are conducted upon receipt of the components and at specified times thereafter.

The missile launcher, the klystron tuner, and the aircraft's wiring are tested with the AN/ASM-9 Simulator Test Set.

AN/ASM-9 Simulator Test Set

This unit when attached to a missile launcher simulates the load presented to the aircraft by the missile, monitors the missile system control functions generated in the aircraft, and provides signals for checking the missile's klystron tuner. It also checks continuity and safety of aircraft wiring associated with the missile. The simulator test set determines whether the aircraft facilities for launching Sparrow III missiles will operate properly. The d-c power normally delivered to the missile is checked by resistance and blower motor loads. Meters and indicator lights are provided for monitoring various electrical quantities that are supplied to the missile by the launching aircraft. This instrument draws upon the aircraft for its power and no external power is required.

For further details on the operation and maintenance of the AN/ASM-9 Simulator Test Set, refer to the Operation and Service Instruction Manual, NavWeps 16-30-ASM9-501 (or latest revision), or other associated publications.

AN/DPM-7 Test Set, Guided Missile

The Missile Test Set AN/DPM-7 is used on operational checks of the guidance and control section of the AIM-7C, 7D, Sparrow III missile. This tester is designed so that it can be used by either land-based or shipboard missile testing teams.

After applying external power and energizing the tester and unit to be tested, the operational testing is initiated by applying power through mechanical and electrical command inputs. The tester monitors and records the outputs of the section under test. The operator analyzes the command readings and determines if the section under test is functioning properly.

To properly use and maintain the above mentioned tester, refer to the Service and Overhaul Instructions Manual, NavWeps 16-30DPM 7-501, or an equivalent publication.

Due to the complexity of the AN/DPM-7, only qualified personnel should be permitted to operate the equipment.

AN/DSM-32 Test Set, Guided Missile

The AN/DSM-32 test set is used for a complete and rapid check on the guidance and control component of the Sparrow III missile. This consolidated tester is used by testing teams aboard aircraft carriers or land-based installations.

Operation of the AN/DSM-32 tester actuates regulated electrical and hydraulic fluid flow, plus simulated flight in the form of microwave command and control signals to the unit being tested. Monitoring the unit being tested is accomplished by meter presentations, indicator lamps or cathode-ray tube indications.

The AN/DSM-32 test set is a very complex precision piece of equipment and should only be used by qualified personnel. The Aviation Weapons Officer should insure that the appropriate publications are available to the operator when performing operational tests. For further details on the tester, consult the Service and Overhaul Instructions Manual, NavWeps 16-30DSM 32-2 (latest revision).

BULLPUP

The assembled Bullpup missile requires no complete testing or component testing (except minor settings). However, the ordnance personnel are required to visually check the missile. Ordnance personnel must also insure that the aircraft circuitry and launcher is functioning properly. This is accomplished by using the AN/USM-75 Electrical Continuity Tester. A no-voltage check of the electrical circuits to the forward and aft umbilical connectors of the Aero 5A launcher must also be performed. This can be accomplished with the Rocket Launcher Firing Circuit Tester.

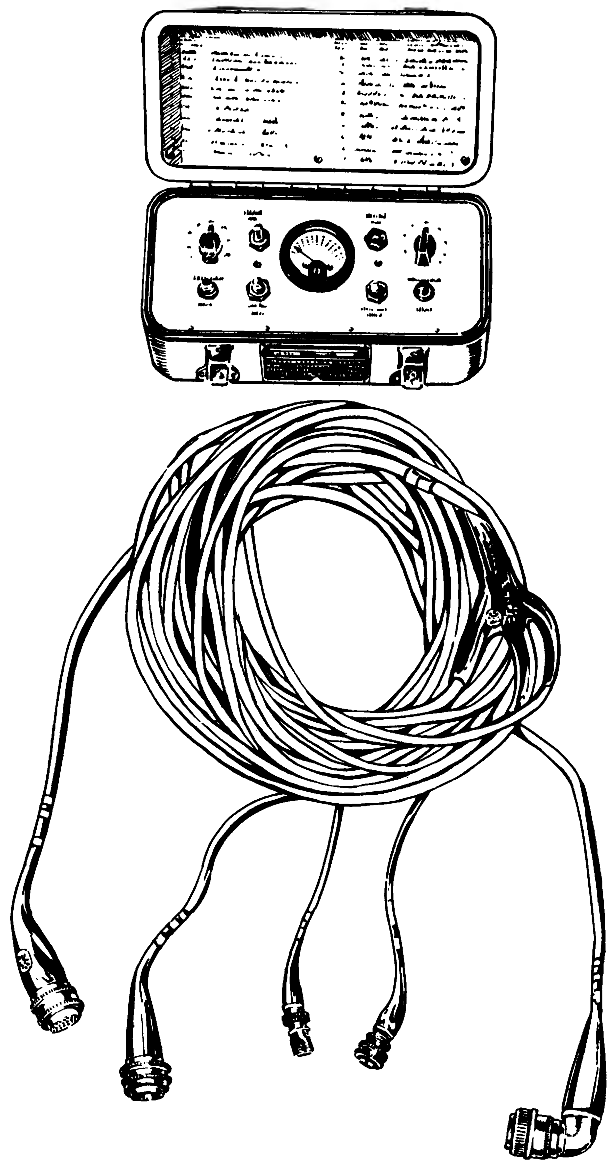


Figure 19-16.—Electrical Continuity Test Set AN/USM-75.

Electrical Continuity Test Set AN/USM-75

The AN/USM-75 test set (fig. 19-16) is a special-purpose voltmeter which is used to verify the electrical operation of the AGM-12A and 12B (Bullpup) guided missile weapon system circuits in certain fighter and attack type aircraft. The test set is a portable unit weighing less than 10 pounds; it consists of a special-purpose branched electrical cable assembly CX-4857/USM-75 and Electrical Continuity Test Set TS 1309/USM-75. The cable assembly is attached to the guided missile launcher Aero 5A in the same manner that the missile cable is attached.

The test cable is composed of a single connector at one end and four branched connectors at the other (one connector is for a power source). All connectors and branch unions are potted with polyurethane potting compound. The test set is comprised of a panel assembly containing a voltmeter, two selector switches, four control switches, a meter fuse, and a spare fuse. The face of the meter is divided into ten equal divisions; six color bands are painted on the scale. The numbered divisions have no significance except as reference points; the color bands indicate the areas on the meter scale in which the pointer should stop with various signals applied. The panel assembly is attached to the case assembly by a wiring harness. This harness is sufficiently long to permit the two assemblies to be separated for maintenance.

When checking a launcher, an operator in the aircraft operates the weapon system for launching and jettisoning the missile. The test set operator selects the various signals and observes their deflection on the test voltmeter. The voltmeter does not indicate the absolute value of the signal; the meter deflection is noted in relation to a standard marking and a GO or NO-GO evaluation is made. Normally, the test set is used for part of the preflight check of an aircraft prior to loading the Bullpup. However, the test set may be used any time it is necessary to verify the electrical operation of the system.

For complete information on operation and maintenance, plus illustrated parts breakdown on the Electrical Continuity Test Set AN/USM-75, refer to Operation and Service Instructions Manual, NavWeps 16-30USM75-1 (latest revision).

MISSILE LAUNCHERS AND EJECTOR LAUNCHERS

AERO 3A MISSILE LAUNCHER AND PYLON

The Aero 3A missile launcher, when properly installed on the aircraft, provides a complete launching system for the sidewinder missile or a suitable configured target rocket. The launcher supports and retains a missile or target rocket until fired. The pylon is a structural member attached to the aircraft wing and serves as a support for the launcher. (See fig. 19-17.) The launcher assembly has a length of 84 inches and a weight of 49 pounds while the pylon assembly length is approximately 50 inches and weighs 30 pounds.

The launcher assembly consists essentially of six major units: A nose installation, a power supply, two cable assemblies, a detent and snubber installation, and a rail assembly. All elements of the launcher assembly, exclusive of the nose installation, are housed under a center cover and an aft fairing. Two pointed screws, staked into the rail, accomplish grounding of the missile or target rocket to the launcher.

The nose installation consists of four functional elements: a cover housing all working parts; a cover latch mechanism consisting of two hooks actuated by a wrench-operated socket with tension provided by two torsion springs; a normal closed safety switch secured to a bracket; an umbilical block breakaway hook for retraction of the severed missile umbilical cord and block upon firing, with tension provided by two torsion springs.

The power supply is a self-contained assembly completely potted except for two shielded vacuum tubes which are soldered into place. It provides both standby and firing power to the missile and amplification of the missile signal. The launcher power supply obtains 400-cps 115-volt a.c. and 28-volt d.c. from the aircraft and furnishes B+ power, heater power, filament power, and firing power to the missile. An audio amplifier amplifies the signal from the missile and drives the pilot's earphones. This signal is the only means by which the pilot can tell that the missile is functioning properly prior to launch.

The cable assemblies consist of connectors and necessary wiring from the power supply to the striker points, safety switch, umbilical connections, target, and rocket flare conectors.

The detent and snubber installation consists of three functional parts. Two fittings retain bolts for attachment of the launcher assembly to the pylon assembly. A detent extending through the rail restrains the missile in both directions. Upon firing, the missile overrides the detent, which may be adjusted for specific releases by means of a screw. Snubber cams extending through slots in the rail, engage the

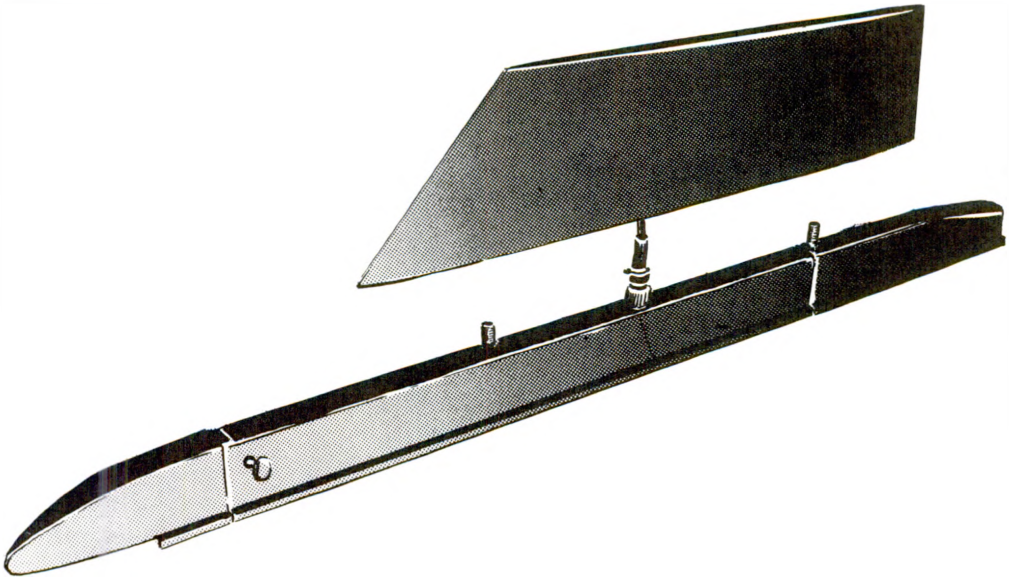


Figure 19-17. —Aero 3A missile and pylon assembly.

forward and aft missile lugs and prevent vertical and lateral movement of the missile until fired. The loading of a missile or target rocket automatically engage the snubber detents and striker points. A wrench is used to actuate mechanical linkage for release of the forward and aft cams and raising of the detent for unloading purposes.

