AD NUMBER

ADC960224

CLASSIFICATION CHANGES

TO: unclassified

FROM: confidential

LIMITATION CHANGES

TO:

Approved for public release, distribution unlimited

FROM:

Controlling Office: Bureau of Naval Weapons, Washington, DC.

AUTHORITY

OPNAV/INST S.5513.16A dtd 3 Jan 2000; NAVSEA ltr dtd 7 Jan 2000

[redacted]

NAVAL WEAPONS

BULLETIN

OCTOBER 1962

NUMBER 4-62 (U)

ISSUED QUARTERLY BY THE BUREAU OF NAVAL WEAPONS
DEPARTMENT OF THE NAVY • WASHINGTON

CONFIDENTIAL

NAVAL WEAPONS BULLETIN

OCT-DEC 1962

NUMBER 4-62 (U)

~~Downgraded at 12-Year Intervals:
Not Automatically Declassified
DOD Dir 5200.10~~

CONFIDENTIAL

~~EXCLUDED FROM THE GDS~~

ISSUED QUARTERLY BY THE BUREAU OF NAVAL WEAPONS
DEPARTMENT OF THE NAVY • WASHINGTON

(This page is unclassified)

COVER

Artist's conception of geodetic satellite ANNA 1-B with flashing beacon energized. See article entitled "ANNA 1-B Geodetic Satellite Successfully Launched" in Astronautics Chapter.
(UNCLASSIFIED)

The issuance of this publication was approved by the Secretary of the Navy on 2 February 1960

(This page is unclassified)

X63-11790

CONFIDENTIAL

DEPARTMENT OF THE NAVY
BUREAU OF NAVAL WEAPONS
WASHINGTON 25, D. C.

DLI-5
31 December 1962

NAVAL WEAPONS BULLETIN NO. 4-62 (U)

Naval Weapons Bulletins are issued quarterly by the Bureau of Naval Weapons for the purpose of:

a. Keeping the Naval Establishment informed of the progress of certain aviation and ordnance projects which are of special interest.

b. Giving Navy-wide dissemination to weapons information likely to be of general interest, including new developments.

c. Indicating the Bureau's action on suggestions or recommendations which are likely to be of general interest.

The thoughts conveyed in this Bulletin range from suggestions which should help in using present equipment to furnishing a background of information on advanced developments and concepts which might be useful for future planning. Suggestions for furthering these ends through the medium of these Bulletins will be welcomed.

Since much of the information appearing in these Bulletins is not readily available elsewhere, Commanding Officers are urged to arrange for widespread routing of the publication, particularly among junior officers.

This Bulletin is CONFIDENTIAL and shall be safeguarded in accordance with security provisions of Chapter 15, U. S. Navy Regulations, 1948, and OPNAV Instruction 5510.1B, 1958. Classification of each individual article is based primarily on the information it contains, not necessarily on the classification of the equipment or project described. Appropriate group notation for purposes of downgrading and declassification, in accordance with DOD Directive 5200.10, has been assigned to each article. A Group 3 classification has been assigned to the publication as a whole. In addition, all previous Bulletins of Ordnance Information and Naval Weapons Bulletins have been assigned a Group 3 classification.

The reproduction of this publication, or any part of it, by other than U. S. Navy activities is not authorized except by specific approval of the Chief of the Bureau of Naval Weapons. For wider dissemination of the information in it, however, unclassified sections may be abstracted at the discretion of Commanding Officers.

Accesion For	
NTIS CRA&I	
DTIC TAB	
Unannounced	
Justification	
By	
Distribution /	
Availability Codes	
Dist	Avail and / or Special
9	

K. S. Masterson
Rear Admiral, U. S. Navy
Chief, Bureau of Naval Weapons

CONFIDENTIAL

Bureau of Naval Weapons, Department of the Navy, Washington, D. C. OCT-DEC 1962

CONTENTS

NEW CHIEF AND DEPUTY CHIEF OF BUREAU

By Xina S. Felder, Technical Information Office, BuWeps

Rear Adm. Paul D. Stroop, USN, former Chief

Rear Adm. Kleber S. Masterson, USN, new Chief

Rear Adm. Wellington T. Hines, USN, new Deputy Chief

Rear Admiral Kleber S. Masterson, USN, became the second Chief of the Bureau of Naval Weapons on 14 November 1962, relieving Rear Admiral Paul D. Stroop, USN. Admiral Masterson had been Deputy Chief of the Bureau since 1961.

Admiral Masterson was born in San Jon, N. Mex., where he spent his early years, later moving to Farmington, N. Mex. Following graduation from high school in Farmington, he attended the University of New Mexico for one year prior to his appointment to the Naval Academy. As a Midshipman he won his "N" in wrestling, participated in track, and was a member of the "Log" staff. He graduated with distinction with the Class of 1930. He attended the Postgraduate School, Annapolis, for instruction in Ordnance from June 1936 to June 1938; and from August 1952 to June 1953 was a student in Strategy and Tactics at the Naval War College, Newport, R. I.

In March 1958, Admiral Masterson was assigned to the Office of the Chief of Naval Operations as Director, Guided Missiles Division, and from April to September 1959 he served in the dual capacity of Assistant Chief of Naval Operations (Development)/Director, Guided Missiles Division. For meritorious service from 7 March 1958 to 1 April 1960 as Director, Guided Missile Division, Office of Chief of Naval Operations, and as Executive Member of the Navy Ballistic Missiles Committee, Admiral Masterson was commended by the Secretary of the Navy.

Prior to his duty as Deputy Chief of the Bureau of Naval Weapons, Admiral Masterson served as Assistant Chief of Naval Operations (Development).

Rear Admiral Paul D. Stroop, USN, was the first Chief of the Bureau of Naval Weapons, being assigned to that position on 10 September 1959, ten days after the Bureau was established by Act of Congress as a result of the merger of the former Bureaus of Ordnance and Aeronautics. Admiral Stroop will assume the responsibilities of Commander, U.S. Naval Air Forces, Pacific, with the rank of Vice Admiral.

****

The new Deputy Chief of the Bureau is Rear Admiral Wellington T. Hines.

Admiral Hines, a native of Woodbury, Ky., attended Western Kentucky State College in Bowling Green for two years before entering the Naval Academy in 1926. As a Midshipman, he won academic prizes in physics, mathematics, and navigation, and was Business Manager of the "Lucky Bag." He graduated with distinction, second in his class, and was commissioned Ensign on 5 June 1930. He was designated Naval Aviator on 17 March 1932. He also attended the Navy Postgraduate School, Annapolis (1936-1938) and was granted the degree of Master in Science in Aeronautical Engineering by the Massachusetts Institute of Technology in 1939.

Admiral Hines has had several assignments in the former Bureau of Aeronautics—as Head of the Experimental Engines Branch, Power Plant Division, where he was concerned principally with the development of turbojet and gas turbine engines now operational; as Assistant Director of the Power Plant Division; as Assistant Chief of the Bureau for Procurement; and as Deputy and Assistant Chief of the Bureau.

From October 1946 to June 1949, he was assigned to the Manhattan Project, Atomic Energy Commission, Oak Ridge, Tenn., where he was under instruction in nuclear science and engineering as applied to production and power.

He has also served as Director of Tests at the Naval Air Missile Test Center, Point Mugu, Calif.; Commanding Officer of the Naval Air Turbine Test Station; and as Overhaul and Repair Officer at the Naval Air Station, Jacksonville, Fla.

Admiral Hines reported to BuWeps from duty as Assistant for Missile Production to the Assistant Secretary General for Production and Logistics, North Atlantic Treaty Organization.

(UNCLASSIFIED)

AIR

Uniform System for Designating and Redesignating Military Aircraft

BUWEPS Instruction 13100.7 of 18 September 1962 (Joint Army, Navy, and Air Force Publication) establishes uniform procedures, authority and responsibilities for designating, redesignating, and naming military aircraft, implementing Department of Defense Directive 4505.6 of 6 July 1962. The new designation system covers all current and newly designed aircraft, and is applicable to all elements of the military departments. Under the new system, an aircraft designation consists of a combination of significant letters and numbers as follows:

a. Status Prefix Symbols. The status letter, if applicable, indicates aircraft being used for experimental purposes, and special or service tests. Authorized status letters and titles are:

Letter		Title
G	-	Permanently Grounded
J	-	Special Test, Temporary
N	-	Special Test, Permanent
X	-	Experimental
Y	-	Prototype
Z	-	Planning

The status letter is placed at the immediate left of the modified mission letter or the mission/type symbols if no modified mission letter is applicable.

b. Modified Mission Symbol. The modified mission letter, if applicable, indicates the current capability of an aircraft when it is so modified that its original intended capability is no longer applicable, or when it has an added or restricted capability. Authorized modified mission letters and titles are:

Letter		Title
A	-	Attack
C	-	Cargo/Transport
D	-	Director
E	-	Special Electronic Installation
H	-	Search-Rescue
K	-	Tanker
L	-	Cold Weather
M	-	Missile Carrier
Q	-	Drone
R	-	Reconnaissance
S	-	Antisubmarine
T	-	Trainer
U	-	Utility
V	-	Staff
W	-	Weather

The modified mission letter, if applicable, is placed at the immediate left of the basic mission/type symbols.

c. Basic Mission and Type Symbols. A basic mission letter is used to denote the primary function or capability of an aircraft. Mission/type symbols denote the mission and type of aircraft other than fixed wing. An aircraft identified by a type symbol, such as "H" for helicopter, will be further identified by only one mission symbol whether it be the basic mission or a modified mission symbol. Authorized basic mission/type symbols are:

Letter		Title
A	-	Attack
B	-	Bomber
C	-	Cargo/Transport
E	-	Special Electronic Installation
F	-	Fighter
*H	-	Helicopter
K	-	Tanker
O	-	Observation
P	-	Patrol

Letter		Title
S	-	Antisubmarine
T	-	Trainer
U	-	Utility
*V	-	VTOL and STOL
X	-	Research
*Z	-	Airship

*Type Symbols

d. Design Number. A number is assigned for each basic mission or type. New design numbers are assigned when an existing aircraft is redesigned to an extent that it no longer reflects the original configuration capability.

e. Series Symbol. A letter is assigned to each series change of a specific basic design. To avoid confusion, letters "I" and "O" will not be used. In designating new aircraft, the series letter will be in consecutive order starting with "A".

f. Source or Manufacturer's Code. A two letter code is used to identify the prime or assembly contractor.

g. Block Numbers. The production block numbering system consists of the assignment of production blocks, starting at 01, next 05, and progressing in multiples of 5 after 05. Intermediate block numbers are reserved for field modifications and are applied by the using military department.

h. Serial Number. The method of assignment of serial numbers is at the discretion of the using military department.

i. Basic Designation. The basic designation consists of items a-e as applicable, in the order shown. A dash (-) is inserted between the basic mission/type symbol and the design number.

All Department of Defense aircraft have been assigned designations to conform with the new system and are listed in Attachment 5 of BUWEPS Instruction 13100.7 to show the new and former designations and the applicable military department.

In redesignating aircraft, the minimum effort required for efficient operations is to be expended. For example:

a. Navy inventory aircraft will be re-identified no later than the next rework. Undelivered aircraft on which model designations have not been affixed will also be identified with the approved current redesignation.

b. Correspondence shall indicate the current designation followed by the former in parentheses.

c. Publications.

(1) Technical publications in being will not be revised solely to reflect the new designations. Supply points are not required to mark publications in stock or received for distribution.

(2) Naval Aeronautic Publication Indexes, in the earliest practicable issue, will refer to aircraft by the new designation followed by the former in parentheses. A cross-reference list will be published in each of these indexes or cumulative supplements as soon as possible.

(3) New publications in preparation and changes and revisions in preparation will reflect the new designations, followed by the former in parentheses, on the title page and covers only, except when the following conditions apply:

(a) If preparation of a new publication or complete revision (reissue) is at a stage where the new designation can be used throughout without delay or additional cost, it will be used. On the cover and title page only, the new designation shall be followed by the former in parentheses.

(b) If the publication, or change or revision, is past the preparation stage where the new designation can be used without cost or delay, no change to the new designation will be made except on the title page and cover, where it will be followed by the former designation in parentheses.

(c) If the publication, or change or revision, is being held for inspection or is ready for submittal, and changing the cover and title page would delay delivery, they will not be changed.

d. Engineering data, drawings, and associated lists and documents will not be revised solely to reflect the new designation. New and revisions of existing data, drawings, and associated documents shall reflect the new designation followed by the former in parentheses on drawings and associated lists, and on title page and covers only of reports and other documents, except when the preparation status conditions of (3)(a), (b), and (c) apply. New drawings and revisions which have received company or Navy approval for release need not be revised to reflect the new designation unless and until they are subsequently revised for some other reason.

Use of both new and former designations in correspondence, covers, and title pages of documents, drawings, and in publication indexes, etc., will continue until further notification by the Bureau of Naval Weapons that the former designation may be omitted.

(UNCLASSIFIED)

MISUSE OF ORDNANCE ON JET AIRCRAFT CAUSES SERIOUS ACCIDENTS

By Comdr. G. R. Otis, USN, Aircraft Project Coordination Office BuWeps

Recent attempts to utilize practice bombs unsuitable for the aircraft involved resulted in the total loss of one A4D-2N and minor damage to two others.[1] Underlying the events which led to this isolated but serious accident was an unfortunate misinterpretation of the appropriate regulatory documents together with certain assumptions which turned out to be invalid.

The documents concerned included BUWEPS Ordnance Pamphlet 2216, BUWEPS Aircraft Armament Bulletin No. 161, NWL Report 1802, and the flight manual for the aircraft concerned. The assumptions were to the effect that the use of the bomb in question was not specifically prohibited for use on this aircraft, had the same basic shape and construction as the one cleared for use, and apparently had been used by another squadron. The result, to quote the Fleet Air Commander was: "What appeared to be a minor variation in ordnance loads from that prescribed in the pilot's handbook (flight manual) proved to be of such a magnitude to cost the Navy a first line aircraft."