The rail assembly consists of plates and gang channels riveted to a heavy aluminum alloy extrusion. The rail assembly contains slots for the umbilical breakaway hook, snubber cams, detent, and for loading the missile or target rocket.

The pylon is enclosed in a streamlined fairing. The necessary attachments are provided to connect the pylon to the aircraft and launcher to the pylon. In addition, a neoprene seal along the upper edge of the pylon skin effects a tight, water resistant joint between the pylon and the aircraft wing lower surface.

Operation

When the firing line is energized, voltage from the launcher power supply ignites the missile gas generator grain through the umbilical cable attached to the launcher nose. Satisfactory generator buildup closes the firing relay in the launcher power supply, thereby applying power to the launcher striker points. The forward striker point energizes the missile influence fuze and the aft striker point fires the missile motor. When the missile thrust buildup reaches the necessary pounds, the missile overrides the restraining effect of the detent and moves along the launcher rail. The forward snubber cams are moved up and forward by movement of the missile and are locked in the up position by cam guides and springs to prevent interference with the rear missile lugs. Forward thrust shears off the umbilical block, and the retractor hook in the launcher nose raises the severed block and cable into the launcher. The missile is now free of all restraint and leaves the launcher.

When target rockets are used, a special firing plug supplied with the rocket kit, is connected to the receptacle in the launcher nose.

A jettison circuit is included in the launcher power supply which allows power to be applied directly to the missile motor striker point, and to the target rocket receptacle without igniting the gas generator or energizing the influence fuze.

GUIDED MISSILE LAUNCHER AERO 5A

The guided missile launcher mechanically supports the missile and transfers prelaunching power from the aircraft to the missile. At launch, the launcher guides the missile for the first 8 inches of flight. The launcher is also used to jettison the missile.

The launcher (fig. 19-18) consists of a main structure assembly containing channel assembly, fitting assemblies, missile launcher tracks, retention mechanism, jettison assembly, and electrical components.

Maintenance

The following inspections should be performed as indicated:

1. Check and lubricate launcher components as required.
2. Visually check bushings and pins for wear on the jettison gun. Also disassemble and clean after each firing.
3. Visually check structural assembly for sharp scoring or pitting every 30 days or 50 missile launches, whichever occurs first.
4. Visually check launcher tracks for excessive wear of bearing surface every 30 days or 50 missile launches, whichever occur first.
5. Electrical connectors are checked every 30 days in service for cracks, dirt, corrosion, and broken connectors.
6. Visually check safety shear pin and bushing for wear after each arresting landing with the missile in place.

When required, remove and replace shear pin. Unless otherwise directed by competent authority, install shear pin with CS (carrier suitable) stamped on the head of the pin. Inspect the inside of the structural assembly for foreign matter and remove as required. Consult the proper instruction or operation manual for the correct steps to be taken in maintenance repairs and replacement of parts.

Tests

All tests should be made as prescribed by current instructions. Some of the many tests are as follows:

1. Using the electrical continuity test set AN/USM-75, perform a preflight check of the launcher. The only special tool needed is the primer socket wrench.

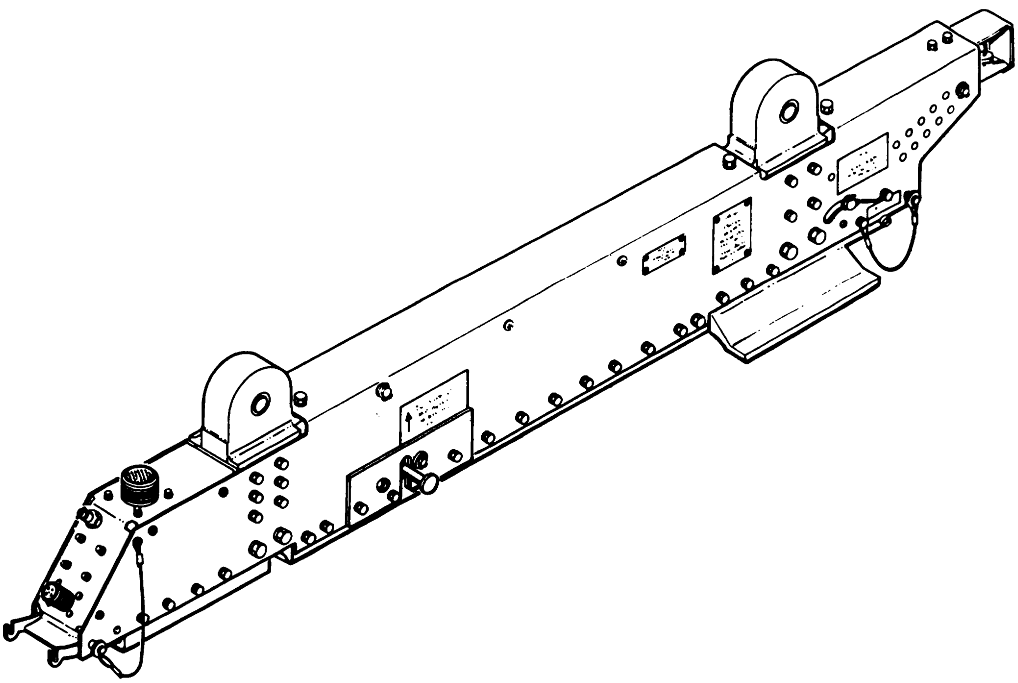


Figure 19-18. —Aero 5A guided missile launcher.

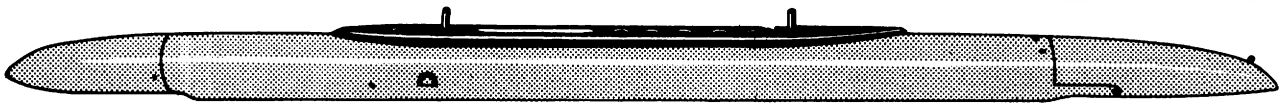


Figure 19-19. —Guided Missile Launcher Model LAU-7/A.

2. Continuity checks as prescribed, making sure the resistance reading is below 1 ohm.
3. Voltage checks are made at five points between specified pins.

NOTE: Refer to the Operation and Service Instruction Manual, NavWeps 11-75A-15, for complete information.

4. Bench check for no voltage, using Aero 1A launcher firing circuit tester or its equivalent.
5. Check the release of the missile retaining solenoid.
6. Test the ordnance firing relay.
7. Test the filament power transformer.

GUIDED MISSILE LAUNCHER MODEL LAU-7/A

The Guided Missile Launcher Model LAU-7/A (fig. 19-19) is a new type of equipment cooled by gaseous nitrogen. The nitrogen system is of primary importance. Proper function of the launcher depends on proper condition of the nitrogen. The launcher consists of a housing assembly, snatch-away umbilical assembly, nitrogen system, mechanism assembly, power supply, and electrical system. When attached to an aircraft, it provides a self-contained launching system for an air-to-air missile. The launcher secures the missile in flight and releases it when actuated by the pilot. The safety circuit prevents accidental release during catapult takeoffs and arrested landings. A safety pin assembly prevents ground firing. Snubbers and detents are used to prevent movement of the missile in flight.

The LAU-7/A launcher is a 70-pound, 101-inch rail type launcher which is government furnished and installed by the operating activity. This launcher is used on aircraft which have AIM-9C cooling provisions added to the missile circuit.

The LAU-7/A launcher with either power supply PP-2315/A or PP-2581/A will accommodate a Sidewinder AIM-9B or AIM-9C. The LAU-7/A launcher contains a nitrogen reservoir and circuitry necessary to provide cooling for the AIM-9C to insure proper operation. The cooling circuit is controlled by the AIM-9C COOL switch in the aircraft missile circuit and the AIM-9C must be installed in order for the circuit to be complete. Other details of the LAU-7/A launcher are the same as for the Aero 3A launcher with the following exceptions: (1) the forward missile acceleration required to override the detent and release the missile for flight and (2) as the missile leaves the launcher and the umbilical block shears, the nitrogen valve is also closed to prevent further flow of nitrogen.

GUIDED MISSILE LAUNCHER AERO 7A

Missile launching capabilities of the F-4 aircraft are accomplished by four Aero 7A ejector type launchers. These launchers are mounted internally to the fuselage structure, and are self-contained gas operating mechanisms, capable of carrying, retaining, and launching (ejecting) the Sparrow III missile. Ejection force is supplied by two gas generating cartridges of the ARD 446-1 type, and are ignited by an electrical impulse supplied by the missile trigger switch. Electrical power for missile motor ignition is supplied by a missile motor plug attached to the aft ejector foot. Power is supplied to the missile guidance control system by the umbilical plug. Upon launching (ejection) of a missile, the missile motor lower connector and the umbilical plug are pulled from the missile.

The ejection components consist of the forward ejection piston mechanism, the aft ejector piston mechanism, and the auxiliary piston. These components are used to eject the missile from the launcher. NOTE: Jig, Service, Aero 7A should be used to properly support the Aero 7A launcher while cleaning, disassembling, or repairing. Pertinent information on the Jig, Service, Aero 7A (McDonnell) may be found in the publication NavWeps 20-250B2-4.

SAFETY PRECAUTIONS

GENERAL

Safety requirements continue to increase both in number and detail with increases in complexity of individual missile units; multiplicity of equipment, ammunition, and components; and potency of weapons. Therefore, an increased degree of vigilance is required by all ordnance personnel.

After the loading operation is completed, responsible petty officers must insure that the missiles are checked for proper physical security on the launchers. All launcher test points are checked for correct resistance readings, which indicate proper mating of the missile to the umbilical connector, and a red "Live Ordnance" tag is placed in the cockpit. This tag lists safe positions of switches and circuit breakers, and serves to give warning to unauthorized personnel who may enter the cockpit.

Key personnel should be instructed to report any violation of safety, improper procedures, or helpful or timesaving suggestions to the Aviation Weapons Officer. He should then insure that the information is passed on to all ordnance personnel.

Missiles loaded on carrier-based aircraft are armed only on the catapult, unless permission to arm elsewhere on the flight deck has been granted by the commanding officer. Safety in arming is achieved by cooperation of the pilot and the crewmembers in the use of distinct and well-understood hand signals.

A signal from the pilot indicates that he is ready for the missiles to be armed and that all switches and circuit breakers are in the correct positions. The signal is relayed by the arming crew chief to a man under each wing. Upon completion of the arming, the two crewmembers give signals to the crew chief who relays them to the pilot and to the catapult officer.

Any persons in the surrounding area must be warned not to stand forward or aft of missiles during and after arming.

When a pilot returns aboard with missiles on the launchers, the missiles must be dearmed and unloaded. It is necessary that the pilot advise the ship concerning the number of missiles being returned, whether live or dummy warheads are involved, and whether a firing attempt has been made. The dearming and ordnance disposal crews are then alerted accordingly.

Missiles remaining on the launchers at the completion of an attack fall into one of two classes: those with which no attempt to fire has been made, and those which failed to leave the launchers after a normal firing attempt. Missiles of the second class are called hangfires.

If the hangfire missile is smoking, the pilot should jettison it immediately. If no smoke is present, the aircraft should be headed in a suitable direction for a specified length of time. If no unsafe or unusual conditions are noted, the missile is then classified as a "misfire" and the pilot returns for a landing and for dearming and unloading of the missile.