Each of the documents previously mentioned serves a specific purpose. OP 2216 contains general and specific information regarding bombs and fuzes. AAB 161 deals with flight restrictions imposed on externally carried bombs stemming from functional or structural limitations of the ordnance items themselves, and is valid primarily for ordnance to be carried on reciprocating engine type aircraft. Naval Weapons Laboratory (Dahlgren, Va.) Report 1802 was a survey to determine the current use, availability, and requirements for practice bombs to aid in the determination of the adequacy of stockpiled practice bombs and requirements for the future. As for the flight manuals, at present, most of the manuals for conventional service aircraft list only jettison and release instructions for stores that cannot be used to the full flight envelope of the aircraft.

[1] A 500# WSF Practice Bomb Mk 65 Mod 0 was substituted for a 1,000# WSF Practice Bomb Mk 66 for use on a Bomb Ejector Rack AERO 7A-1 on the A4D-2N aircraft. The bomb disintegrated upon release.

Restrictions on the use of aircraft ordnance are based on extensive flight testing to determine functional and structural limitations as well as separation characteristics of the various bomb/aircraft combinations. To verify, publish, and maintain an up-to-date compilation of all possible combinations of ordnance for use on all types of service aircraft would be prohibitive from a budgetary standpoint. A more logical approach to the problem is to modify the flight manuals for each type of aircraft to incorporate a table of ordnance items which have been tested and are authorized for carriage and release. Such tables are already included in the flight manuals of the F-4 (F4H), A-5 (A3J), A-4 (A4D), F-3 (F3H), F-6 (F4D), and AF-1E (FJ-4B) series aircraft. Action is being taken to provide similar tables in the flight manuals for all other service aircraft as applicable. The Aircraft Flight Manual is intended to be the basic authority for use of ordnance on each type aircraft. Bureau approval must be obtained if deviation from the flight manual is desired. A Bureau of Naval Weapons Instruction to this effect is being issued.

(UNCLASSIFIED)

New Technique for Testing Ejection Seats

From Naval Air Material Center, Philadelphia, Pa.

The Air Crew Equipment Laboratory (ACEL) of the Naval Air Material Center (NAMC), Philadelphia, Pa., has put into operation a new and more efficient technique for testing ejection seats at speeds up to 260 knots. Improved instrumentation, photographic coverage, and significant cost savings have resulted from use of this new concept.

The new test technique utilizes the existing 7,000 feet of tracks and jet car pushers located at U.S. Naval Air Station, Lakehurst, N.J. In the past, the facility at Lakehurst has been utilized to evaluate shipboard type arresting gear and barricades. The ACEL technique involves modification of a cockpit section so that it can be mounted on a truck chassis with four high-speed aircraft tires. The loaded ejection seat is then installed within the cockpit and prepared for test (see Figure 1). The cockpit assembly incorporating the seat is then placed on the track and mated to the pusher which consists of a vehicle on wheels incorporating four J-33 Jet Engines (see Figure 2). The jet engines are started and the pusher and cockpit section released allowing the combination to accelerate along the track.

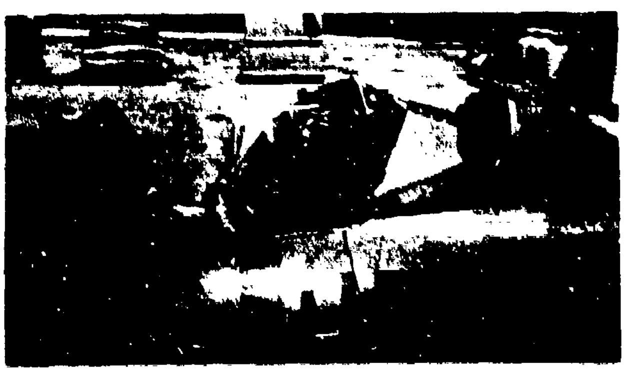


Figure 1.—Ejection seat and dummy installed in ACEL ejection seat test vehicle

Upon reaching the proper speed and location along the track, the ejection seat is fired automatically with subsequent automatic actuation of the parachute recovery system. The dummies used in this program have been provided with a telemetry system which transmits technical information to a central control station during the progress of the tests.

This technique fulfills an urgent requirement for a facility that can perform ejection tests at speeds up to 260 knots. Future plans call for modifications that will enable the facility to conduct tests of escape capsules and ejection seats at speeds up to 500 knots.

(UNCLASSIFIED)

Figure 2. —Overall view of ACEL ejection seat test vehicle and jet car at Naval Air Test Facility (Ship Installations), Lakehurst, N. J.

674622 O-63-2

Small Airfield for Tactical Support (SATS)

U. S. Marine Corps Special Aviation Support Equipment

The mission of Marine Aviation during an amphibious assault is to furnish cover for and air support to the Marine Divisions ashore. Because of the need for rapid establishment of a small airfield and to release carriers for other duties, the Small Airfield for Tactical Support (SATS) has evolved. In 1956, the Commandant of the Marine Corps defined new time and space parameters for expeditionary airfield construction as follows: small, quick construction; ready for use within first 5 days of an amphibious assault; approximately 2,000 feet in length and 70 feet in width; usable for 30 days.

In order to meet the above listed parameters it was necessary that a new concept of airfield construction and support material and equipment be developed. This equipment must include an easily transported, quickly emplaced runway surfacing material, expeditionary catapult and arresting gear, optical landing aids and expeditionary lighting system, and a system for the expeditionary handling of large quantities and wide varieties of air-launched weapons.[1] Shortcomings in existing equipment were noted during test exercises on Formosa in March 1960 and Vieques Island in February 1961. Although these exercises were not performed precisely within the parameters previously discussed, the exercises definitely proved that the SATS concept is feasible and further, that the development of the necessary expeditionary equipment should be pursued.

One of the larger and relatively untested problem areas in the SATS concept is the expeditionary handling of large quantities and a great variety of air-launched weapons. The World War II and Korean type of storage and handling has been, for the most part, outdated by the introduction of more sophisticated and complicated air-launched weapons. With the increase in the ordnace-carrying capacity of the modern jet aircraft and the strong requirement for the decrease in aircraft turn-around time, the SATS weapon handling and loading system must be fast and efficient.

The responsibility for the development of the SATS air-launched weapon handling and loading system has been assigned to the Bureau of Naval Weapons (RSWI). Utilizing to the fullest extent possible the development characteristics prepared by the Marine Corps Equipment Board, Quantico, Va., and the lastest weapons handling and aircraft loading techniques being developed for carrier operations, the Bureau established the basic SATS air-launched weapon handling and aircraft loading system concept (see Figure 1). In this concept the primary considerations are proper weapon assembly and ready-service storage facilities, expeditious weapon delivery to the aircraft, and rapid, efficient, aircraft loading. These requirements are governed by the unique SATS environmental conditions and the expeditionary nature of the equipment established by the Marine Corps Equipment Board.

The concept is divided into the following three general areas and interconnections between these areas:

1. The Ammunition Dump - the area where all weapons are stored in their shipping configuration.

2. The Weapon Checkout, Assembly and Ready-Service Storage Area - the area where the weapons are made ready for

[1] An article entitled "Development of SATS System Components," by Naval Air Engineering Laboratory (Ship Installations), Naval Air Material Center, Philadelphia, Pa., was published in Naval Weapons Bulletin No. 2-62.

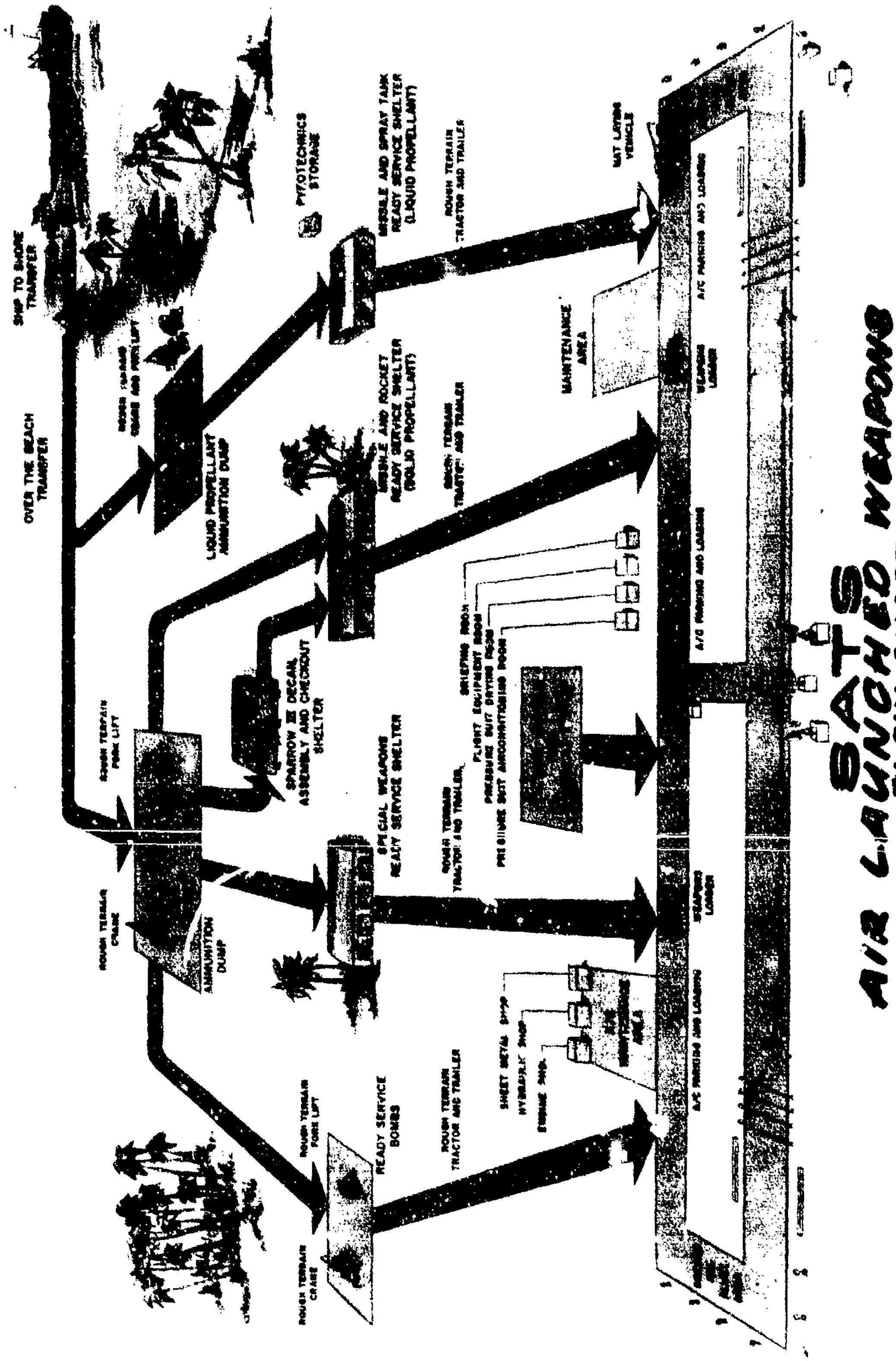


Figure 1. —SATS Weapons Flow Chart

use and stored until required for tactical operations.

3. The Aircraft Loading Area - the area where the weapons are loaded on the aircraft.

4. Interarea Transportation - the transportation of a great variety of weapons in various configurations between areas.

In each of the areas, the SATS installation must have the capability of adequately handling a great variety of air-launched weapons. These weapons include:

1. Conventional bombs
2. Low-drag bombs
3. Special Weapons
4. Fire bombs
5. Air-to-air missiles:
   SPARROW III
   SIDEWINDER
6. Air-to-surface missiles:
   BULLPUP 7
   BULLPUP 7a
7. Air-to-surface rockets
8. Special-purpose weapons such as the AERO 14B Spray Tank.

In order to satisfy the requirements, both operational and environmental, of the SATS program, the Bureau currently is developing the following equipment.

Figure 2.—Ready-service weapons shelter, weapons trailer and cradles, air-launched weapons

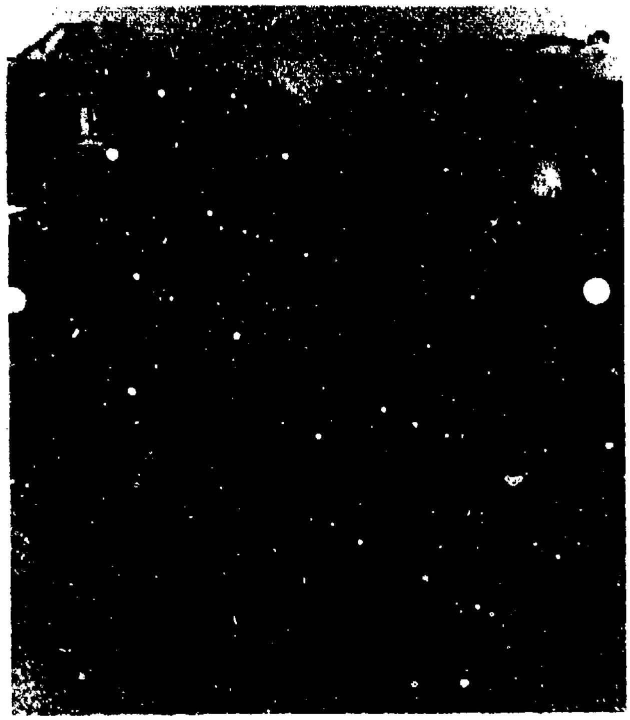


Figure 3.—Weapons trailer and cradles, air-launched weapons

1. TRAILER, PNEUMATIC-TIRED, ROUGH-TERRAIN, AIR-LAUNCHED WEAPONS (Figures 2 and 3). This vehicle is utilized to transport missiles, rockets, bombs, loaded multiple bomb racks and other weapons from ready-service shelters to the aircraft and, in some instances, from ammunition dumps to the service areas. A pattern of sockets for the receipt and restraint of various cradles for a variety of stores, is provided on the bed of the trailer. Currently two types of trailers are being developed. One type features a "second tier or platform" for increased load-carrying capacity and is equipped with four-wheel coordinated steering. On the second type, the cradles (refer to paragraph 2) will be stacked with the stacking structure supplied as part of the cradle. This trailer will be equipped with two-wheel conventional steering. The two trailers will be evaluated during the fall of 1962 to determine the features best suited for the SATS operation.

The trailer design includes rough-terrain features such as 12-inch ground clearance and 20 percent side slope stability. Power for the lights and braking systems will be supplied by the prime mover which may be any standard ordnance vehicle equipped for use as a prime mover.

2. CRADLES, AIR-LAUNCHED WEAPONS (Figures 2 and 3). Currently under development is a family of cradles which will be utilized to support the various weapons during storage in the ready-service areas and during transportation on the weapons trailer of paragraph 1 or the loader/trailer of paragraph 4. The family consists of eight cradles which are as follows:

a. 8" to 12" diameter stores
b. 13" to 20" diameter stores
c. 21" to 30" diameter stores
d. SPARROW III
e. SIDEWINDER
f. Multiple Bomb Rack
g. LAU-10 Rocket Pack
h. AERO 7D Rocket Pack

The cradles are basically welded aluminum structures with separate "yokes" for stacking during ready-service storage. Forklift pockets are provided for use by the weapons loader. The lugs on the bottom of the cradle, which are utilized for attachment to the weapons trailer, are also utilized for attachment to the loader/trailer.

3. WEAPONS LOADER, 4,000 LB. (Figures 4 and 5). This vehicle will be utilized to remove the weapons on cradles from the weapons trailer and load the weapons on the aircraft. The loader utilizes forks, a boom, and manually operated hydraulic system to provide the six degrees of freedom required for aircraft loading. It is self-propelled (gasoline-engine-driven) with a 4 x 2 drive. The ground clearance when operating on the surfacing mats is approximately 6 inches. The loader may be reconfigured (see Figure 6) to provide 12 inches ground clearance for amphibious loadout and over-the-beach transportation.

Figure 4. —Weapons loader, 4,000-lb. capacity

4. TRAILER, AIR-LAUNCHED WEAPONS TRANSPORTING/LOADING, 3,500 LB. CAPACITY (Figures 7 and 8). A combination trailer and weapons loader is being developed currently with the weapons trailer and weapons loader of paragraphs 1 and 3. This device is designed to serve as a rough-terrain trailer for weapon transportation and includes features for aircraft loading without transferring to a separate loader. The loader/trailer utilizes a manually operated hydraulic system to raise and lower the trailer bed to provide the required 12 inches of ground clearance for weapon transportation and the vertical motions required for aircraft loading. The necessary yaw and roll motions are provided through manually operated mechanical linkages. The loader/trailer is equipped with a lighting system and air-over-hydraulic brakes, the power for which is supplied from the prime mover.

The weapons trailer and separate weapons loader and the combination loader/trailer will be evaluated late in 1962 to determine the features best suited for the SATS operation.

5. READY-SERVICE WEAPONS SHELTERS (Figure 2). These shelters provide a protected environment for the decanning assembly, checkout, and storage of various weapons. The shelters are constructed of a lightweight aluminum framework covered with a flameproof fabric

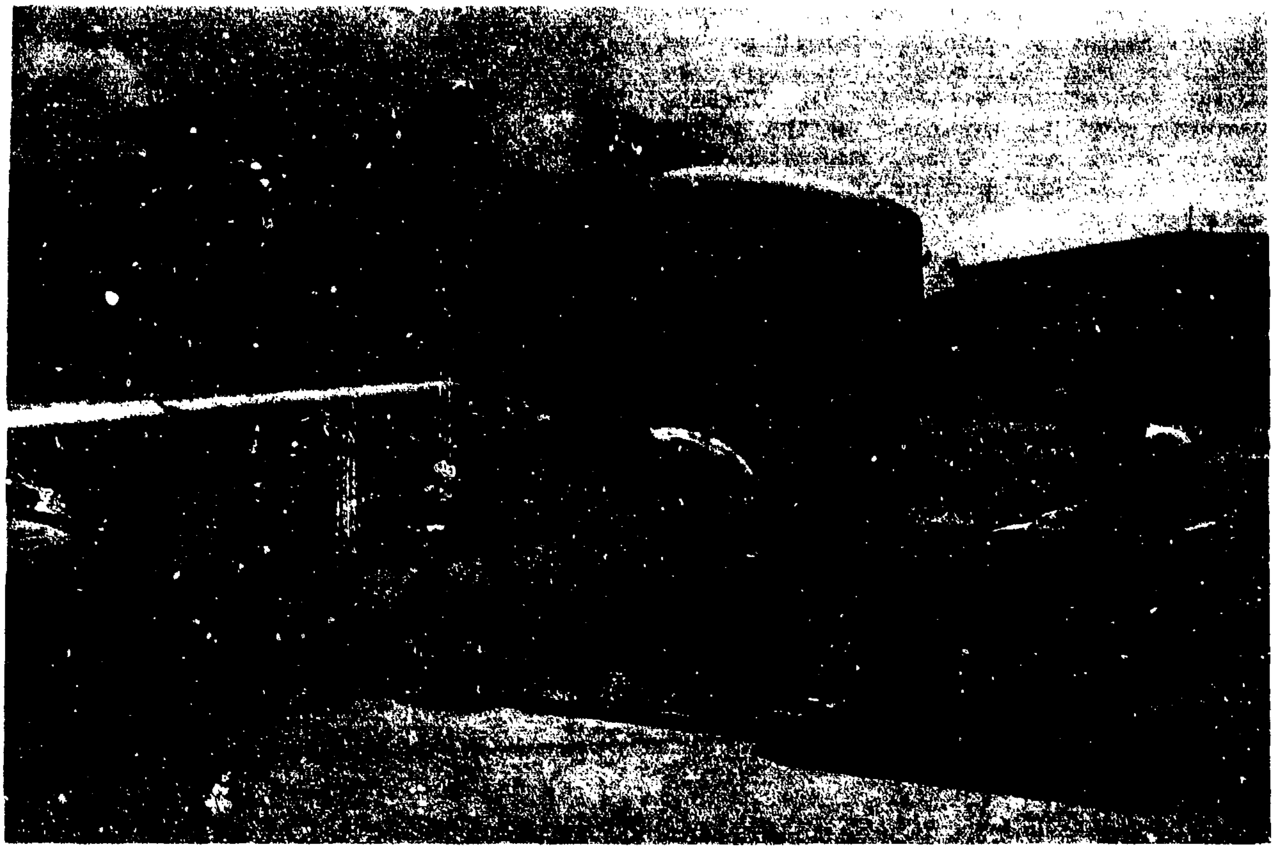


Figure 5. —Weapons loader, 4,000-lb. capacity, loading an AF-1E (FJ-4B)

(see Figure 9). Erection time for the shelter is approximately one hour. Overhead monorail hoists are provided to permit the expeditious transfer of material within the shelters. The monorail system is equipped with extensions to permit offloading to trailers, pallets, etc. (see Figures 2 and 10). Flooring is not provided as part of the shelter; however, the surfacing mat may be utilized for this purpose. Necessary connectors for the input of electrical power and heating ducts are provided as part of the shelter.

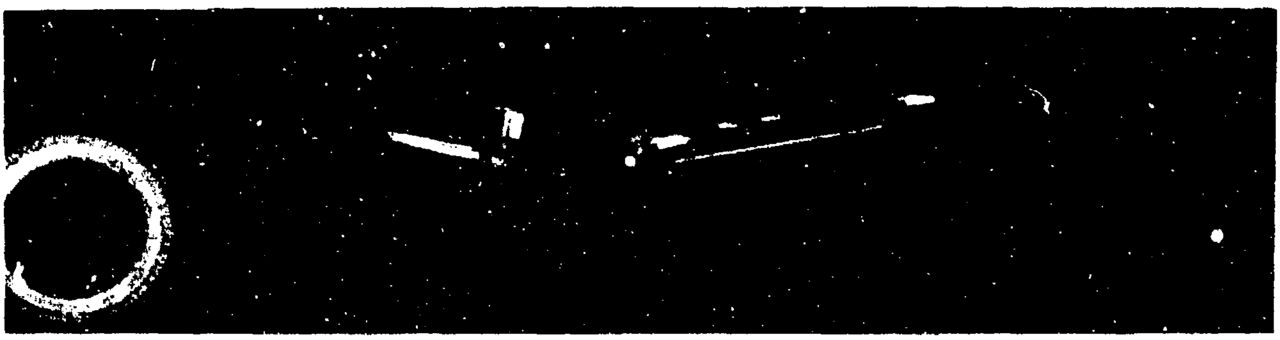


Figure 6. —Weapons loader, 4,000-lb. capacity, towing configuration

Figure 7. —Trailer, air-launched weapons, transporting/loading, with SPARROW III missile

Figure 8. —Trailer, air-launched weapons, transporting/loading, hydraulic system

It is anticipated that 13 shelters (20' x 40') will be required for each SATS installation. The following weapons will be stored in the aforementioned shelters:

BULLPUP 7, 7a, and 7b
SPARROW III
SIDEWINDER Ia and Ic
ZUNI
2".75 Rockets
AERO 14B Spray Tanks
Special Weapons

Conventional bombs will not be stored in the shelters but will be stored as required in open areas. Separate shelters will be provided for solid propellants, liquid-propellant pyrotechnics, and special weapons as dictated by safety requirements.

Ammunition dumps will be established in an area, and at a location, selected by the air base commander. The dumps will be stocked and resupplied as necessary by conventional methods. A 3-ton-capacity rough-terrain crane and a rough-terrain forklift truck will be utilized to offload material from transporting vehicles and to move pallets, containers, cargo nets, etc., to their respective locations at the dump.

Figure 9. —Ready-service weapons shelters, construction

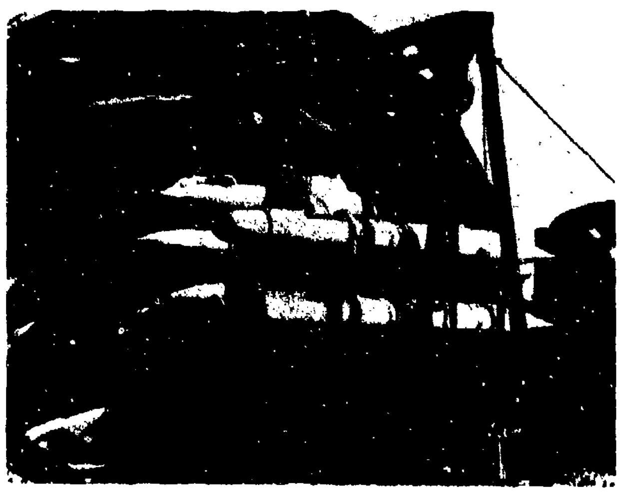


Figure 10. —Ready-service weapon shelters, monorail system

The previously described ready-service shelters will be erected and supplied from the dumps as required. Palletized and packaged ordnance components will be delivered to the ready-service shelters by means of the rough-terrain trailers, and prime mover combination or the rough-terrain forklift truck. Overhead monorail hoists, integral with the shelters, will be used to offload the pallets or containers and transfer them to respective assembly, checkout, or storage areas. The special family of cradles developed for use at the SATS will be used in the ready-service shelters to store air-launched weapons after checkout and assembly. The primary function of the cradles, however, is for use with the weapons loader or the loader/trailer. The operations necessary for moving ordnance components within the shelters will be performed utilizing the overhead monorail hoists with necessary slings.

When ordnance is required for expenditure, prime movers with rough-terrain trailers in tow, will be dispatched to applicable ready-service shelters. The overhead monorail hoist of the shelters will be utilized to move fully loaded cradles from storage to a position where they may be lowered onto the bed of the trailer. Any other necessary material (wings, fins, canards, flares, crystals, fuzes, etc.) will also be placed on the trailer. The trailers will then be towed to the aircraft arming area and unloaded by the weapons loader. This will be accomplished by inserting the forks of the loader into the forklift pockets on the cradles and lifting the cradle and weapons off the bed of the trailer.

The loader will then be maneuvered into a position near the aircraft from which the weapons may be loaded onto the launchers or racks.

When the loader/trailer is used, this vehicle will be placed under the monorail hoist, the weapons on cradles will be loaded on the vehicle, and the vehicle towed to aircraft arming areas. The loader/trailer will then be manually positioned under the aircraft rack or launcher and, by use of the manual hydraulic system and mechanical adjustments, the weapon will be raised and latched to the aircraft.

(UNCLASSIFIED)

MICROELECTRONIC TECHNIQUES IN AVIONICS

By John L. Hoover, Project Engineer, Technical Support Branch, Avionics Division, BuWeps

In the present world we are confronted by a very complex system of avionics in military aircraft. During a relatively short period of time the number of electronic equipments in aircraft has increased considerably. During this period the complexity of these equipments has increased in orders of magnitude. This increase in complexity has had an adverse effect on the availability of aircraft and has created an enormous logistic system with its attendant problems. To help alleviate the logistic problems and to increase the "up" time of aircraft, the Avionics Division of BuWeps has initiated and is vigorously pursuing a microelectronic techniques and hardware program.