The procedures used with the two classes of returned missiles differ principally as to the personnel involved. Dearming crews handle missiles returned after no firing attempt has been made. After the pilot has come to a stop forward of the barriers and has signaled that all switches and circuit breakers are in the safe positions, the missile crew begins dearming.

The rocket motor is made safe by pulling the igniter safety lanyard, and a red pennant is hung on the arming lanyard. (NOTE: Safety features differ with missiles; in any event, all applicable safety requirements for each particular missile must be rigidly followed.) If the missile contains batteries, these are removed from the outboard missiles. The pilot then taxies the aircraft to the parking spot where the crew completes the process of dearming. If spotting flares are used, they are removed. Battery boxes are removed from the inboard missiles, the jettison cartridges are removed, and the missiles are unloaded and struck below.

Procedures used with misfires require the services of an ordnance disposal crew that accompanies the dearming crew and meets the aircraft as it taxies forward of the barriers. A visual inspection is made for signs of dangerous or unusual conditions. If any are noted, the aircraft is pointed in a clear direction, the engines are stopped, and the area cleared immediately of flight personnel. The ordnance disposal crew then assumes responsibility for handling the missiles.

If no dangerous conditions are found by the ordnance crew, the dearming process proceeds and the missile or missiles are unloaded in the manner described above.

MISSILE SAFETY PRECAUTIONS

Although the safety precautions mentioned below are listed in various publications dealing with missiles and munitions, it is deemed helpful to reiterate some of them with the thought in mind that safety cannot be overstressed when working with ordnance. A few of the more pertinent safety precautions are as follows:

1. Qualified personnel must supervise all loading, unloading, assembly, and disassembly of missiles.
2. All missile handling must be carried out in accordance with approved local safety regulations in force on shipboard, at depots, or wherever the work is accomplished. Detailed precautions must be observed and specific instructions must be followed with each type of guided missile. These are given in the manual or other classified publications pertaining to the missile.
3. Only authorized handling equipment should be used with any missile, or with any missile section, component, or related parts, including shipping crates and containers.
4. When transporting the missiles to the aircraft on skids or dollies, care must be taken to avoid subjecting them to hot jet exhaust or to intense radiation from nearby electronic equipment.
5. After assembly, all dangerously sharp edges should be covered with guards.
6. Keep fingers and hands away from wings and fins when the control section of the missile is energized to avoid injury from moving surfaces.
7. Fuze covers are left on until the last convenient moment before arming the missile.
8. Tools used for uncrating missile components during assembly must be of the type specified in the missile manual.
9. Never attempt to force any unit; if it does not fit or function properly, determine the cause and correct it before proceeding.
10. Work areas must be kept clear of obstructions, loose cables, hose, and any unneeded equipment during missile assembly and testing. Only those persons engaged in the work in progress should be permitted in the work area or in the vicinity of the missile at these times.
11. All missile test equipment must be operated by properly qualified personnel only. Before applying test pressures to any missile, be sure that all air and hydraulic connections are well secured. A loose connection is dangerous, since the pressures used are generally capable of causing serious injury and damage.
12. Be sure that the missile airframe is well grounded electrically at all times. Before connecting ignitiers in rocket motors, check the firing leads for stray or induced voltages and for static charge.
13. If, during loading, a missile is dropped or severely jarred, it must be rejected and struck below for disassembly and inspection.

MISSILE ORDNANCE SAFETY PRECAUTIONS

Missile ordnance materials include rocket motors, igniters, fuzes, warheads, and in some cases, boosters, or auxiliary rockets. All of these units are potentially dangerous; and any particular unit must be handled in accordance with the specific procedures authorized for it in the appropriate publication.

Before handling any piece of ordnance material, inspect the safety device to be sure that it is in the SAFE position. If not, the unit must be made safe by experienced personnel before further work is carried out.

Some missile warheads are shipped and stowed with fuzes installed. Insure that safety pins and safety devices are installed in accordance with local directives.

Safety pins in fuzes, or any other device requiring removal or adjustment before flight, must be removed or adjusted only after the missile has been loaded on the launcher.

Missiles not expended on live runs must be made safe at the first opportunity in accordance with current instructions for the various ordnance assemblies.

All safety devices provided in ordnance units must be used exactly as designated. These devices must be kept in order and operative at all times.

Changes, modifications, or additions to ordnance items must be made only upon explicit direction by the Bureau of Naval Weapons.

Electric igniters, VT fuzes, detonators, and electrically fired rocket motors must be carefully protected from radiofrequency emissions. None of these units should be exposed within 5 feet of any operating electronic transmitting equipment, including antennas and antenna leads. When the transmitting apparatus is a part of authorized test equipment or is a part of the weapon system, special instructions concerning its operation must be followed. No danger exists, however, from radiofrequency potentials with detonators of any type while they are completely enclosed in metal containers.

PRECAUTIONS WITH HIGH-PRESSURE SYSTEMS

Certain units in many missiles are supplied with primary power by means of an accumulator charged from gas bottles or cylinders, containing compressed air or nitrogen. The high pressures used in those units make it necessary that extreme caution be exercised by personnel charging the accumulators and gas bottles or handling the containers in which the gases are stowed. A few of the more pertinent safety precautions are listed below:

1. All hydraulic fluid and air charges must be discharged from accumulator units before the wing-control section is removed. High pressures, capable of causing injury to personnel and damage to equipment, exist at the connection between the wing section and the accumulator unit when the latter is charged with hydraulic fluid.

2. When testing for leaks in a gas container, use soapy water.

3. When any hydraulic unit is disassembled for inspection or repair, be sure that the workbench is thoroughly cleaned of dirt and metal filings.

4. Keep the hands and other parts of the body well clear of exhaust streams when working with test equipment employing high pneumatic pressures.

5. Upon completion of systems tests, be sure that the air and hydraulic supplies have been turned off and bled before removing the lines from the missile.

6. Remain constantly on the alert to avoid injury or damage to person or property caused by slipstream, jet blast, or rocket or missile blast.

CHAPTER 20

RESEARCH AND TESTING ACTIVITIES

Experience has proven that there are no short cuts to good weaponry. Behind every successful weapon is a bona fide operational requirement. Every true operational requirement stems from two fundamental considerations: First, there is the nature of the two opposing strategies—ours and the potential foe's; and second, there is the specific nature of the threat or target against which the weapons are to be employed.

In practice, an operational requirement is usually studied for years before it is formulated into a firm guide for weapon development. It is examined from every aspect, how it affects our national strategy, how it fits into our current tactical doctrine, whether it can be produced with available knowledge, etc. Feasibility studies are made which are correlated with the basic considerations for establishing the original operational requirements. Operational analyses are conducted. Ideas are crystallized. Finally, performance specifications are compiled which, in turn, establish the need for solving other operational and logistic problems.

For example, consider the requirements for a new high performance attack aircraft. Obviously, it is always desirable to increase the aircraft's combat radius—this will either allow the reduction of the vulnerability of the launching carrier wing to enemy action, or it will permit deeper penetration into enemy territory. However, as combat radius increases, the size of the aircraft must also increase to handle the larger fuel load. An alternative to greater size is to use in-flight refuellers. In any event, whether the aircraft are made larger or whether refuelling aircraft are assigned to the carrier, fewer attack aircraft can be accommodated by the carrier. The same rationale applies to increased speed. Greater speeds generally call for larger aircraft if the aircraft are still to be able to carry a load of weapons and to perform a naval mission.

A further study of operational problems reveals other requirements. Consider the matter just discussed, carrier loading. What is the optimum loading? What percent of the aircraft should be used for offense and what percent for defense?

A possible solution to this situation would be to design aircraft to serve a dual (defensive-offensive) purpose. Certainly versatility is desired, but so is simplicity. Here the Navy is involved with the difficult area of trade-offs in complexity, effectiveness, reliability, growth potential, and cost.

The Navy must rely on operational and technological analyses plus experience in evaluating weapons and aircraft. Experience has shown that each of the Navy's successful aircraft has been conceived and designed for a clear-cut basic mission. As long as the capability to perform this basic mission was held inviolable, additional support missions could be added. But wherever this basic capability has been degraded in the process, the aircraft in practically all cases has resulted in something less than desired.

Nevertheless, this dual capability has been achieved in certain cases. For example, the F-4B (Phantom II), introduced in to the fleet in 1961, is the fastest, longest ranged, highest flying fighter in the Navy today. With its excellent search and tracking radar, the F-4B can locate enemy aircraft under all conditions of visibility and can engage them with Sparrow III and Sidewinder missiles. Besides this superb capability for fulfilling its basic mission, the Phantom can carry and deliver up to 11,000 pounds of bombs in a strike.

The very close relationship between aircraft and their ordnance and armament is particularly apparent during research and development of these equipments. As a direct by-product of the exhaustive tests to determine the effectiveness of aircraft weapons, the vulnerable spots of the aircraft become evident. Thus, new military aircraft must be of improved design to eliminate this particular design deficiency.

The Korean War tended to motivate research and development and provided the impetus for progress in guided missiles, air defense, antisubmarine methods, and various other devices. The high degree of success of the Sidewinder employed by the Chinese Nationalists in the Quemoy crisis has also intensified interest in missiles and missile countermeasures. The high degree of success with rockets and missiles in destroying aircraft in the air has resulted in a new intensified research program to develop countermeasures that will allow aircraft to perform their assigned missions.

As the Navy looks ahead to the weapons of the future, it must profit by some of the lessons of the past. The cost, complexity, and maintenance of new weapons and aircraft have climbed at an alarming rate. Future trends in weapons must be toward integration, simplicity, and reliability. This can only be accomplished by research, testing and evaluation of current and future weapons and aircraft.

Congress has provided specific funds so that the Navy may purchase certain equipment thought suitable for shipboard use and perform equipment shipboard environmental tests in addition to the usual laboratory tests. If the equipment performs satisfactorily, it may then be purchased.

The same concept also allows the Navy to procure commercially developed items to determine their suitability. In many cases, the only changes needed to adapt commercial equipment to service use is the use of military standard parts and structural strengthening to withstand shock, vibration, etc.

Major changes which will affect Navy procurement and research and development have been initiated. These changes are as follows:

1. Establishment within the Office of the Secretary of the Navy of a Plans Appraisal Office. The office reviews all service programs before their presentation to the Secretary of Defense to insure that they fulfill the broad guidelines established by the Department of Defense. The office operates along the same lines as the current Department of Defense management policy which centralizes decision-making authority in the Office of the Secretary of Defense.

2. Establishment in the Office of the Chief of Naval Operations of a Plans and Programs Office designed to insure that the Navy fulfills and adheres to the Department of Defense's 5-year program package management concept. This provides that all development programs must have detailed plans covering a 5-year period, which establishes scheduling, progress of development, and funding requirements.

3. The Chief of Naval Material, as the head of the newly created Naval Material Support Establishment, has direct control over the Bureau of Yards and Docks, Bureau of Naval Weapons, Bureau of Ships, and the Bureau of Supplies and Accounts. The Chief of Naval material reports directly to the Secretary of the Navy. The functions of the Bureau of Naval Personnel and the Bureau of Medicine and Surgery remain unchanged.

4. Establishment of a Field Support Activity under the Chief of Naval Operations. The mission of the Field Support Activity is to carry out management control responsibilities with respect to assigned naval shore activities; and to provide administrative and logistic support to headquarters of unified, specified, and their subordinate commands, as may be assigned by the Chief of Naval Operations.