To the reader many questions arise, some of which are: What is microelectronics? How will microelectronics affect reliability? What efforts will be made toward standardization? What problems will arise during field maintenance? What immediate effect will this program have on existing equipments and proposed equipments? The writer will attempt to answer these questions without delving too

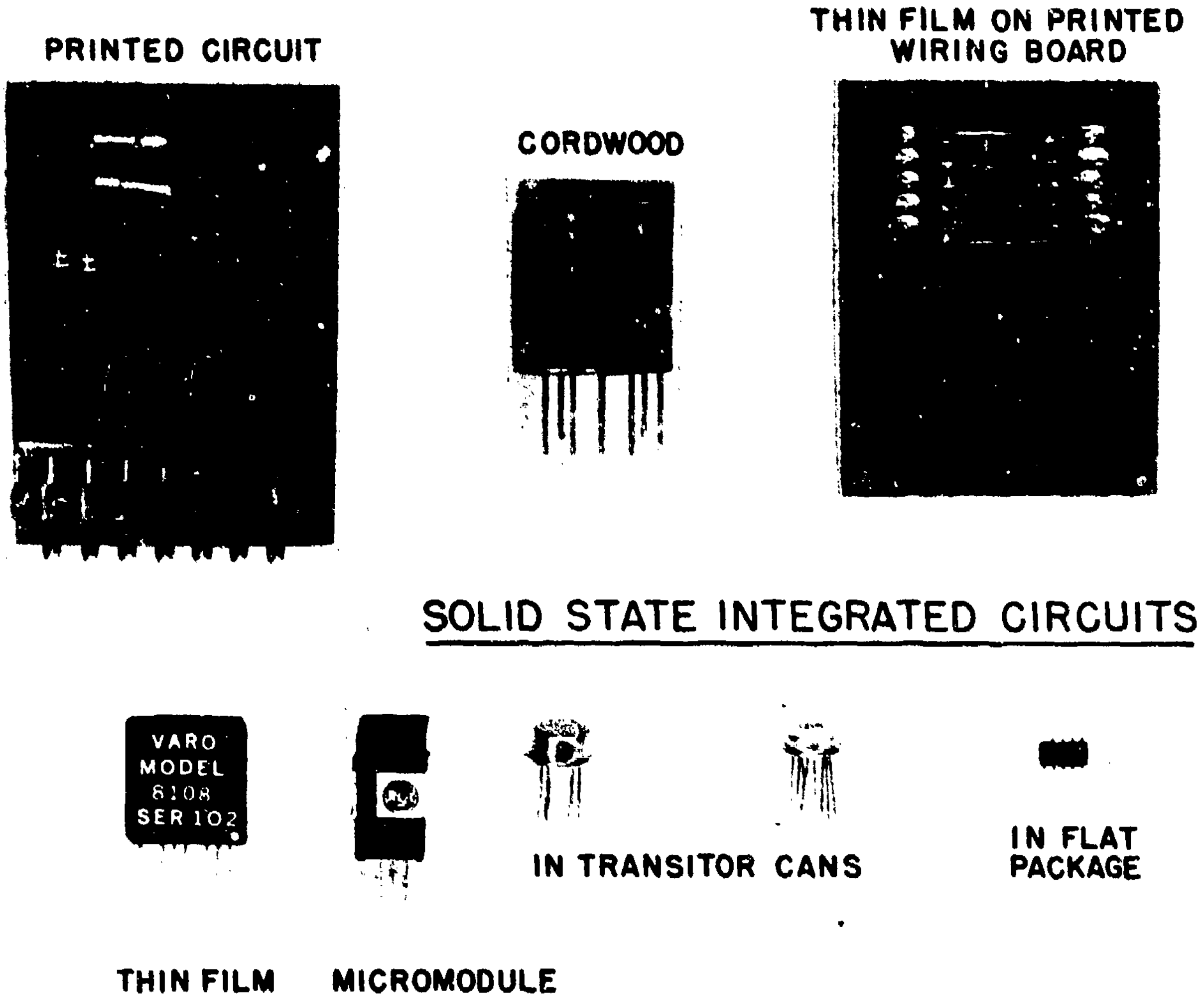


Figure 1. —Flip-flop circuitry, showing evolution of electronic circuitry from conventional devices to microelectronic devices

deeply into the techniques and application of microelectronics.

Microelectronics is a term given to a device(s) which incorporates active and/or passive elements into a single package. The circuitry can be as simple as an inverter consisting of a transistor and a clamping diode or as complex as a set-reset Flip-Flop element containing as many as 19 transistors and 15 resistors. A variety of package shapes and sizes is available at the present time. Two major techniques are at present used in the manufacture of these devices. In one technique the active elements are formed in a common semiconducting substrate with the passive elements being formed by diffusion or similar techniques in the substrate or by deposition on the passivated surface of the substrate. This technique is generally referred to as the diffused substrate technique. In the other technique, the passive elements are formed by deposition on an electrically passive substrate and the active elements are formed by deposition on the substrate or by separate attachment. This technique is generally

674622 O -63 -3

referred to as the thin-film technique. The selection of a particular technique is dependent upon the particular application involved. However, the emphasis should be placed upon the technique which results in a completely integrated assembly, i.e., contains no separate attachments. At the present time, most of the programs being pursued by the Bureau (Avionics Division) are slanted to the substrate technique. An example of the evolution of electronic circuitry from conventional devices to microelectronic devices is shown in Figure 1.

The microelectronic techniques program will have a marked effect on the reliability of future avionic equipments. Where a need for a critical circuit using selected or matched components exists, the microelectronic device will be designed to meet the circuit requirements. Through the use of rigid quality control during manufacture, the duplication of a particular microelectronic device on a production run will be simplified. This approach will virtually eliminate the use of selected or matched components from future equipments. Since a microelectronic device will be used to replace a partial or complete electronic circuit, the number of components that could fail will be greatly reduced. Also, the time spent in "wringing-out" a circuit will be lessened. These factors alone will greatly enhance the "up" time of military aircraft. While it is recognized that the microelectronic approach will require more skill on the part of field maintenance personnel in recognizing a defective circuit, the microelectronic device will be nonrepairable. Thus, when the defective circuit is located, the maintenance involved will be a matter of plugging-in or soldering-in the new device. Another factor that will have a marked effect upon equipment reliability is the increase of minimum life requirements. Present day military specifications for semiconductor devices call out a minimum life of 1,000 hours. The Naval Air Development Center (Johnsville, Pa.) general specification (EL5-13A) for microelectronic devices calls out a minimum life of 5,000 hours.

A manual is being prepared which will contain from 75 to 200 circuits with attendant electrical parameters. These circuits are to be representative of the functions most often encountered in the design of avionics equipments. This manual is intended as a guide in the design of microcircuit modules for use in future avionics equipment. The immediate effect upon the Navy's supply system will be an increase in stock items. However, after the microelectronic technique has been incorporated into the avionics equipments, there will be a marked decrease in the number of individual components carried in stock; since, at the present state of the art, a single microelectronic device can replace as many as 50 or more conventional components. In one of the improvement programs being pursued, a set-reset Flip-Flop circuit card which uses 137 components is being replaced with an exact equivalent card containing eight microelectronic devices. In order to maintain interchangeability with the existing equipment, the physical dimensions of the existing card are maintained. The present microelectronic card is adaptable, without changing the physical layout, to a 50 percent or more reduction in size, if it is decided in the future to reduce the size of the existing equipment.

The major problems arising during field maintenance will be the same problems that are present in today's electronic equipment, i.e., What component or circuit is not functioning properly? Is a replacement card or part readily available? Is there a substitute that will do the job until the proper replacement is available? Are there any special techniques necessary when replacing the defective part?

In the microelectronic approach, the step of finding the defective component in a circuit will be eliminated. The circuit becomes the basic element or component. In most circuits, the microelectronic component will be a multi-lead device with as many as a dozen leads emanating from the device. Special soldering or welding techniques will be required when these devices are replaced. Most of the cards or boards, on which the microelectronic devices are mounted, will be nonrepairable in the field. Thus, field maintenance usually will be a matter of removing the defective card or board and replacing it with a new or repaired one. Because of the complexity and variation of the circuitry involved, the extent to which boards or cards can be standardized has not been determined. Where there is a relatively simple circuit involved, the microelectronic device will not have over four or five leads. In these instances, the microelectronic device may be available as a field replacement item. At this level, it is believed that a maximum of standardization can be achieved.

The immediate effect on present-day equipments will be small insofar as field maintenance personnel is concerned; however, the future effect will be great. At the present time many programs are being carried out by the contractors for avionics equipment. These programs are for R&D equipments and for improving existing equipments. Almost all new R&D contracts under the technical control of the Avionics Division (BuWeps) now require that effort be made towards the incorporation of microelectronics techniques in the equipment, and in most cases the effort is substantial.

In order to effect an orderly change from conventional devices to microelectronic devices, a control group has been set up at U.S. Naval Air Development Center, Johnsville, Pa. Since its inception, this group has performed an invaluable service to the Navy. Through the efforts of this group a proposed specification for standard types of microelectronic devices has been formulated and various feasibility studies have been made. This group is responsible for monitoring the various microelectronic technique programs contracted by the Avionics Division. It is expected that this group will also review the microelectronic technique studies made by the contractors of Avionics Division, BuWeps, and make recommendations on these studies.

The time scale set up by the Avionics Division, BuWeps, requires the immediate use of microelectronic techniques and hardware where feasible in all avionics R&D programs, and the use of microelectronic techniques and hardware, where feasible, in production contracts for avionics equipment after 1 January 1965. The eventual goal is to use microelectronic circuitry wherever possible in avionics equipment with the result being more reliable, more efficient, and less costly—both initially and logistically—electronic equipment for the Navy's aircraft. (UNCLASSIFIED)

SURFACE

TERRIER FIRE CONTROL

Missile Guidance and Tracking Set AN/SPG-55B (U)

From Surface Weapons Control Branch, Missile Weapons Control Division, BuWeps

The Missile Guidance and Tracking Set AN/SPG-55B is the latest addition to the AN/SPG-55 family of radars that are employed as part of the TERRIER weapons systems installations in certain ships of the DLG, CVA, and CG classes. The AN/SPG-55B, like the AN/SPG-55A, employs an X-band, continuous-wave (CW) illuminator for guidance of semi-active homing TERRIER missiles. Functionally, operation of the 55B and the 55A, except for CW guidance, is the same as the basic AN/SPG-55, which was described previously in BuWeps Bulletin No. 2-59.

The AN/SPG-55B tracking and guidance radar is distinguished from the 55 and 55A radars by the incorporation of the following features:

1. A new high-power (1 megawatt), FM-swept, wide-pulse (26-microsecond) track transmitter.

2. The incorporation of pulse compression (PC) techniques in the track receiver.

3. The use of pulse-to-pulse frequency-diversity transmission.

The combination of the high-power, FM-swept, wide-pulse track transmitter and pulse compression techniques in the track receiver gives the radar the increased detection capability of the long pulse while still retaining the range resolution and accuracy of a short pulse. Frequency-diversity transmission serves as an anti-jam feature by forcing the jammer to spread its power over a wider band of frequencies, thereby reducing its jamming power per megacycle. In addition, frequency diversity increases the acquisition range of the radar over that in fixed-frequency operation by decorrelating the target returns from pulse to pulse.

A simplified block diagram of the track transmitter is shown in Figure 1. The source tube, a solenoid type, backward wave oscillator, is the basic frequency source for the 55B transmitter. When the system is in frequency diversity, the source tube frequency is varied from pulse to pulse in a random manner. To simplify the explanation, however, it can be assumed that the system is in fixed-frequency operation and the source tube is generating CW at fixed frequency f_o.

A portion of the source tube output at frequency f_o is fed to the receiving system as the local oscillator (L. O.) signal. The remainder of the source tube output goes to the single-sideband (SSB) modulator where it is mixed with the signal from the single-sideband driver. The output from the SSB modulator is a CW carrier which is linearly swept in frequency about the carrier once each pulse for 40 microseconds. The frequency of the carrier is 30 mc./sec. below the source tube frequency f_o (the L. O. frequency). The SSB modulator output is then amplified by the CW TWT and by the pulsed traveling wave tube (TWT), which in turn is pulsed-on for 26 microseconds at a 216 rep rate by the TWT pulser, thus converting the signal to pulsed RF. The timing is adjusted so that the center of the pulsed TWT output coincides with the