5. Bureau of yards and Docks is given responsibility for maintenance at all Navy bases and installations now handled by the various bureaus.

6. The regional Navy District Commanders are assigned to represent the Field Support Activity in the coordination of fleet support activities. This is in addition to their current duties as heads of reserve units, public information, and representatives of the Chief of Naval Operations and the Secretary of the Navy in their areas.

NAVAL RESEARCH FACILITIES

The Bureau of Naval Weapons is responsible for the research, development, design, test, operating standards, manufacture, procurement, fitting-out, storage, distribution, issue, maintenance, alteration, repair, overhaul, material effectiveness, disposition, and salvage of all naval weapons.

Numerous government and private research and testing establishments carry on the research, experimentation, testing, and evaluation which are basic to the design of weapons and devices in the field of naval airborne ordnance. These facilities range from the large rocket and missile development and test station at China Lake, California, and the 875-acre Naval Ordnance Laboratory at White Oak, Maryland, to the small but important naval unit at the Army's White Sands Proving Ground in New Mexico.

Several of the largest research facilities are still expanding, notably the Naval Ordnance Test Station at China Lake, the Naval Ordnance Laboratory at White Oak, and the Naval Missile Center at Point Mugu.

OFFICE OF NAVAL RESEARCH

The Office of Naval Research, Washington, D.C., was established by Congress on August 1, 1946 and is commanded by the Chief of Naval Research who is appointed by the President.

The Office of Naval Research is charged with the duties of encouraging, planning, initiating, and coordinating naval research, and conducting naval research in augmentation of and in conjunction with the research and development conducted by the respective bureaus, offices, and other agencies of the Department of the Navy. The Chief of Naval Research is the adviser to the Assistant Secretary of the Navy (Research and Development) on research and such other matters as the Assistant Secretary may direct. He keeps the Assistant Secretary of the Navy (Research and Development) and the Chief of Naval Operations advised on naval and other research. The Chief of Naval Research is the principal representative of the Department of the Navy in dealings of Navy-wide interest on research matters with other government agencies, corporations, educational and scientific institutions, and other organizations and individuals concerned with scientific research.

The Chief of Naval Research plans and coordinates research and exploratory development programs throughout the Department of the Navy. He studies and collaborates with the Chief of Naval Operations, the Commandant of the Marine Corps, and the bureaus and offices in the formulation of the principal development programs of the Department of the Navy. He disseminates scientific information to these agencies for use in their development programs. All proposals within the Department of the Navy for establishment of, abolishment of, or significant changes in all laboratories concerned with research or development are referred to the Chief of Naval Research for comment and recommendationprior to final action.

The Chief of Naval Research surveys the worldwide findings, trends, potentialities, and achievements in research and development, keeps the Assistant Secretary of the Navy (Research and Development) and the Chief of Naval Operations advised thereon, and disseminates such information as appropriate to interested bureaus and offices within the Department of the Navy and to other governmental or private agencies.

The Office of Naval Research supervises, administers, and controls all activities within or on behalf of the Department of the Navy relating to patents, inventions, trademarks, copyrights, royalty payments, and similar matters, and correlates such activities with the research and development activities of the Department of the Navy.

The Chief of Naval Research is authorized to undertake upon his own initiative, or at the direction of the Chief of Naval Operations, or at the request of any bureau, office, or headquarters of the Department of the Navy, maintenance, modification, and improvement of training devices and aids, and components thereof. The Chief of Naval Research may insure at the request of the Chief of Naval Operations or any bureau, office, or headquarters of the Department of the Navy, the design and development of training devices and aids, and components thereof, to the extent that appropriations are made available therefor.

The office is charged with the management control and technical direction of the Naval Research Laboratory, Washington, D.C.; the Naval Training Device Center, Sands Point, Port Washington, Long Island, N.Y.; the Navy Underwater Sound Reference Laboratory, Orlando, Fla.; and the Naval Biological Laboratory, Oakland, Calif. It has, in addition, under its management control and technical direction, branch offices in London, (England), Chicago, New York, Boston, Pasadena, and San Francisco, and various resident representatives in areas of extensive research activity.

NAVAL ORDNANCE LABORATORY, WHITE OAK, SILVER SPRING, MARYLAND

The Naval Ordnance Laboratory (NOL), Silver Spring, Maryland, has been one of the Navy's principal sources of new weapons for more than 40 years. Located on an 875-acre tract, this laboratory has the primary mission of originating, developing, and evaluating naval weapons for the fleet.

NOL has a physical plant of almost 200 buildings with a replacement value of over 50 million dollars and equipment valued at 10 million dollars. The scope of the laboratory's work has constantly broadened in keeping with its increased size. Originally devoted almost exclusively to mine development, now less than one-third of its total effort is spent on mines.

The laboratory is equipped to perform research and development in the fields of conventional explosives, aerodynamics and aeroballistics, weapons effects, solid state physics, magnetic materials, plastics, underwater acoustics, and magnetism. Projects range from relatively small tasks and products to the development of the most modern complex weapons.

In order to perform its work, NOL has some outstanding technical facilities. These include wind tunnels operating up to 10 times the speed of sound; instrumented pressurized ballistic ranges, one of which is 1,000 feet in length; computers for data reduction and analysis; technical shops for construction of engineering designs, components, and experimental devices; and a 100-foot deep mine test tank for evaluating moored mines and antisubmarine weapons.

There are also the following facilities: a plastic laboratory for study and development of plastic materials and production techniques; environmental evaluation facilities to produce extremes of temperature, humidity, pressure, and acceleration; a ship-model magnetic measurements laboratory where degaussing systems are designed and calibrated; X-ray equipment with up to 10 million electron volts for nondestructive testing; and specialized facilities for research in chemistry and the physical effects of explosions.

In addition to the laboratory at White Oak, NOL has test facilities at Fort Lauderdale, Fla.; Fort Monroe, Va.; and Solomons, Md. These three facilities, with combined staffs of about 200 employees, are utilized for air-dropped weapons, mines, and other weapons requiring full-scale field trials. At the Fort Monroe and Fort Lauderdale facilities, inert mine fields are maintained where ships of the fleet pass through to check the effectiveness of new mines and the ship's degaussing systems.

NAVAL MISSILE CENTER, POINT MUGU, CALIFORNIA

The Naval Missile Center at Point Mugu is under the direction of the Bureau of Naval Weapons and is designed to be one of the most extensive guided missile test centers in the world. Its mission is the testing and evaluation of guided missiles and their components. Flight tests include powered tests of self-propelled missiles, captive flight tests of missiles attached to aircraft, and free-fall tests of missiles launched from aircraft.

Laboratory tests of missile components simulate flight conditions and various operating conditions. Various launching means are utilized, including powder catapults and booster rocket launchers. Flight tests and drop tests are conducted over the Pacific Missile Range at Point Mugu.

The Naval Missile Center covers about 7,000 acres; outlying stations have been established at five remote islands to permit observation and instrumentation seaward for some 60 miles from Point Mugu. Missiles fired from Point Mugu can be tracked by radar, and their flight can be controlled and measured from the island stations.

The missiles that have been tested and evaluated at Point Mugu include the Loon, Lark, Sparrow, Sidewinder, Meteor, Regulus, and Corvus.

NAVAL ORDNANCE TEST STATION

The Naval Ordnance Test Station, China Lake, California, was established in 1943 for the purpose of research, development, and testing of weapons, particularly rockets and guided missiles. It is one of the largest research and test facilities of the Bureau of Naval Weapons. This station, located in the Mojave desert area, covers about 1,000 square miles of desert, plains, and mountains. The test ranges offer a complete system of communications and are equipped for radar, optical, and Doppler tracking, and for telemetering. Projects at the Naval Ordnance Test Station are directed by five technical departments: Aviation Ordnance, Weapons Development, Propellant and Explosive, Research, and Test.

The Naval Air Facility at the Naval Ordnance Test Station conducts tests on launching as well as the explosives carried on the launchers. The first 5-inch rockets and 5-inch high performance folding-fin aircraft rockets (ZUNI) were given their initial aircraft tests at this facility. Test firings evaluate in a practical way the effects of rocket blast, test various types of launchers, and determine sighting constants and penetration ability under varying conditions.

Initial tests of the HIPEG (High Performance External Gun) system were also conducted at this test station.

The Underwater Ordnance Department has headquarters at the Naval Ordnance Test Station Annex, Pasadena, California, with extensive facilities for study of water entry and underwater behavior of torpodeos and other weapons at Morris Dam, located a short distance northeast of Pasadena.

Located at the Naval Ordnance Test Station, China Lake, is a supersonic track which is used for aeroballistic tests. This supersonic naval ordnance research track (SNORT) is used for testing in the fields of guided missiles, crosswind ballistics, aircraft damage, and fuze development. Testing on this facility is midway between static or wind-tunnel testing and free-flight testing.

The Michelson Laboratory is also located at China Lake. It is one of the most complete research facilities of its kind in the world, and is equipped for basic and applied research in physics, chemistry, aerophysics, metallurgy, ballistics, propulsion, fire control, and guidance systems for rockets and other missiles.

NAVAL AIR TEST CENTER, PATUXENT RIVER, MARYLAND

The Naval Air Test Center located at Patuxent River, Maryland, is a large air station with many facilities and multimissions to perform. The main facility of concern to the Aviation Weapons Officer is the Weapons Systems Test Division. The mission of the Weapons Systems Test Division is to evaluate and test new aircraft armament and weapons systems for fleet suitability. Such items as bomb racks, bomb shackles, bomb ejector racks, missile launchers, and many other devices receive preliminary tests and evaluation at the test center.

NAVAL WEAPONS LABORATORY, DAHLGREN, VIRGINIA

Since 1945 the Naval Weapons Laboratory, Dahlgren, Virginia has grown from essentially a test activity to one involved in research, development, evaluation, and testing. The laboratories presently include the high speed computing center, the materials laboratory, facilities for studying transient phenomena, and extensive aeroballistic ranges.

The computation center houses the Naval Ordnance Research Calculator (NORC), which is designed especially for the solution of the most complex problems of science and technology. By using all of the available facilities a broad scope of investigation covering research in materials; physics, mathematical studies; determination of interior, exterior, and terminal ballistics of missiles and bombs; and equipment testing under extreme environmental conditions is made possible.

APPLIED PHYSICS LABORATORY OF JOHN HOPKINS UNIVERSITY, SILVER SPRING, MARYLAND

The Applied Physics Laboratory of the Johns Hopkins University is not a naval laboratory; however, since some if its contracts are with the Bureau of Naval Weapons, the research being performed there is of interest to Aviation Weapons Officers. This laboratory has developed proximity fuzes for rotating projectiles, and an influence type torpedo exploder. An effective telemetering system, now in wide use for missile testing, was also produced there.

U.S. NAVAL AVIONICS FACILITY

The U.S. Naval Avionics Facility (NAFI) located at Indianapolis, Indiana, has been studying advanced electronics technologies for the Bureau of Naval Weapons since 1959. These studies have covered both the weapons research and development area and the manufacturing technology development area.

The functional testing of aviation ordnance suspension and releasing equipment is also conducted at the Naval Avionics Facility.

U.S. NAVAL AIR DEVELOPMENT CENTER

The U.S. Naval Air Development Center (NADC) is located at Johnsville, Pennsylvania. NADC performs research, design, development, testing, and evaluation of aeronautical systems and components. During the last quarter of a century, the laboratory has made significant contributions to the Navy in areas of navigation, automatic controls, cockpit instrumentation, and integrated avionics systems.