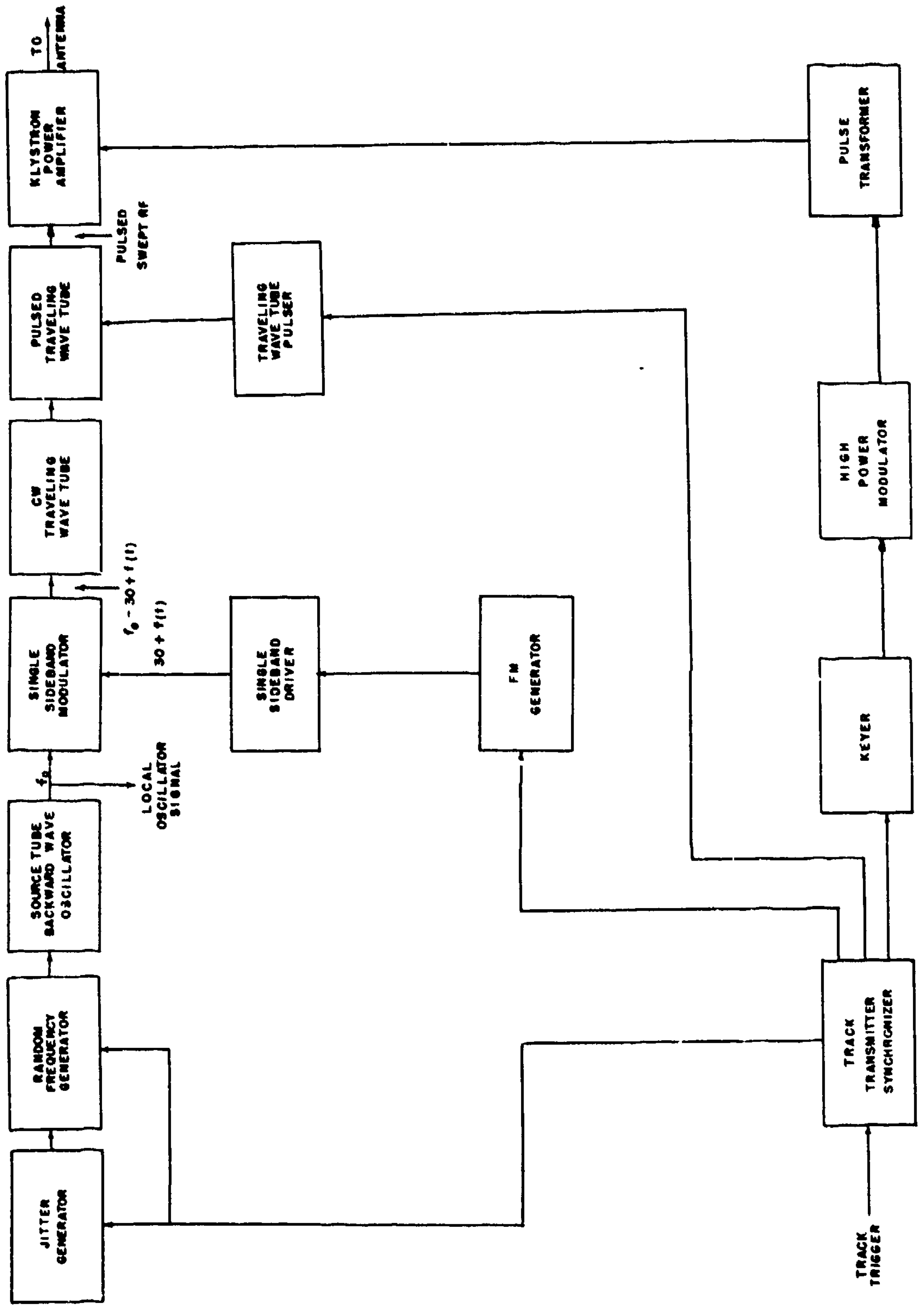


Figure 1. —AN/SPG-55B transmitter, block diagram

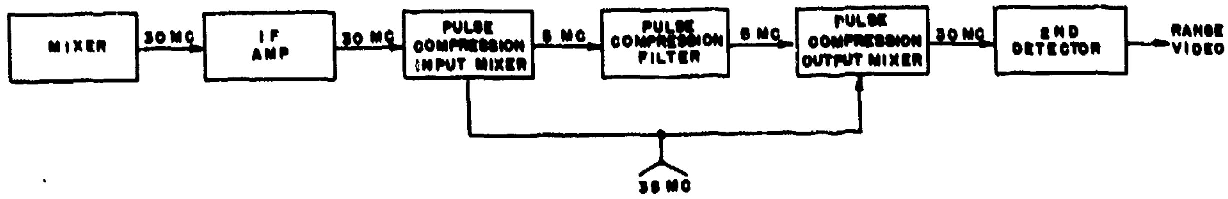


Figure 2. —Receiver, simplified block diagram

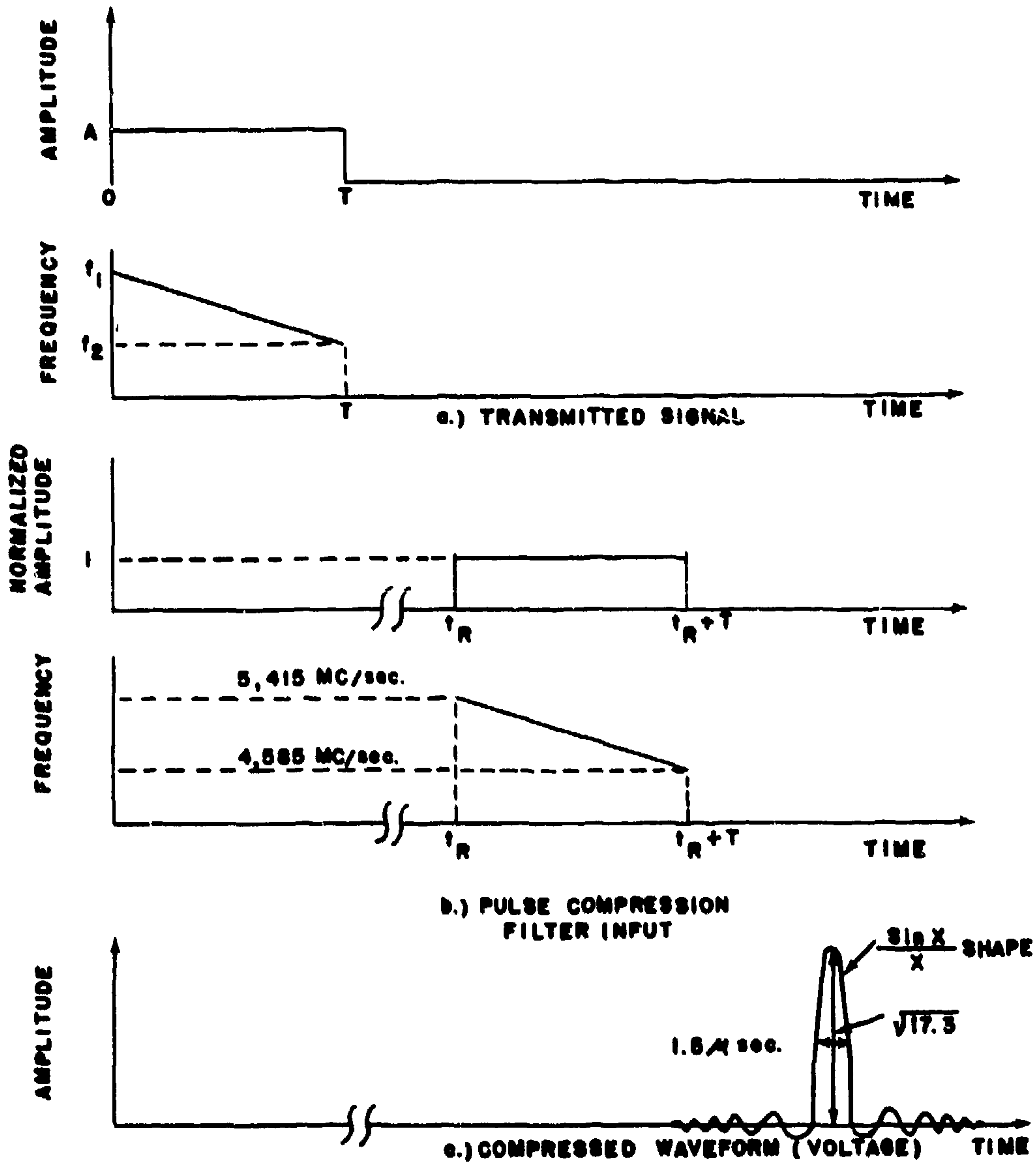


Figure 3. —Pulse compression waveforms

Figure 4. —Typical DLG shipboard installation showing two AN/SPG-55B radars and below-deck equipment for one system

center of the sweep on the input swept CW signal. The pulsed TWT output is a 26-microsecond pulse which is linearly swept ± 415 kc. about the carrier. The final amplification is in the klystron power amplifier that amplifies the pulse to a 1-megawatt output which is fed through the track microwave system and radiated from the main antenna.

A simplified block diagram of the track receiver range channel is shown in Figure 2. The angle channels are the same as the range channel except that the second detector is replaced by the phase detector and angle-third detector. The microwave section is functionally the same as in the 55A and is not shown.

On reception, the incoming linearly swept, 26-microsecond, RF pulses are mixed down to IF frequency and amplified as in a conventional pulsed radar receiver. The IF output is fed to the PC filters, which are designed so that the velocity of propagation through the filter decreases linearly with frequency for the band of frequencies contained in the incoming signal. This causes the frequencies at the leading edge of the signal to be delayed relative to the frequencies at the trailing edge, with frequencies in between being delayed proportionately. The result is that the energy contained in the 26-microsecond input pulse is compressed into a shorter pulse of approximately 1.5 microseconds duration. This is illustrated in Figure 3. The envelope of the compressed pulse approximates a Sin(x)/x waveform. The peak power of the original pulse is increased by a factor of about 17 to 1, or 12 db, while the voltage pulse amplitude is increased by $\sqrt{17.3}$. The "Compression Ratio" of the IF Amplifier-PC filter combination, therefore, is 17 to 1. The compressed IF signal is then fed to the second detector. The ranging system locks on to and tracks the compressed video in the same way as in the 55 and 55A, except that it tracks the center of gravity of the video instead of the leading edge.

When the system is in frequency-diversity operation, the frequency of the source tube is varied from pulse to pulse in a random manner by varying the voltage applied to the source tube helix. The transmitting frequency and the L. O. signal frequency are thus varied by the same amount, so that the 30 mc. /sec. difference between them is maintained. Frequency diversity has the twofold advantage of:

1. Forcing a jammer to reduce its jamming power per megacycle increases "burnthrough" range of the radar.

2. Decorrelating the radar returns from pulse to pulse reduces target fluctuation loss and increases the acquisition range over that in fixed frequency.

For the amount of diversity employed in the 55B, it is estimated that the fluctuation loss is reduced by 6. 3 db yielding an increase in acquisition range of about 43 percent. The acquisition range of the 55B under these conditions for a 1-square

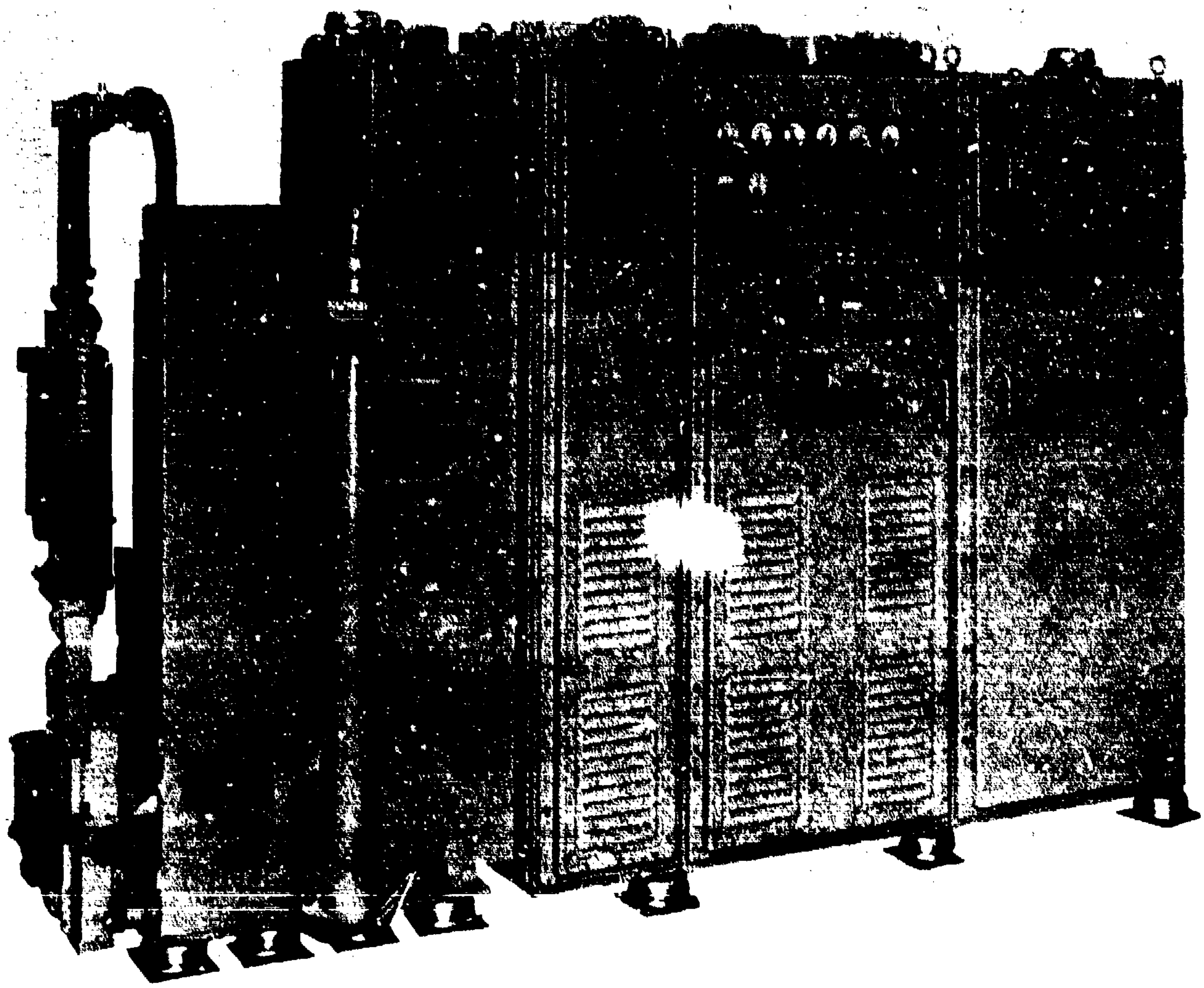


Figure 5. —AN/SPG-55B high-power transmitter

meter (avg.) target is approximately twice the acquisition range of the 55 and 55A radars.

Because of difficulties encountered in production of the AN/SPG-55B, frequency diversity was waived for the first eleven radar systems. It is anticipated that production systems incorporating frequency diversity will be available in March 1963. Ordalt kits to provide diversity in the first eleven AN/SPG-55B's should be available commencing in February 1963.