Numerous aviation ordnance items were designed and received further refinement at the air development center.

MAJOR PROBLEMS IN AVIATION ORDNANCE RESEARCH

In certain weapon developments, extreme technological problems stem from the operational requirement which originally initiated the development. It is no simple matter to come up with a sound operational requirement. Detailed intelligence estimates of the enemy are needed. Operational evaluation studies must be made of possible tactical situations. An appraisal of what can or cannot be accomplished within the technological possibilities is most important. Also, there are certain human or psychological considerations which inhibit the logical and objective development of a superior arsenal of weapons.

There is a tendency on the part of military personnel to be conservative toward radical concepts. Thus it is that the operational requirements originally spelled out for a weapons system is often conditioned by the experience of the most recent war. In some cases, the requirement is specifically aimed at correcting deficiencies experienced in combat and it is frequently stated in terms that tend to restrict or to channel the development along certain technological lines.

Many of the problems of current concern in modern aviation ordnance research have been brought about through the increased altitudes and speeds at which aircraft operate. Operating altitudes and speeds have increased considerably and indications are that they will continue to increase and continue to pose problems to those in the ordnance research field. Problems have also arisen in the design of aircraft and accessories. New concepts in hydraulic and electrical systems had to be developed to withstand high-speed operations and temperature changes.

The new aircraft require faster firing ordnance and more accurate accessories and controls. The increased acceleration loads of high performance aircraft further complicate the design of airborne ordnance; lubrication of delicate ordnance equipment is a difficult problem if the weapons are to be flown at very high altitudes, even for a brief period.

Current aircraft must be designed to handle rockets and guided missiles including the rockets Mighty Mouse and Zuni, and the missiles Sparrow, Bullpup, Sidewinder, and others. The day of the missile is here, and although it cannot be considered the ultimate weapon in its present state of development, it is the current weapon upon which the Navy depends to provide the fleet with air defense and to provide air, surface, and submarine striking forces with the capability of attack.

AVIATION ORDNANCE RESEARCH PROGRAM

To perform the various tasks required, the Navy must remain a flexible service capable of action under an extremely wide variety of conditions, ranging from brush fires to the extreme case of all-out unrestricted warfare.

During the first half of this decade, the research and development work of the Bureau of Naval Weapons has yielded sophisticated guided missiles, advanced underseas warfare weapons, nuclear weapons, and modern ordnance to the fleet. Significant progress has been made in development of futuristic weapons, weapons with humanlike senses and responses, weapons of fantastically great power, and continued improvements in the levels of existing weapons.

Advancements that have been made in aviation ordnance in the first half of this decade include the following:

1. Improvement to the Bullpup. Bullpup B is now undergoing final development.
2. Sparrow III has been refined to destroy high performance aircraft at practically all altitudes, in all weather, and from any angle.
3. The Sidewinder has been greatly improved. The high performance Sidewinder IC is being delivered to the fleet.
4. The Shrike, an antiradar missile, is being developed and is scheduled for delivery to the fleet.
5. Another additional missile for the naval arsenal now being developed is the Phoenix. It will eventually become the long-range, air-to-air missile planned as the major armament for the Navy's version of the F-111B tactical fighter.
6. Improved ASW mines for aircraft and submarine laying, and mine countermeasures

equipped to detect, localize, and neutralize enemy mines are being developed and are scheduled for service use in the near future.

7. An extensive program of bomb modernization is underway to make a stockpile of bombs compatible with modern high performance aircraft and to improve their ballistic properties.

8. A complete new family of free-fall weapons is being developed which will have greater effectiveness and lethality than similar existing weapons. Among the free-fall weapons series are the Rockeye, Gladeye, Snakeye, Walleye, and Sadeye.

Since there is no substitute for firepower, the requirements of the future for improved naval weapons is expected to assume even greater importance in the missions of the Navy. Newer weapons must be of greater range, more easily moved, and possess greater killing power. The research and development field is a continuing and challenging one.

ORDNANCE PROBLEMS OF HIGH PERFORMANCE AIRCRAFT

Some of the many problems encountered concerning high performance aircraft that have recently been solved or that are in the process of being solved include the following:

1. Faster firing guns.
2. Streamlined weapons of all types to adapt to high performance aircraft.
3. Electrical fuzing (elimination of external arming devices).
4. Weapons able to withstand high speed impact.
5. Mechanism to retard descent of weapons to allow low flying aircraft a margin of safety.
6. Integrated weapons systems to meet current needs.
7. Modifications of obsolete equipment to current needs (elimination of excessive waste).
8. Safety devices to keep pace with modern equipment.
9. Missile countermeasures.
10. Weight and balance problems.
11. Aircraft suspension and releasing devices with multmission capabilities.
12. Handling equipment designed for a maximum variety of stores.

ORDNANCE PHASES OF COLD-WEATHER RESEARCH

Naval operations in the Arctic regions, including submarine and antisubmarine warefare, emphasized the need for airborne ordnance capable of operating under all meteorological conditions. The present research and development program is designed to equip all-weather aircraft with all-weather armament and weapons control systems.

Although naval surface operations rarely encounter subzero weather conditions, aircraft and their armament may encounter -70°F at high altitudes in any latitude. Severe icing or the freezing of moisture inside control units or instruments may make training hazardous or radically reduce combat effectivenes. It is the long-range objective of cold-weather ordnance research to study and improve each component so that all equipment will be operable under the most extreme conditions likely to be encountered in training or in combat.

Among the important types of ordnance undergoing study in cold-weather operations are aircraft rockets, torpedoes, and instruments of various types. Low-temperature lubrication of armament release equipment, ammunition components, and instruments are continuously being evaluated, especially those items which have moving parts affected by temperatures, humidity, or other conditions accentuated in cold weather.

ORDNANCE PHASES OF HIGH ALTITUDE RESEARCH

Operating altitudes of current aircraft together with the utilization of rockets and missiles have created a demand for the study of atmospheric conditions and the effect of these conditions upon ordnance equipment.

The composition of the air must be accurately known at all attainable altitudes if turbojet and ramjet engines are to be utilized to their fullest extent. Rocket motors to be effective also demand continuous study of the atmospheric conditions.

The design of long-range guided missiles for accuracy of guidance depends upon thorough knowledge of temperatures, pressures, electrical phenomena, earth's magnetism, and all other physical and meteorological factors which influence bodies traveling at extreme altitudes and at speeds of several thousand miles per hour. Skin friction at such speeds, when the missile reenters the earth's atmosphere, becomes so high as to melt the surface of ordinary materials, especially the lighter types desired for missiles with high payloads.

NUCLEAR RESEARCH FOR MILITARY PURPOSES

Nuclear research has large implications for airborne ordnance, in addition to the obvious facts that the nuclear bomb is designed for delivery by aircraft.

Fundamental responsibility for research, development, and production of nuclear weapons rests with the Atomic Energy Commission to deliver to the Armed Forces such quantities of fissionable materials as it deems necessary.

Atomic Energy Commission (AEC)

The purpose of the Atomic Energy Act is to provide by national policy that the development, use, and control of atomic energy is directed to make the maximum contribution to the general welfare, and to the common defense and security, and to promote world peace, increase the standard of living, and strengthen free competition in private enterprise. The Atomic Energy Commission has been established to provide and administer programs and to encourage private participation in such programs for research and development, international cooperation, production of atomic energy and special nuclear materials, and the dissemination of scientific and technical information. The AEC has the responsibility to protect the health and safety of the public, and to regulate the control and use of source, byproduct, and special nuclear materials.

Defense Atomic Support Agency

The Armed Forces Special Weapons Project (AFSWP) was established in 1947 to conduct a program of research in the application of nuclear energy to military weapons. On May 6, 1959, the AFSWP was redesignated the Defense Atomic Support Agency (DASA).

Personnel are assigned to DASA by each of the military services and the position of Chief, DASA, is rotated among the services. The Chief, DASA, is responsible to the Secretary of Defense through the Joint Chiefs of Staff.

DASA conducts joint nuclear weapons technical operations for the Department of Defense, administers the defense portion of joint Department of Defense—Atomic Energy Commission effort in the control of the national stockpile of nuclear weapons, and processes nuclear weapon requirements in numbers and military characteristics through development, production, distribution, maintenance, modernization, and replacement in the national stockpile. DASA conducts technical training, performs technical inspections of deployed nuclear capable units; develops environmental criteria and construction standards for nuclear weapon storage and maintenance facilities; reviews operational safety measures in nuclear weapons systems; and provides overall surveillance, coordination, advice, and assistance on major actions affecting the nuclear weapons stockpile. DASA conducts the joint program for research in nuclear weapons effects, and plans for and supervises Department of Defense participation in nuclear weapons effects tests of primary concern to the Armed Forces and the weapons effects phases of developmental or other tests of nuclear weapons.

To accomplish its mission, the DASA is organized into a headquarters in Washington, D.C., Joint Task Force Eight in Washington, D.C., a Field Command at Albuquerque, N. Mex., and military units in certain storage locations.

GUIDED MISSILE RESEARCH

Research groups in all three services are studying concepts of future air-launched missile systems. However, operational requirements and actual development are currently being performed chiefly by the Navy. The Bureau of Naval Weapons is the principal bureau concerned with guided missile research and the development of specific missiles.

The Navy has several missiles that are currently being used in the fleet and has several missiles that are in the planning stage. The Sparrow III, Sidewinder, Shrike, and Bullpup are in operational use with the fleet. Other missiles that are undergoing research are the Condor and the Phoenix.

The problems encountered in guided missile research are numerous. Solid propellant versus liquid propellant has been continuously debated. However, the greatest requirement in air-to-surface missiles is probably for improved accuracy—chiefly a guidance problem. Greater range is another problem facing designers, and this becomes important in proportion to the improved performance capabilities of defensive weapons. As the speed of new launching aircraft continues to increase, future air-launched missiles will face new design and material problems.

APPENDIX I

FILM LIST

MC-8997 Jet Carrier (28 minutes). This film covers carrier operations with the latest type Navy aircraft aboard the USS Forrestal. Such operations as catapult launches, simulated nuclear weapons strikes, mirror landings, and carrier controlled approaches are dramatically portrayed. Applicable to chapters 1, 3, 7, and 12.

MN-8526 Sea Power—The Navy and the Missile Age (30 minutes). The necessity of protecting the world's shipping lanes is brought out and Soviet objectives are presented giving facts, figures, and ideological considerations. Counteraction to Communist aggressions by the Navy and other forces is discussed, stressing the readiness and mobility of the fleet. Details of the Navy's latest capabilities such as the Forrestal class carriers, guided missile advances, and ASW advances are also covered. Applicable to chapters 1 and 7.

MN-8529 Sea Power—The Sixth Fleet—Force for Peace (56 minutes). This is a story of the Sixth Fleet in action patrolling the Mediterranean frontiers. This film depicts the events of a typical "Med Rotation," beginning with the departure of the relief units from the east coast. The role of the officers and men of the Sixth Fleet both as ambassadors of good will and keepers of the peace in a troubled area is illustrated. Applicable to chapters 1 and 7.

MA-8891 Introduction to Automatic Date Processing (31 minutes). This film discusses the automatic Date Processing System (ADPS), explaining its underlying concept, capabilities, operation, and application as a new management tool. Applicable to chapters 2, 3, 4, 6, and 7.