Figure 4 shows a typical installation of two AN/SPG-55B systems on board a DLG. The cutaway portion shows the below-deck equipment associated with one of the systems. Figure 5 is a view of the below-deck high-power transmitting portion of the radar. The total weight of a complete AN/SPG-55B radar system is approximately 29,000 pounds. (CONFIDENTIAL)

Medium-Range TYPHON Missile—Ordnance Components (U)

By H. W. Freeman, Project Engineer, Missile Ordnance Division, BuWeps

An important feature of the Medium-Range TYPHON Missile (Bulletin No. 4-61) is the capability of delivering either a conventional or nuclear warhead. All of the ordnance components for either the conventional (high-explosive) warhead or the nuclear warhead will be packaged as interchangeable, integrated ordnance sections. Besides the obvious tactical advantage attendant upon this capability, fleet logistics will be simplified. The feasibility investigations for most of the ordnance section components have been completed. Research and development of these components are now under way.

The high-explosive warhead ordnance section consists of the following components: Fuze Target-Detecting Device (TDD) EX 35, warhead arming and firing system (WAFS), and the continuous-rod (CR) Guided Missile Warhead EX 42 Mod 0.

The TDD is designed with high sensitivity for very small targets and with counter-countermeasure features. The effective detection range is approximately 50 feet.

The WAFS consists of two main parts, a fuze safety-arming device (S-A) and an explosive-electrical transducer (EET). The EET is still in the feasibility stage pending a decision as to whether the warhead will require electrical or explosive initiation, and the S-A is under development.

Figure 1 shows the proposed arrangement of the Medium-Range TYPHON high-explosive warhead ordnance section. The

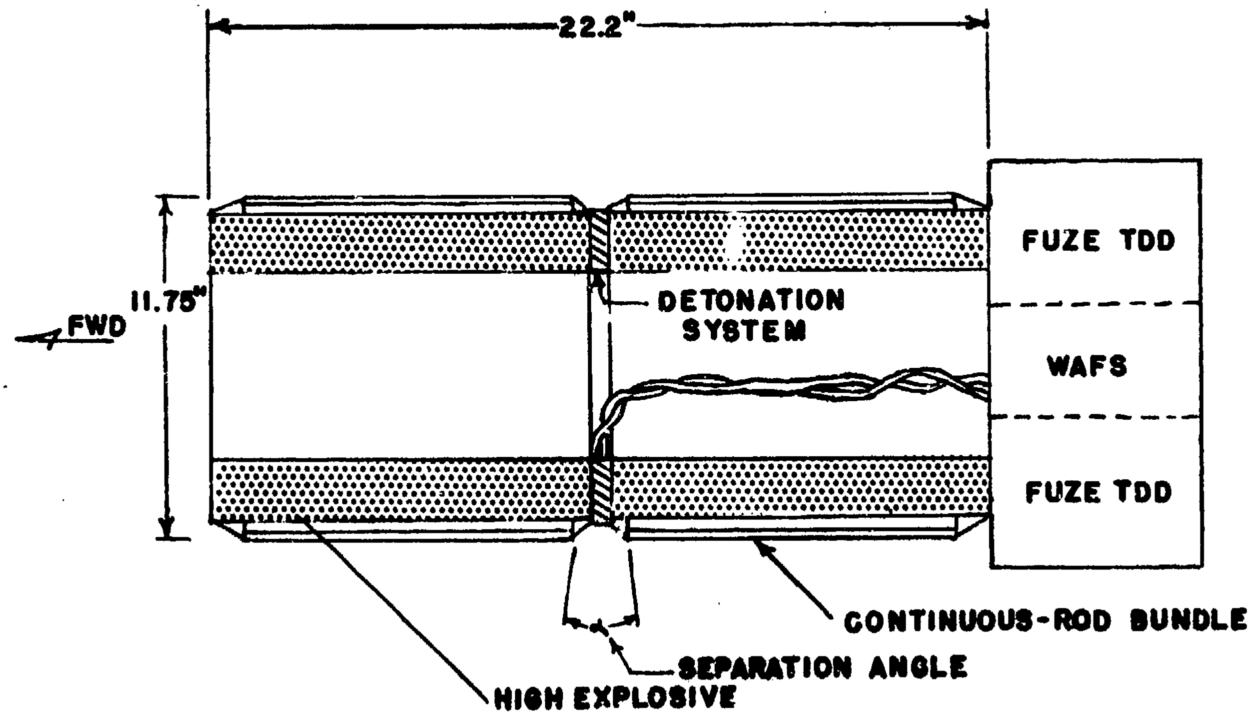


Figure 1.—Double-ring, continuous-rod warhead, Medium-Range TYPHON (Weight, 170 lb.)

674622 O-63-4

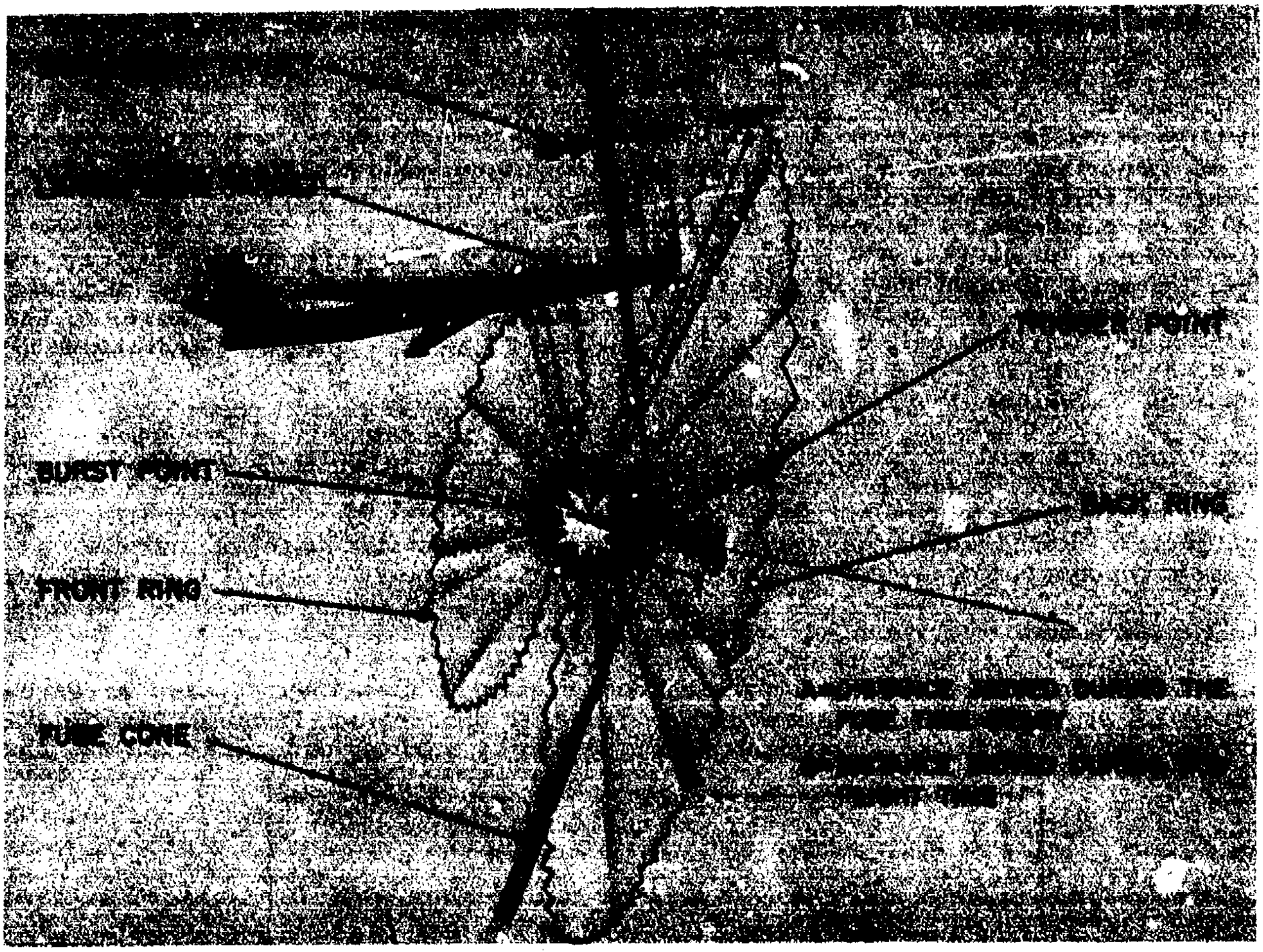


Figure 2. —Medium-Range TYPHON double-ring, continuous-rod warhead

warhead consists of two separate continuous-rod bundles mounted end to end, each with a separate explosive charge, and separated by a common detonation system. This detonation system detonates the warhead explosive charges upon initiation by the WAFS. The firing of the warhead by the detonation system causes the two explosive charges to project the rod bundles radially as expanding circles. Out to 45 feet from the missile trajectory, the average velocity of the rod circles is about 5,000 feet per second. At this velocity, the continuous rod has sufficient momentum to cause fatal structural damage to air targets. At relatively close miss distances from the target, the warhead effectiveness is enhanced by the contribution of explosive blast.

The missile fire control system in the missile ship determines the closing velocity of the missile and the target and computes an optimum time delay. This time delay is sent to the fuze TDD in the missile and the warhead is detonated at the end of the time delay. The use of a double-ring warhead enhances the probability of successfully engaging targets differing widely in both size and velocity, inasmuch as the rear ring has a good chance of hitting the small, fast target which the front ring may have missed. Figure 2 illustrates this feature diagrammatically. The detonation system assures the proper dynamic separation angle (α) of the two rod bundles, which is on the order of 12° to 15°.

The nuclear warhead ordnance section consists of the same fuze TDD EX 35 and a nuclear adaption kit (AK). The AK will provide the primary safing and arming, and will transmit the arming and firing signals required for detonation of the nuclear warhead. Tests that are now under way will assist in the selection of the proper nuclear warhead.

In exercise missiles for telemetered flights, the warhead arming and firing system is replaced by an arming and firing device (A-F) and the warhead is replaced by a destructor charge. Upon command or upon missile failure, the A-F will fire the destructor charge. The destructor charge ruptures the airframe of the missile, thereby the flight is terminated.

(CONFIDENTIAL)

THE TYPHON SYSTEM ELECTROMAGNETIC RADIATION SAFETY PROGRAM (U)

By W. J. Dichtel, Assistant Director, TYPHON Program, Surface Missile Systems, BuWeps

As the speed of weapon delivery increases, a ship must identify prospective attackers further afield if it is to survive. This, as well as the fact that targets are becoming smaller commensurate with advances in technology, dictates that the "all-seeing radar eyes" of the fleet must be more powerful.

During the early days of radar, hardly anyone gave second thought to the possible dangers of an electromagnetic beam, and indeed, there was no danger. As years have gone by, the ramifications of electromagnetic energy have become evident in our daily life. Some examples are: the warning signs that transmitters should be turned off while passing blasting operations; the stories of radars igniting photoflash bulbs; and progress reports on the cooking of meals with electromagnetic radiation.

Through the years, the increased power and hence dangers of a radio frequency source has been a rather linear function, directly related to the capability of a final tube in the transmitter. The development of the multiple-tube concept, however, suddenly presented the Navy with a problem completely out of step with previous experience. For example, the TYPHON radar—Missile Guidance and Tracking Set AN/SPG-59—will utilize as many as 1,200 power tubes in parallel to form a single high-power beam (see Bulletin No. 3-61, pp. 30-33 describe AN/SPG-50). Furthermore, the modern antenna is a spherical unit with thousands of elements and with beam forming and direction being contingent upon the signal strength and phase directed at each output element. While this system gives us an antenna with instantaneous response and none of the usual "dish" problems, the electronic beam forming is somewhat sloppy under the practical limitations of shipboard "real estate." Consequently, beam side lobes that will spray the ship can be expected in greater profusion with this system than with dish radars, and their radiated power will be far greater because of the parallel output tubes.

Even before the "New TYPHON Look," the Navy was starting to experience real problems in this radiation-hazard area. For example, RF currents of 1 ampere and potentials of 300 volts have been measured between the fuselage of an aircraft and the deck of a ship when a nearby radio antenna was radiating 1,400 watts. Electric hazards in the form of shocks are only part of the story. In addition, one must guard against igniting fuel and exciting electro-explosive devices (EED), such as squibs and detonators. Most insidious of all is the direct-heat damage to the human body. The TYPHON weapon control system could (under some conditions) cause each type of damage if proper measures were not considered.

It has always been the tradition of the U. S. Navy to consider the safety of the man as one of the most important factors in ordnance and ship design. Equally significant, the Navy has always been a leader in the adoption of new ideas and concepts for the fleet. These two essential goals, meeting head on, have resulted in an extensive program that will guarantee the early delivery of an advanced weapon system to the fleet with adequate instructions and safeguards to insure under all circumstances the well-being of the men who will operate it.

Paper studies and laboratory experiments are important first steps and provide the designers with guidelines essential to the achievement of the desired objective. But the proof of a system lies in full-scale "all-up" tests. Accordingly, the full certification of system safety will follow the completion of a detailed safety program to be conducted on the prototype installation in USS NORTON SOUND (AVM-1). (See article, "USS NORTON SOUND-Sea-Going TYPHON Tester," in Bulletin No. 1-62, pp. 27-30.)

Inasmuch as every Navy man who comes within line of sight of a TYPHON installation could be affected by this powerful source of electrical energy which is invisible to the naked eye, it will be reassuring for him to know the steps being taken to protect him.

The general problem of hazards of electromagnetic radiation to ordnance (HERO) is being treated on a Bureau-wide basis. Specifically, standards of maximum radiation expected in the future from each major electromagnetic source have been tabulated. Every weapon system in turn is required to demonstrate immunity in such an environment. Early tests to this end are being made in simulated environments at the Naval Weapons Laboratory (NWL), Dahlgren, Va.