KN-10,007 BuWeps Malfunction Reporting Program (30 minutes). The film discusses the new malfunction reporting program and shows the proper preparation of a Failure Unsatisfactory or Removal Report, NavWeps Form 13070/3. Applicable to chapter 2.

FN-9433G Principles of Paperwork Management—The Navy Directives System (18 minutes). This film shows the use of Navy directives, preparation, distrubution (on need-to-know basis), filing, and maintaining the system. Applicable to chapter 3.

MN-8242 Security—Your Personal Responsibility (16 minutes). To civilian and military personnel handling classified material, the film shows numerous situations where security leaks can occur. It makes clear that the maintenance of security in every case is a personal responsibility. Applicable to chapter 3.

MN-9997 Today is Tomorrow (21 minutes). This film encourages eligible naval officers to participate in postgraduate educational programs. Applicable to chapters 3, 6, and 7.

FN-8909 Danger—Stacked Deck (20 minutes). This film emphasizes six rules that are basic to flight deck safety aboard a large aircraft carrier underway. Each rule is shown being disregarded by flight deck personnel and the consequences are vividly illustrated. The film demonstrates how the safety rules should be observed. Applicable to chapters 5, 7, and 17.

MC-9514 Operation Top Gun (15 minutes). This film shows activity at the 1959 Naval Air Weapons Meet in Yuma, Arizona. It is a tactical demonstration of modern naval aircraft. Applicable to chapter 5.

MN-8681A Environmental Factors Affecting Reliability of Electronic Equipment (17 minutes). This technical film report presents the important role that naval shipboard environments—shock, vibration, salt spray, temperature, etc.—play in affecting the reliability of electronic equipment. Correlation of these environmental factors with the specifications and testing procedures is demonstrated. Applicable to chapters 5, 14, 15, 16, and 19.

MN-8706 The U.S. Naval Ordnance Test Station—Expanding Frontiers in Ordnance (21 minutes). This film describes the mission and operation of the Naval Ordnance Test Station and its activities at various sites in California. Stressed are the professional and educational opportunities for career personnel. Applicable to chapters 6 and 20.

MN-8147A 2.75 Folding Fin Aircraft Rockets—Handling and Loading Instructions (16 minutes). The film explains the makeup of folding fin rockets and how they are handled, both in loading into launchers and removing from launchers unfired. Safety precautions are stressed. Applicable to chapter 10.

MA-6692 Fundamental Principles of Fuzes (20 minutes). The film defines the basic fuze components and discusses the functioning of various types of fuzes, including impact superquick, impact delay, and time or aerial burst. It discusses various forces (setback, inertia, centrifugal, and spring tension) applied and safety devices. Final sequence discusses the VT fuze. Applicable to chapter 11.

MN-7359A Aircraft Launching of Active Acoustic Torpedoes—Introduction (20 minutes). A general overall discussion of the principles of operational active homing torpedoes is given. A short history of passive type homing torpedoes is presented, and a detailed discussion of the special operational characteristics of the Mk 32, 41, 43-0, and 43-1 is given. Applicable to chapter 12.

MN-9837 Mk 43 and Mk 57 Weapons Shipboard Handling Including Aircraft Loading (U) (20 minutes). Shipboard nuclear weapons handling of stockpile-to-target and replenishment at sea. Applicable to chapter 12.

MN-8109 Propellants—Research and Production (Confidential) (26 minutes). This film shows how propellants are developed, tested, and manufactured. It describes the various types of propellants used by the Navy; the basic nature of propellants; the basic fuels used; and the effects of physical design upon the burning rate. Applicable to chapters 8, 10, and 20.

MA-9475 U.S. Rifle, Cal. 7.62MM, M14-Operation and Cycle of Functioning (28 minutes). This film describes the design, capability, functioning, and operation of the M14 rifle. It is gas operated and capable of fully automatic and semiautomatic fire with standard NATO 7.62-mm ammunition. Applicable to chapter 9.

MN-7285B Materials Handling Equipment Operation—Gantry Truck and Warehouse Cranes (21 minutes). The film shows the various handling equipment; how to operate them properly; how to use them safely; emphasis on operational "know how" and safety measures. Applicable to Chapter 15.

MN-9740A Multiple Bomb Rack Rearming (17 minutes). This film shows recent developments and improved techniques in stores loading procedures. The use of the Bomb Truck Aero 33 and its various adapters is presented in situations involving weapons movements both ashore and afloat. Applicable to chapters 15 and 17.

MN-9301 Safety in Aircraft Line Operations (16 minutes). This film emphasizes the hazards of everyday aircraft line operations. It shows what might happen when the basic principles of safe aircraft handling are ignored during engine warmup, taxiing, armament loading, refueling, and inspection and maintenance. Applicable to chapter 17.

MN-8431 Tow Target Launching Technique—Drag and snap Takeoff Methods (20 minutes). The film shows how to prepare aerial towed targets for launching, the launching technique, and the recovery in both drag and snap takeoff methods. Applicable to chapter 18.

MN-8324 Defense by Air-to-Air Missiles (Confidential) (25 minutes). This film shows the actual firing of Sidewinder and Sparrow III missiles, also the development of missiles and the difficult problems to solve. Applicable to chapters 19 and 20.

MN-8420 Introduction to the Sidewinder (Confidential) (20 minutes). This film is a chalk talk introduction to the Sidewinder missile, explaining the operation of the guidance system and other missile components. The missile in flight is also shown. Applicable to chapter 19.

MN-8736B Bullpup Handling Procedures (Confidential) (20 minutes). This film shows the various components and operational characteristics of the Bullpup missile. It also demonstrates loading, preflight, arming, and dearming procedures. Applicable to chapter 19.

MN-8848 Missiles of the Navy (19 minutes). This film delineates the difficult task of designing and producing missiles to fulfill the unique requirements of the Navy. Applicable to chapters 19 and 20.

MN-9161B Guided Missile—Theory of Operation (20 minutes). An introductory film for presenting a study of guided missiles. Main emphasis is upon component parts and shows effectiveness of missiles launched at sea or on the shore. Applicable to chapter 19.

MN-9179B Navy Guided Missile Report (Report No. 2) (Confidential) (15 minutes). This film shows the actual firing of five different missiles and traces some of the major developments achieved. Applicable to chapters 19 and 20.

MN-8865 The Naval Research Laboratory Reactor (21 minutes). The film explains the construction, operation, and uses to which this reactor is adapted. Applicable to chapter 20.

MN-9165 Naval Ordnance Laboratory—The N-O-L Story (20 minutes). A description of the work involved in the research and development of the Navy's latest weapons. The film shows at close range some of the most unique scientific instruments in the world, including N-O-L supersonic wind tunnels, 10-million-volt betatron, giant magnetic coils, bomb-drop test tower, and hydrostatic pressure tanks. Keynote of the film is the vital part played by science in the modern and closely integrated work of the many professions involved. Applicable to chapter 20.

MN-9607 The U.S. Naval Research Laboratory (27 minutes). This film describes the resources and operations of the U.S. Naval Research Laboratory, located in Washington, D.C. Established in 1923, it is the Navy's largest and oldest laboratory devoted exclusively to research in the physical sciences. A survey of typical projects in electronics, nucleonics, and materials shows how NRL's scientists support the development of tomorrow's Navy. Applicable to Chapter 20.

APPENDIX II

REDESIGNATION OF NAVAL AIRCRAFT

ATTACK SERIES

Current Designation	Former Designation
A-1E	AD-5
EA-1E	AD-5W
EA-1F	AD-5Q
A-1H	AD-6
A-1J	AD-7
A-3A	A3D-1
EA-3A	A3D-1Q
A-3B	A3D-2
EA-3B	A3D-2Q
RA-3B	A3D-2P
TA-3B	A3D-2T
A-4A	A4D-1
A-4B	A4D-2
A-4C	A4D-2N
A-4E	A4D-5
A-5A	A3J-1
A-5B	A3J-2
A-5C	A3J-3
A-6A	A2F-1
EA-6A	A2F-1H

NOTE: Future New Attack Aircraft will be designated starting at Design No. -7A.

BOMBER SERIES

Current Designation	Former Designation
UB-26J	JD-1
DB-26J	JD-1D

NOTE: Future New Bomber Aircraft will be designated starting at Design No. -1A.

HELICOPTER SERIES

Current Designation	Former Designation
UH-1E	HU-1E
UH-2A	HU2K-1
UH-2B	HU2K-1U
SH-3A	HSS-2
VH-3A	HSS-2Z
TH-13L	HTL-4
TH-13M	HTL-6
TH-13N	HTL-7
UH-13P	HUL-1
UH-13R	HUL-1M
CH-19E	HRS-3
UH-19F	HO4S-3
UH-25B	HUP-2
UH-25C	HUP-3
LH-34D	HYS-1L
SH-34G	HSS-1
UH-34D	HUS-1
VH-34D	HUS-1Z
UH-34E	HUS-1A
SH-34H	HSS-1F
SH-34J	HSS-1N
CH-37C	HR2S-1
UH-43C	HUK-1
OH-43D	HOK-1
CH-46A	HRB-1
QH-50A	DSN-1
QH-50B	DSN-2
QH-50C	DSN-3
XH-51A	NEW

NOTE: Future New Helicopters will be designated starting at Design No. -52A.

ANTI-SUB SERIES

Current Designation	Former Designation
S-2A	S2F-1
TS-2A	S2F-1T
S-2B	S2F-1S
S-2C	S2F-2
RS-2C	S2F-2P
S-2D	S2F-3
S-2E	S2F-3S

NOTE: Next design No. for Anti-Sub is No. -3A.

TRAINER SERIES

Current Designation	Former Designation
T-1A	T2V-1
T-2A	T2J-1
T-2B	T2J-2
T-28A	T-28A
T-28B	T-28B
DT-28B	T-28BD
T-28C	T-28C
T-33B	TV-2
DT-33B	TV-2D
DT-33C	TV-2KD
T-34B	T-34B
T-39D	T3J-1

NOTE: Next New Trainer design will start at No. -41A.

UTILITY SERIES

Current Designation	Former Designation
U-1B	UC-1
U-6A	L-20A
U-11A	UO-1
HU-16C	UF-1
TU-16C	UF-1T
HU-16D	UF-2

NOTE: Utility series will continue with Design No. -17A.

OBSERVATION SERIES

Current Designation	Former Designation
O-1B	OE-1
O-1C	OE-2

NOTE: Future New Observation Aircraft will be designated starting at Design No. -2A.

PATROL SERIES

Current Designation	Former Designation
P-2D	P2V-4
P-2E	P2V-5F
DP-2E	P2V-5FD
EP-2E	P2V-5FE
SP-2E	P2V-5FS
P-2F	P2V-6
MP-2F	P2V-6M
TP-2F	P2V-6T
P-2G	P2V-6F
P-2H	P2V-7
SP-2H	P2V-7S
LP-2J	P2V-7LP
P-3A	P3V-1
QP-4B	P4Y-2K
P-5A	P5M-1
SP-5A	P5M-1S
TP-5A	P5M-1T
P-5B	P5M-2
SP-5B	P5M-2S

NOTE: Next Design No. will be -7A.