Fully realistic tests with TYPHON will commence in 1963 on board USS NORTON SOUND to substantiate and validate the extrapolated data obtained earlier at NWL with low-power equipment at TYPHON frequencies. Incidentally, the TYPHON missiles and equipment will also be tested to the same standards at all frequencies; first as components, and finally in USS NORTON SOUND as "all-up" fully instrumented missiles. Only after complete certification of safety will propulsive and explosive-loaded missiles be put on the USS NORTON SOUND for evaluation and test firings.

The problem of radiation hazards extends beyond the confines of the TYPHON ship. The influence of the TYPHON radar on personnel, ordnance and equipment on other vessels such as resupply ships or even close-flying aircraft is a vital one too.

Several possibilities for protection exist here, thanks to the tremendous capacity of the beam-forming computers that stand by continuously to execute pre-recorded commands. One of these commands will be to cease radiating in a specific quadrant or to radiate at a low-power level either over the whole hemisphere or in a specific quadrant. Like any decision on the ship, this one will be weighted by the specific situation, such as coverage provided by other ships in the task force. (These data, incidentally, will be provided continuously to the TYPHON system via the Naval Tactical Data System.)

Instructions also can be given to the computer to avoid acquisition and tracking of friendly targets within the danger range of the main beam in order to protect aircraft and crews. The safe distance for personnel exposed to the main beam, under these circumstances, is now computed to be 500 feet or less as shown in Figure 1. It must be recognized, however, that in an unique and somewhat unrealistic situation where all ten guidance beams are focused simultaneously on a single target, the calculated safe distance would be as great as 2,075 feet. Some consideration has been given to loaded plastics for aircraft canopies in order to provide another measure of protection should this ever prove necessary. It must be stressed again that these represent measures that can be taken in the event that the "worst case" computations are proven to be valid in the NORTON SOUND installations.

The most difficult problem to cope with is that of the effect of the electromagnetic radiation on the human body. As we observed earlier, the main cause of damage is that due to heating. The effect is most injurious to those parts of the body where low blood circulation prevents rapid removal of the heat produced by absorption of the radio-frequency energy. The eyes and testes are particularly vulnerable and the effect in the eyes is cumulative. To further confuse the issue, the energy penetration decreases as the frequency increases to radar frequencies. Nonetheless, even surface heating is dangerous to eyes and testes.

As a first step in establishing a fiducial point, the Bureau of Medicine and Surgery has confirmed a safe energy level that takes the aforementioned points into consideration. Specifically, the standard of 0.01 watts per $cm.^2$ average power has been established as the Navy standard; that is, a man can absorb this level of

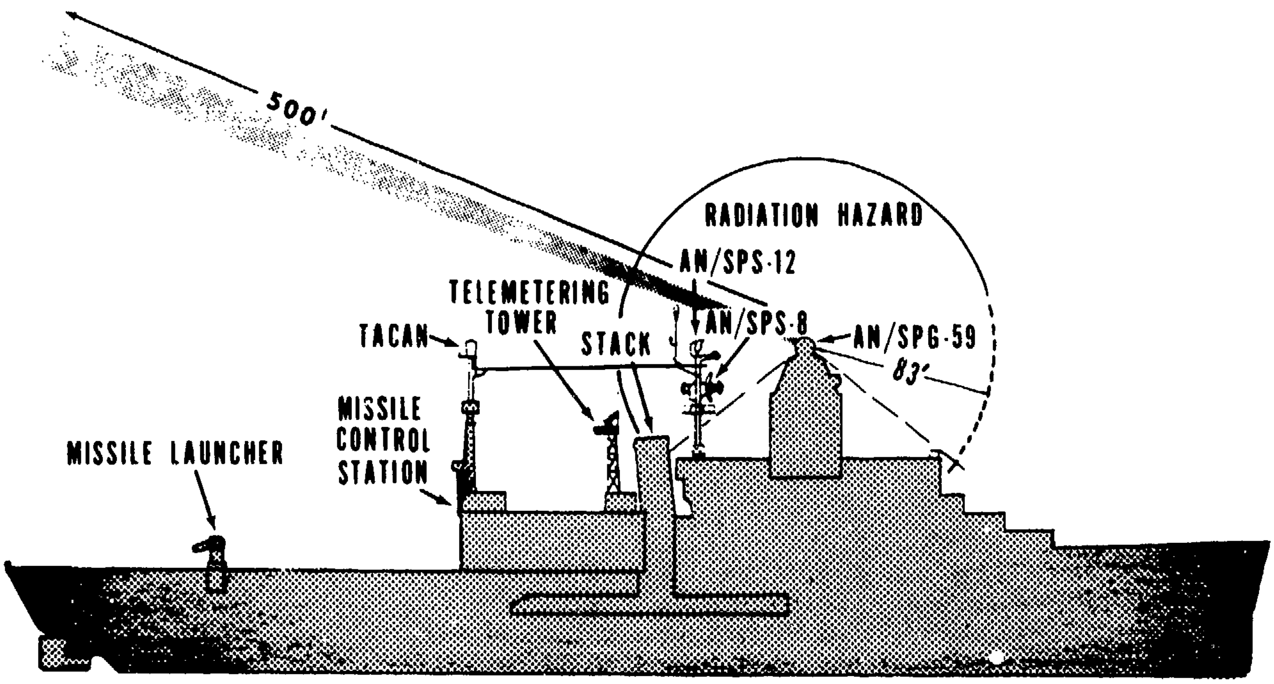


Figure 1. —Computed radiation hazard zone, USS NORTON SOUND (AVM-1)

power on a continuous basis without harm. For short periods of time, this level can be exceeded as long as the total energy exposure during any 30-second period does not exceed 0.3 joules per $cm.^2$ which equates directly: 0.01 $watts/cm.^2$ x 30 seconds = 0.3 joules per $cm.^2$ continuing exposure; or a power density of 20 $mw./cm.^2$ would be a safe exposure if it did not exceed 15 seconds in any 30-second period; or 1,000 $mw./cm.^2$ would be an acceptable level for 0.3 seconds during a 30-second period.

Naturally, these values must be equated to the power expected in the vicinity of the radar antenna. The power level of the main beam is not of primary importance to men on the deck of the TYPHON ship itself inasmuch as the beam will be prevented from pointing directly towards own ship. Means of preventing beams from being directed at personnel on other ships, or shore positions, have been discussed earlier.

Based on realistic engineering computations, the Bureau expects the potential side-lobe danger level to extend about 83 feet from the transmitting sphere of the AN/SPG-59 radar. This number will be confirmed by energy measurements in the USS NORTON SOUND by the Bureau of Ships as a first order of business after the radar installation is completed. Early tests of the system will be conducted in Chesapeake Bay to insure that inadvertent harm is not caused to human life by the main beam.

The physical design of USS NORTON SOUND is already being influenced by potential radiation hazards in that open passageways that must be manned for proper operation of the ship are being covered. Although all shields being planned now are solid steel structures, it is interesting and possibly important to note that ordinary 1/4-inch or 1/8-inch square mesh hardware cloth will provide 15-20 db of attenuation which is more than adequate in most cases. Special RF-absorbing material is currently under development which may provide additional protection against possible "spill over" of energy around the edges of screens, thereby minimizing the size of the screens required. These screens could be significant on a combatant ship where observations were required or where weight is significant. Open areas where occupancy is optional will be monitored by closed-circuit television. An interlock system of hatches will be incorporated to give the ships officers and crew a continuous check on any unsafe act that an individual crew member might e taking. Doors which open into any dangerous area will be conspicuously marked and connected with a warning system to provide a visual or audible warning when opened during periods of radar transmission to guide the men on the spot. The need and desirability of each of these devices, or the proper combination of them, will be evaluated in the prototype USS NORTON SOUND installation to guide the tactical ship design.

It is altogether possible that under certain circumstances men will be required to enter into areas that are hazardous. The Bureau of Ships, as lead Bureau for the Navy, is working on the design of protective goggles and clothing for use in the vicinity of high-power radars. Unquestionably, these will have their place, under certain conditions, in the TYPHON Navy. Generally, the suit consists of a plastic helmet, goggles, and a suit of coveralls made of material with small wire threads (similar to the material employed in radar-reflective target sleeves). It is estimated that an attenuation of 12 to 15 db can be obtained with this gear without extensive development.

In conclusion then, we are entering an era when another new hazard presents itself if the Navy is to survive in the technological race that it finds itself in. Electromagnetic radiation is a well-known phenomenon that can be measured so that adequate protective action can be taken.

The Navy is aware of the problem and will have adequate protective procedures prepared and equipment designed and proved in time to accompany the delivery of the TYPHON Weapon System to the fleet. (CONFIDENTIAL)

DOWNGRADED AT 3-YEAR INTERVALS:
DECLASSIFIED AFTER 12 YEARS.
DOD DIR 5200.10

TARTAR Missile Checkout and Maintenance in DDG-15 Class Ships (U)

By H. J. Shechtel, Assistant Division Engineer for Test Equipment, Missile Guidance and Airframe Division, BuWeps

Checkout and maintenance of the Basic TARTAR Missile in naval vessels of the DDG-2 class are described in the Bulletin of Ordnance Information No. 4-59, of 30 November 1959. Beginning with the DDG-15, a modified version of the original shipboard missile-checkout installation will be used. Briefly, this will incorporate a new type of missile, the Improved TARTAR; a new launcher, the Mk 13; and certain changes within the checkout area proper. In addition, a new design of missile-checkout handling equipment is to be effected. As in the Basic TARTAR installation, two guided missile test sets are used. These are located in the missile checkout room, Frame 135, 01 level. By means of a switching panel, either test set may conduct Missile System Test (MST) on the launcher (Figure 1) or a missile (Electronic or E-Section Test) in the checkout room (Figure 2). Missile checkout is performed on each missile in sequence. The missiles in the magazine are checked before making any repairs. Any missile shown to be faulty is noted and scheduled for later servicing. The latter operation involves removal and replacement of the faulty E-Section. Missiles are tested as soon as practical after transfer to the DDG for an initial test. MST's are conducted in 30-day intervals for the first 90 days and at 90-day intervals thereafter.

To conduct an MST on a TARTAR missile, it is loaded on the Mk 13 launcher. The launcher is positioned to enable the

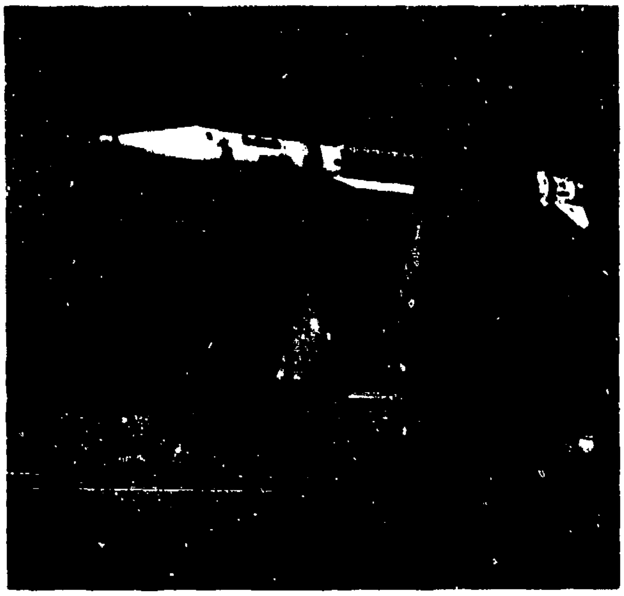


Figure 1.—TARTAR Missile System Test on Guided Missile Launcher Mk 13

placing of the RF (radio frequency) hood over the radome and the securing of the RF simulator box to the warhead section. The launcher contractor is retracted, test cables are used to power and excite the round. Continuity of circuitry is provided through a fan room junction box, ships cabling, and a main switching panel back to the guided missile test set. The main test cable connects to a receptacle on wheel 5 of the missile. Other cables carry front and rear RF signals and control the TDD RF Simulator Box. The

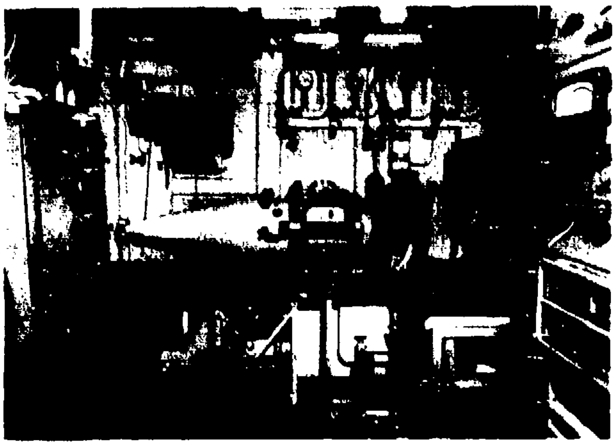


Figure 2. —TARTAR E-Section Test in missile checkout area

Figure 3. —Guided Missile Test Sets AN/DSM-55(V) and Signal Comparator CM-122/DSM in missile checkout area

main test cable (55-pin) connects to the side of wheel 5, while the normal missile-to-launcher connection is replaced by a 23-wire test cable. The latter is used to feed the missile with external 115-volt 400-cycle, 3-phase, 4-wire power which is controlled by the test set. The launcher is depressed to 0° elevation and trained to 147° or 213°. No personnel are permitted in the launcher area during the MST. No connection is made to the missile firing circuit, thereby preventing accidental firing of the missile. For shipboard testing, the tail servos are not actuated and the tail surfaces remain folded. The missile internal power is not turned on.

Figure 3 shows the two Guided Missile Test Sets AN/DSM-55(V) type B. Each one independently can apply a series of electrical signals to activate the missile guidance system within its design parameters. The sequence of events programmed by the test set simulate missile functions and conditions such as warmup, launch, boost, and target acquisition. Selected steering signals are monitored at various points in the missile and compared to tolerance limits within the test set. At the end of the MST, but prior to removal of external power, the missile gyro recages and the program timer resets to zero to return the missile to a flight-ready status.