CARGO/TRANSPORT SERIES

Current Designation	Former Designation
RC-45J	SNB-5P
TC-45J	SNB-5
C-47H	R4D-5
EC-47H	R4D-5Q
LC-47H	R4D-5L
SC-47H	R4D-5S
TC-47H	R4D-5R
VC-47H	R4D-5Z
C-47J	R4D-6
EC-47J	R4D-6Q
LC-47J	R4D-6L
SC-47J	R4D-6S
TC-47J	R4D-6R
VC-47J	R4D-6Z
TC-47K	R4D-7
VC-54N	R5D-1Z
C-54P	R5D-2
VC-54P	R5D-2Z
C-54Q	R5D-3
VC-54Q	R5D-3Z
C-54R	R5D-4R
C-54S	R5D-5
VC-54S	R5D-5Z
C-54T	R5D-5R
C-117D	R4D-8
LC-117D	R4D-8L
VC-117D	R4D-8Z
C-118B	R6D-1
VC-118B	R6D-1Z
C-119F	R4Q-2
C-121J	R7V-1
EC-121K	WV-2
WC-121N	WV-3
EC-121L	WV-2E
EC-121M	WV-2Q
TC-117D	R4D-8T
C-130F	GV-1U
KC-130F	GV-1
LC-130F	C-130BL
C-131F	R4Y-1
C-131G	R4Y-2
C-140C	UV-1

Because of the size of the design numbers for Cargo Aircraft, this series will start over at -1A. Following are new assignments made under new series of numbers:

Current Designation	Former Designation
C-1A	TF-1
EC-1A	TF-1Q
C-2A	NEW

NOTE Future New Cargo/Transport Aircraft will be designated starting at Design No. -3A.

FIGHTER SERIES

Current Designation	Former Designation
F-1C	FJ-3
DF-1C	FJ-3D
MF-1C	FJ-3M
DF-1D	FJ-3D2
F-1E	FJ-4
AF-1E	FJ-4B
F-2C	F2H-3
F-2D	F2H-4
F-3B	F3H-2
MF-3B	F3H-2M
F-3C	F3H-2N
F-4A	F4H-1F
F-4B	F4H-1
RF-4B	F4H-1P
F-6A	F4D-1
F-8A	F8U-1
DF-8A	F8U-1D
QF-8A	F8U-1KD
RF-8A	F8U-1P
TF-8A	F8U-1T
F-8B	F8U-1E
F-8C	F8U-2
F-8D	F8U-2N
F-8E	F8U-2NE
DF-9E	F9F-5KD
F-9F	F9F-6
DF-9F	F9F-6D
QF-9F	F9F-6K
QF-9G	F9F-6K2
F-9H	F9F-7
F-9J	F9F-8
AF-9J	F9F-8B
TF-9J	F9F-8T
RF-9J	F9F-8P
F-10A	F3D-1
F-10B	F3D-2
EF-10B	F3D-2Q
MF-10B	F3D-2M
TF-10B	F3D-2T2
F-11A	F11F-1

NOTE: Future New Fighter Aircraft will be designated starting at Design No. -12A.

SPECIAL ELECTRONIC INSTALLATION SERIES

Current Designation	Former Designation
E-1B	WF-2
E-2A	W2F-1

NOTE: Future New Special Electronic Installation Aircraft will be designated starting at Design No. -3A.

APPENDIX III

REFERENCE BIBLIOGRAPHY

PUBLICATIONS

ABC Warfare Defense, NavPers 10099.
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Aircraft Electrical Systems, NavPers 10791.
Basic Electricity, NavPers 10086-A.
Basic Electronics, NavPers 10087-A.
Circuitry of Naval Aircraft Electronic Systems, NavPers 10480 (Confidential).
Cumulative Supplement to U.S. Navy Film Catalog, NavWeps 10-1-772.
Division Officers Guide, U.S. Naval Institute.
Fleet Use of NAVSTRIP, NavSandA Publication 410.
Handbook Naval Air Launched General Ordnance, NavWeps 00-120A-2 (Confidential).
Handbook Naval Air Launched Guided Missiles, NavWeps 00-120A-1 (Confidential).
Handbook Naval Air Launched Nuclear Weapons, NavWeps 00-120-3 (Confidential).
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Index of Ordnance Publications, NavWeps OP 0.
Information and Education Manual, NavPers 16963-D.
Instructor Training, NavPers 92050.
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Manual for Courts-Martial United States 1951.
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Personnel Administration, NavPers 10848-C.
Ship Activation Manual, NavPers 10006-A.
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The Naval Aviator's Guide, U.S. Naval Institute.
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Uniform Code of Military Justice, NavPers 100 (Form).
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United States Navy Regulations, 1948, and General Orders, 1948.
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DIRECTIVES

GENERAL

Department of the Navy Security Manual for Classified Information, OpNav Instruction 5510.1B.
Navy Correspondence Manual, SecNav Instruction 5216.5

Navy-Marine Corps Standard Subject Classification System, SecNav Instruction P5210.11.
Organization Guide for the Naval Weapons Shore Establishment, BuWeps Instruction 5450.89.
Required List of COMTAC Publications for Naval Shore Activities, OpNav Instruction P5605.27.
The Naval Aircraft Maintenance Program, BuWeps Instruction 4700.2.
The Navy Directives System, SecNav Instruction 5215.1A.
U.S. Navy Physical Security Manual, OpNav Instruction 5510.45A.

CONVENTIONAL AMMUNITION DISTRIBUTION SYSTEM

004400.7 (OpNav). SUBJECT—Allocation of expendable ordnance items in short supply. PURPOSE—Provides guidance for the allocation of expendable ordnance items in short supply or limited supply.

08010.3 (BuWeps). SUBJECT—Designation of and issuance of priorities for expendable ordnance in a critical supply category. PURPOSE—Establishes criteria for classifying and managing expendable ordnance in critical supply and contains the procedure for promulgating lists of critical items.

4355.4 (BuWeps). SUBJECT—Scheduling of periodic coordinated conventional ordnance quality evaluation program. PURPOSE—Establishes a coordinated periodic surveillance program for all conventional ordnance items stored at the continental (and Oahu) ammunition depots.

4421.11 (BuSandA). SUBJECT—U.S. Navy Ordnance Supply Office; material mission of. PURPOSE—Promulgates a mission in terms of material over which OSO is assigned supply management responsibilities; also complements the functional mission of OSO promulgated by separate BuSandA instructions.

4420.28 (SecNav). SUBJECT—Uniform inventory management system; development of. PURPOSE—Promulgates policy guidance for the development and implementation of a uniform system for the inventory management of an item used by the Navy other than bureau cognizance items.

8000.9 (OpNav). SUBJECT—Inventories and expendable ordnance; reporting of. PURPOSE—Provides the basis for the periodic reporting of expenditures data to CNO; and to consolidate earlier CNO directives requiring such reporting.

8010.1 (OSO). SUBJECT—Marker, Location, Marine, Mk 25, Mods 0 and 1; information concerning. PURPOSE—Promulgates advance information on the description, usage, and availability of the Marine Location Marker, Mk 25, Mods 0 and 1.

8010.1 (BuWeps) SUBJECT—Ammunition Data and Record Card, NavWeps Form 8010/1; procedures for processing of. PURPOSE—Promulgates procedures for processing and use of the Ammunition Data and Record Card.

8010.2 (OSO) SUBJECT—Renovation of projectiles and nuclear warheads; replacement of fuzes during. PURPOSE—Provides guidelines applicable to the replacement of fuzes in projectiles and rocket warheads during the renovation process.

4460.1 (OSO). SUBJECT—Special purpose pallets, adapters, and associated components for U.S. Navy ammunition; inventory control of. PURPOSE—Provides procedures and instructions for the procurement, distribution, issue, use, and control of special purpose pallets, adapters, and associated components.

4610.1 (BuWeps). SUBJECT—Shipments of ammunition and explosives via Navy Sea Cargo Coordinators at NAD Earle and NAD Concord. PURPOSE—Amplifies OpNavInst 4610.4 as it relates to activities under the management control of the Chief, BuWeps, having responsibilities in connection with the shipment of ammunition and explosives.

4610.4 (OpNav). SUBJECT—Navy Sea Cargo Coordinator; designation and responsibilities of. PURPOSE—Establishes a coordinator for Navy Sea Cargo in certain continental coastal areas to centralize the booking of cargo with appropriate Military Sea Transportation (MSTS) Commands, and to provide effective local controls over the Navy Sea Cargo program for the area concerned.

08010.3 (CINCLANTFLT). SUBJECT—Fleet control of expendable ordnance items short supply; establishment of procedures for. PURPOSE—Delineates responsibilities and procedures for the control of stocks of expendable ordnance (except nuclear) items in short supply status within the LANTFLT/NAVEUR area.

08011.3 (BuWeps). SUBJECT—Active fleet training allowances of ammunition and guided missiles. PURPOSE—Promulgates the training ammunition allowances for all phases of active fleet training as established by CNO.

08011.14 (BuWeps). SUBJECT—Training allowance for Military Assistance Program (MAP) ships and MAP foreign personnel. PURPOSE—Promulgates training ammunition allowances authorized under the auspices of MAP.

P4235.1 (COMSERVPAC). SUBJECT—Pacific Requisitioning Guide. PURPOSE—Promulgates requisitioning procedures and channels established in the Pacific for those categories of material for which COMSERVPAC has supply responsibility.

5450.27 (BuWeps). SUBJECT—Responsibility for conventional ammunition inventory management and related functions; reassignment of. PURPOSE—Advises all activities concerned of the reassignment of functional responsibilities for the inventory management of certain conventional ammunition.

5450.28 (BuSandA). SUBJECT—U.S. Navy Ordnance Supply Office, Mechanicsburg, Pennsylvania; functional mission statement of. PURPOSE—Promulgates the functional mission statement of the U.S. Navy Ordnance Supply Office, Mechanicsburg, Pa. The material mission was promulgated by BuSandA Instruction 4421.11.

7300.5 (BuWeps). SUBJECT—Ammunition issues to the U.S. Coast Guard; accounting for. PURPOSE—Advises ammunition issuing activities that selected items of ammunition which heretofore have been issued to the U.S. Coast Guard on a cash sale basis may now be furnished without reimbursement.

8000.4 (COMSERVLANT). SUBJECT—Requisitioning and issue procedures for expendable ordnance. PURPOSE—Provides guidance and assistance to Fleet Units and Ex-CONUS bases in the LANTFLT/CARIBSEAFRON/NAVEUR areas concerning requisitioning procedures for expendable ordnance.

8010.11 (OSO). SUBJECT—Repairable cartridge actuated devices; turn-in of. PURPOSE—To establish procedures for the turn-in of overage or unserviceable cartridge actuated devices that have been removed from aircraft.

8010.12 (OSO). SUBJECT—Conventional Ammunition Distribution System; policy, procedures, and responsibilities for. PURPOSE—To describe the Conventional Ammunition Distribution System and define policy, procedures, and responsibilities for that portion of the system under inventory management of the U.S. Navy Ordnance Supply Office.

8011.4 (BuWeps). SUBJECT—Aircraft ammunition allowances for Marine Corps air stations and auxiliary air stations. PURPOSE—Promulgates the service and training ammunition allowances for Marine Corps air stations as approved by CNO.

8011.5 (BuWeps). SUBJECT—Ammunition allowances for east coast air stations (south). PURPOSE—Promulgates the service and training ammunition allowances for east coast air stations as approved by CNO.

8011.6 (BuWeps). SUBJECT—Ammunition allowances for east coast air stations (north). PURPOSE—Promulgates the service and training allowances for east coast air stations (north) as approved by CNO.

8011.7 (BuWeps) SUBJECT—Allowance of EOD equipment for ships having EOD and EOD-NW responsibilities. PURPOSE—Promulgates the allowances for EOD material for ships having EOD and EOD-NW responsibilities approved by CNO.

8011.8 (BuWeps). SUBJECT—Allowance list for EOD equipment for EOD and EOD-NW teams and units ashore. PURPOSE—Publishes the services and training allowance of equipment and ammunition for shore-based EOD and EOD-NW units and teams as approved by CNO.

8011.9 (BuWeps). SUBJECT—Allowance list for all Marine Corps EOD and EOD-NW activities assigned EOD responsibilities. PURPOSE—Promulgates the allowance for EOD material for Marine Corps activities having EOD and EOD-NW responsibilities as approved by CNO.

8011.10 (BuWeps). SUBJECT—Ammunition allowance for MSTS. PURPOSE—Promulgates the pyrotechnic and small arms ammunition allowance for MSTS ships and activities as recommended by the Commander, MSTS and approved by CNO.

8011.11 (NavOrd). SUBJECT—Ammunition allowances for Naval Reserve training ships and ships assigned to naval districts. PURPOSE—Sets forth the service and training ammunition allowances for the subject ships as established by CNO letter OP411D2/NS Serial: 2743P41 of 16 July 1958 (NOTAL).

8011.12 (BuWeps). SUBJECT—Ammunition allowances for Naval and Marine Air Reserve. PURPOSE—Promulgates annual ammunition allowances for Naval and Marine Reserve training as approved by CNO.

8011.13 (BuWeps). SUBJECT—Small arms training and matches. PURPOSE—Promulgates allowances of small arms ammunition for indoctrination, marksmanship, familiarization, team training, and matches for certain categories of naval personnel authorized to use Navy-procured small arms ammunition.

8012.1 (BuWeps). SUBJECT—Fleet control of expendable ordnance items in short supply; establishment of procedures for. PURPOSE—Establishes the procedures for designing an item as "Fleet Controlled" by Fleet Commanders.

8012.1 (NavOrd). SUBJECT—Issue and distribution of ammunition; instructions pertaining to. PURPOSE—Reaffirms and, in certain instances, modifies the procedures governing the issuance of ammunition and ammunition details.

8012.1 (OSO). SUBJECT—Procedures for controlling and requisitioning quality evaluation samples. PURPOSE—Establishes procedures to be followed in controlling and requisitioning quality evaluation (QE) samples under Navy standard Requisitioning Procedures.

8012.2 (BuWeps). SUBJECT—High explosives; procurement, distribution and issue of. PURPOSE—Amplifies and clarifies the responsibilities of the U.S. Navy Ordnance Supply Office for the procurement, distribution and issue of explosives.

8012.3 (OSO). SUBJECT—High explosives; procurement, distribution, issue and control of. PURPOSE—Promulgates the procedures and instructions for the procurement, distribution, issue, and control of high explosives and components.

8013.1 (BuWeps). SUBJECT—Overhaul cycles and grand-lotting procedures for conventional ammunition; instructions concerning. PURPOSE—Sets forth instructions and policies on overhaul cycles of ammunition.

8013.1 (NavOrd). SUBJECT—Inspection instructions for ammunition returned by forces afloat. PURPOSE—Establishes and furnishes revised instructions for visual inspection of ammunition turned in by forces afloat.

8014.4 (NavOrd). SUBJECT—Ammunition renovation program. PURPOSE—Establishes the ammunition renovation program.

8015.1 (ALMECH). SUBJECT—Fleet Ammunition Asset and Expenditure Reports handling and control of. PURPOSE—Establishes within the U.S. Naval Supply Depot and the U.S. Navy Ordnance Supply Office, the funding policy and procedures for the receipt, handling, safeguarding, and mailing of the Fleet Ammunition Asset and Expenditure Report.

8015.1 (COMSERVPAC). SUBJECT—Reports of assets and expenditures of expendable ordnance items. PURPOSE—Provides supplementary instructions concerning submission of the Expendable Ordnance Reports described in BuWeps Instruction 8015.4.

8015.1 (OpNav). SUBJECT—Expenditures of conventional ammunition and stock status of selected ammunition; standardized reporting of. PURPOSE—Establishes a standard system of reporting conventional ammunition expenditures and stock status of selected ammunition items by ships and aviation squadrons.

8015.1 (OSO). SUBJECT—Ammunition stock recording procedures for secondary stock points. PURPOSE—Provides ammunition stock recording procedures for secondary stock points.

8015.2 (OSO). SUBJECT—Ammunition in process; recording and reporting of. PURPOSE—Establishes standard procedures for recording and reporting items of expendable ordnance while in process of repair, rework, renovation, or other production type operations.

8015.3 (BuWeps). SUBJECT—Physical inventory of critical/limited supply expendable ordnance items based on a priority sequence; request for. PURPOSE—Directs a physical inventory of items and emphasizes the importance of reconciling all station stock and financial records with the physical inventory counts.

8015.3 (OSO) SUBJECT—Unsegregated ammunition, condition code G material; reporting of. PURPOSE—Establishes standard operating procedures for recording and reporting the receipt, condition transfer, and reconciliation of unsegregated items of ammunition.

8015.4 (BuWeps). SUBJECT—Assets and expenditures of expendable ordnance items; standardized reporting by fleet units. PURPOSE—Promulgates revised and clarifying reporting procedures to further refine the standardized reporting requirements prescribed by OpNavInst 8015.1.

8015.4 (OSO). SUBJECT—Ammunition stock recording and reporting procedural changes for distribution points; instructions for. PURPOSE—Provides stock recording and reporting procedural changes for distribution points.

8015.5 (BuWeps). SUBJECT—Reporting assets and expenditures of Navy-owned expendable ordnance items by commands and activities of the Navy Shore Establishment. PURPOSE—Establishes a standardized system for reporting assets and expenditures of Navy-owned expendable ordnance items by CONUS activities.

8023.1 (COMEIGHT). SUBJECT—Ammunition handling within the Eighth Naval District. PURPOSE—Implements OpNavInst 8023.2, OpNavInst 8023.10, and Ordnance Pamphlet 5 within the Eighth Naval District relative to the handling and transportation of ammunition and explosives.

8023.4 (BuWeps). SUBJECT—QUICKTRANS explosive and hazard safety procedures; establishment of. PURPOSE—Establishes responsibilities and provides guidelines, for the safe and efficient handling of ammunition, explosives, and other dangerous articles being shipped or received by or transsiting naval and Marine Corps activities via QUICKTRANS.

8026.2 (NAD Crane). SUBJECT—Handling and disposition of unserviceable and repairable cartridge cases and cartridge case brass; instructions for. (NOTE: This instruction is in the process of being revised by OSO.) PURPOSE—Establishes mobilization reserve retention levels for cartridge case brass and provides categories of and disposition instructions for unserviceable and repairable cartridge cases.

8026.3 (BuWeps). SUBJECT—Rocket igniters; procedures for disposition of by burning. PURPOSE—Promulgates instructions for disposition of unserviceable rocket igniters.

8026.9 (NavOrd). SUBJECT—Procedures for disposal of ammunition by dumping in deep water. PURPOSE—Establishes procedures incident to and for disposal of ammunition by dumping in deep water. The disposal of ammunition by detonation and burning is covered by separate instructions. The term ammunition as used throughout the instruction will include:

a. Inert and explosive—loaded ammunition.
b. Pyrotechnic and chemical ammunition.
c. Other hazardous items for which disposal by dumping in deep water is authorized; except radioactive waste which is the subject of a separate instruction.

8027.7 (NAD Crane (ALPEC)). SUBJECT—High explosives; instructions for burning of PURPOSE—Establishes basic procedures for the burning of high explosives.

8035.1 (BuWeps). SUBJECT—Saluting batteries allowance and stowage of ammunition for ammunition allowance instructions. PURPOSE—Promulgates allowances and stowage requirements and provides issue and use procedures for saluting ammunition.

8050.1 (NAD Crane (ALPEC)). SUBJECT—Disposal of pyrotechnic items by burning. PURPOSE—This instruction has been prepared in connection with BuOrd Task Assignment #9-57 and is intended to establish basic procedures and guidelines for the disposal of various pyrotechnic items by burning.

8370.2 (OpNav). SUBJECT—Small arms equipment and ammunition allowances for continental U.S. naval stations. PURPOSE—Provides small arms, equipment and ammunition allowances for training, security, and disaster control for activities of the Naval Establishment within the continental United States.

MISCELLANEOUS

Ordnance Publication (OP) 4, Volume 1, Ammunition Afloat. PURPOSE—Provides historical data, general information, and theoretical considerations with regard to the types of ammunition in use by the Navy.

Ordnance Publication (OP) 4, Volume 2, Ammunition Afloat. PURPOSE—Provides instructions for issuing, receiving, handling, stowing, surveillance, maintenance, and returning ammunition by the forces afloat, and for preparing reports which may be required from time to time.

Ordnance Publication (OP) 5, Volume 1, Ammunition Ashore; handling, stowing, and shipping. PURPOSE—Prescribes regulations for the safe handling, stowing, shipping, and surveillance of ammunition, ammunition components, and the explosives, chemicals, and raw materials normally associated therewith

Ordnance Publication (OP) 5, Volume 2, Production and Renovation. PURPOSE—Prescribes safety regulations and safe and uniform procedures for the production and renovation of ammunition, ammunition components, and ammunition details.

Ordnance Publication (OP), 5, Volume 3, Ammunition Ashore; advanced bases. PURPOSE—Same as prescribed for Volume 1.

Navy Property Redistribution & Disposal Regulation No. 1 (NPR&D No. 1). Revised 1 July 1958 as amended. PURPOSE—Prescribes the policies and procedures to be followed within the Department of the Navy in the reporting and distribution of all excess government-owned personal property under the jurisdiction of the Navy, and disposal of all such property determined to be surplus.

NavOrd List 23161-E (BuWeps). SUBJECT—Ammunition allowance list for west coast air stations (north and south). PURPOSE—Provides small arms, equipment, and ammunition allowances for training, security, and disaster control for activities of the Naval Establishment within the continental United States.

COMSERVPAC letter FF4-15 EDD 8012 Ser: 253-0881 of 26 Sep 1963. SUBJECT—PACFLT control of expendable ordnance items in critical supply. PURPOSE—Provides issue control of specified items by Fleet Commanders.

BuWeps letter FQAO-424:ARP of 1 Jun 1962 as modified by BuWeps letter FQ-1:WJK of 21 Aug 1962. SUBJECT—Waivers and deviations; procedures for handling. PURPOSE—Establishes the procedures and channels to be used by BuWeps managed activities and commercial contractors when submitting waiver and deviation requests on project orders and contracts respectively.

CINCLANTFLT letter Ser: 0175/42 of 1 Feb 1961. SUBJECT—Ordnance Logistics Agent; assignment of. PURPOSE—Assignment of Ordnance Logistics Agent for CINCLANTFLT.

MCO-P4235.17 Chapter 9. SUBJECT—Military Standard Requisitioning and Issue Procedure (MILSTRIP). PURPOSE—Establishes requisitioning and issue procedures for use by CMC.

MCO-8010.1 SUBJECT—Class V Logistical Procedures. PURPOSE—To prescribe class V logistical procedures for use in the planning and support of combat operations involving Fleet Marine Forces.

MCO-P8011.4 SUBJECT—Marine Corps Table of Allowances for Class V Material (Peacetime). PURPOSE—To promulgate class V material allowances for all activities, units, or detachments of the Marine Corps.

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