At the completion of the MST, the test set indicates the missile operational capability by means of indicator lamps. If the NO-GO lamp is on, one or more of the fault-location lamps will also be illuminated, giving an indication of the wheel or parameter within the missile malfunctioning. Separate microwave signals developed in the AN/DSM-55(V) are applied to the missile or E-Section under test. The rear signal is composed of surface-based radar coding and doppler reference information, while the front signal comprises target reflection intelligence which normally contains spillover from the surface-based radar. These signals simulate those which would be received normally by the missile homing seeker during flight.

Before each MST, the AN/DSM-55(V) performs an automatic check of its own evaluation and interlock circuitry, as well as the critical power supply voltages, to assure that test set malfunctions will not produce an erroneous MST result. The result of this self-test is displayed by indicator lights on the control panel.

The Target Detection Device in the missile is tested by means of the RF simulation box previously referred to, and the TDD tester module in the AN/DSM-55(V). The RF simulator box acts as a simulated target for the TDD. The test set also controls the application of ram-pressure air to the ram-pressure probe on the front of the missile. Pneumatic connection is made from the missile to an actuator in the test area by means of an air hose.

In addition to the Guided Missile Test Sets AN/DSM-55(V), other major pieces of equipment also located in the checkout area are the Signal Comparator CM-122/DSM and the Telemetric Data Receiving, Recording, and Scoring Set AN/SKQ-1.

The Signal Comparator CM-122/DSM, shown between the two AN/DSM-55(V) test sets in Figure 3, is used to set up and measure the parameters of the microwave signals generated in the guided missile test set and the continuous-wave (CW) illuminator of the Radar Set AN/SPG-51(B). In addition, extremely low AM and FM noise can be detected on these microwave signals by means of the signal comparator. By employing this equipment, the testing of the missile with the same RF signal it receives in flight is assured.

The Telemetric Data Receiving, Recording, and Scoring Set AN/SKQ-1 shown on the left of Figure 4 replaces three major pieces of equipment used previously. These are the Telemetric Data Receiving Set AN/UKR-10, the Telemetric Data Recording Set AN/SKH-1, and the Miss Distance Measuring System AN/USQ-11A. Signals are received by one of two dual-purpose antennas—one for port firing and one for starboard firing—from three FM/FM telemetering transmitters in the exercise missile. The drone transponder signal on the somewhat different frequency is simultaneously received with the same antenna. Composite subcarrier telemetering intelligence is recorded on three tracks, one for each transmitter/receiver link, while miss-distance voice, timing, event and 100 kc. precision information is stored similarly on the fourth track of the magnetic tape. Play-back is later effected by means of an oscillograph recorder in the AN/SKQ-1 for the final data reduction. Figure 4 shows this equipment being used for preflight checkout of a telemetered head for an exercise missile.

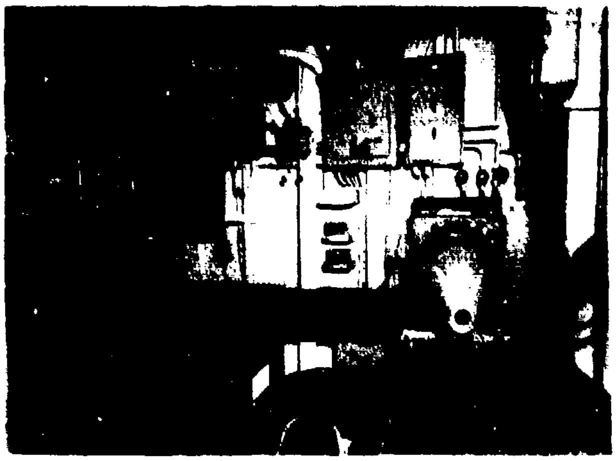


Figure 4.—Telemetric Data Receiving, Recording, and Scoring Set AN/SKQ-1 being used to test TARTAR exercise head in missile checkout area

Also located in the TARTAR missile checkout room are cabling and waveguide switching panels, junction boxes, power distribution panels, and telemeter control panel. These, together with the major equipments described earlier, enable shipboard personnel to carry out missile test and service operations.

(CONFIDENTIAL)

DOWNGRADED AT 3 YEAR INTERVALS:
DECLASSIFIED AFTER 12 YEARS.
DOD DIR 5200.10

674622 O -63 -5

Proximity Fuzes for TARTAR/TERRIER HT-3 Guided Missiles (U)

By Eugene McFall, Fuze Department,
Naval Ordance Laboratory, Corona, Calif.

The Navy's first tactical experience with surface-to-air guided missile fuzing systems came when the TERRIER BW-0 missile, with its Target Detecting Device (TDD) Mk 1, was introduced into fleet service in 1955. Since then the necessity of defending against more sophisticated targets has brought about the development of much more complex missile systems; and the fuzing requirements of these new systems are demanding continual advances in missile fuzing. The proximity Guided Missile Fuze Mk 308, now in fleet service for the TARTAR/TERRIER HT-3 family of missiles, represents such an advance in the state of the art of fuzing.

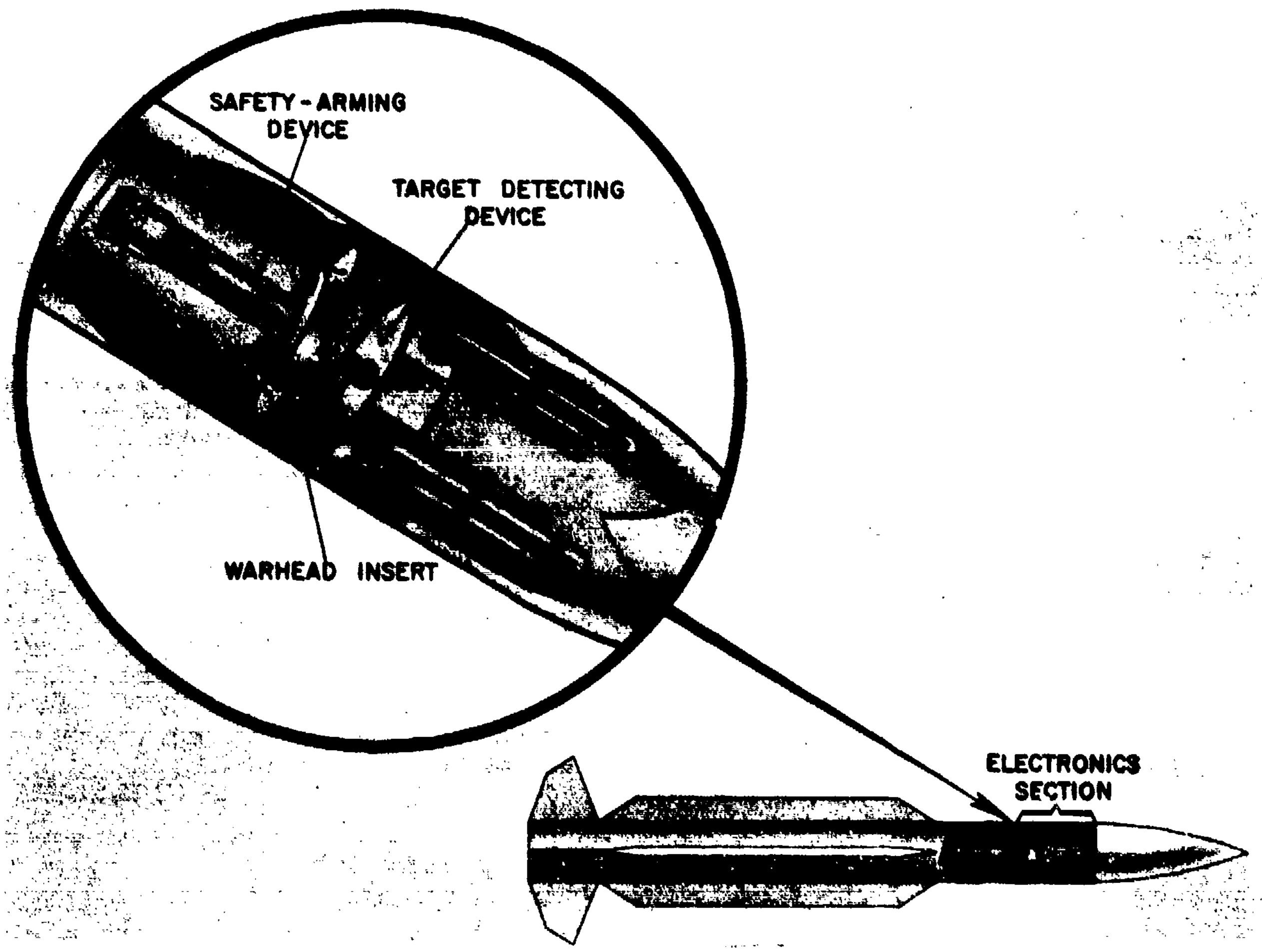


Figure 1. —Guided Missile (proximity) Fuze Mk 308

To counter the threat of modern high-speed targets, greater missile performance has had to be achieved. In the TARTAR/TERRIER HT-3 missiles this has been accomplished by higher speeds, greater maneuverability and the use of a more effective continuous-rod warhead. The use of the continuous-rod warhead has necessitated the precise determination of relative target position. The effectiveness of this warhead has been enhanced by controlling the time between target detection and warhead detonation through the technique of generating a continuously variable time delay that is inversely proportional to the missile-to-target closing velocity. Information about the latter is derived by the missile system and supplied to the TDD as a range rate (R) voltage.

The Basic TARTAR missile is now in fleet service on board destroyers of the USS ADAMS (DDG-2) class; the Improved TARTAR (IT) is in service in six of the DDG-2 class destroyers, i.e., the DDG-4, -8, -10, -11, -12 and - 14; and the TERRIER HT-3 is being deployed for use by guided missile frigate USS PRATT (DLG-13). The IT and HT-3 missiles will soon be in tactical operation in the remaining DDG-2 class TARTAR ships, and DLG 16-25 class, CGN-9 and CVA-63 and -64 TERRIER ships. DLG's 8-12 will be backfitted next regular overhaul. These missiles have the operational requirement to defend against high-speed, low-altitude attacks.

The Naval Ordnance Laboratory, Corona, Calif., has the responsibility for development of all Navy guided missile fuzing systems from early feasibility studies through fleet support phases. In compliance with this assignment, the Mk 306 fuze, which comprises the TDD Mk 7 and the Safety-Arming Device (S-A) Mk 7, was developed to meet the exacting requirements of the TARTAR/TERRIER HT-3 missiles. To intercept low-flying targets, the Laboratory introduced a fuzing system which achieves sharp cut-off discrimination against the surface of the sea, yet retains optimum target detection characteristics. Subsequent engineering ideas have greatly improved operation of the fuzing system, and in addition, its reliability has been increased and its storage life lengthened as the result of using new and improved electronic components and circuits, and new techniques for high-density electronic packaging.

A TDD is required to survive long periods of storage, endure the rigorous temperature, shock, and vibration environments incident to flight, and still function perfectly at intercept. Added to the problems of design inherent in meeting such requirements are those imposed by the complexities of intercepting today's airborne threats. The intercept is characterized by a transient event, milliseconds in duration, which occurs only once. The transient to which the TDD responds must be the result of target detection and nothing else. Transients from any other source, such as self-generated transients caused by environmental or input power changes, transients caused by friendly RF interference, or those resulting from intentionally deceptive countermeasure signals of all types, must be rejected by the TDD.

The TDD Mk 7 Mod 0 was designed for use with the Mk 10 warhead in the Basic

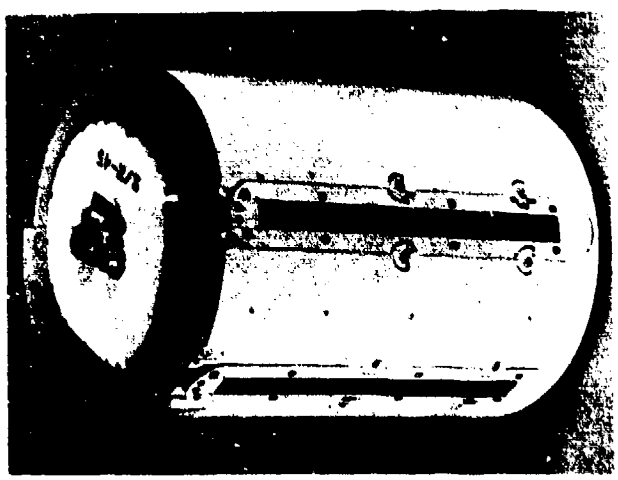


Figure 2.—Missile electronics section, less Wheel No. 1, with Target-Detecting Device Mk 7 and antennas installed

TARTAR missiles, and the detection angle and the time-delay computer characteristics were optimized to be compatible with that warhead and missile. The TDD Mk 7 Mod 1 detection angle and time-delay computer characteristics were optimized for use with the Mk 10 warhead in the IT/HT-3 missiles. The TDD Mk 7 Mod 2 (not yet available to the fleet) is optimized for use with the Mk 51 warhead in the IT/HT-3 missiles. The Mods are electrically and mechanically interchangeable among these missiles, although they should not, of course, be interchanged except to meet emergencies. However, if interchange is required, only minor reduction in system effectiveness will result. This tactically advantageous factor is made possible by the use of a wheel-type mechanical design which is common to all three missiles. Figure 1 is an artist's conception of the arrangement of the Mk 308 fuze. The missile's electronic section contains five wheel packages (see Figures 1 and 2). The TDD is mounted in the after wheel package and the S-A is mounted in the warhead insert. The S-A cable connects with a plug which is integral with the TDD housing lid. Because the missile is designed to break at the electronics section, that entire section, or the TDD, or the S-A can readily be changed for another unit. Figure 3 shows the TDD Mk 7 removed from the wheel package.

In the early developmental stages, the firing circuit of the TDD was permitted

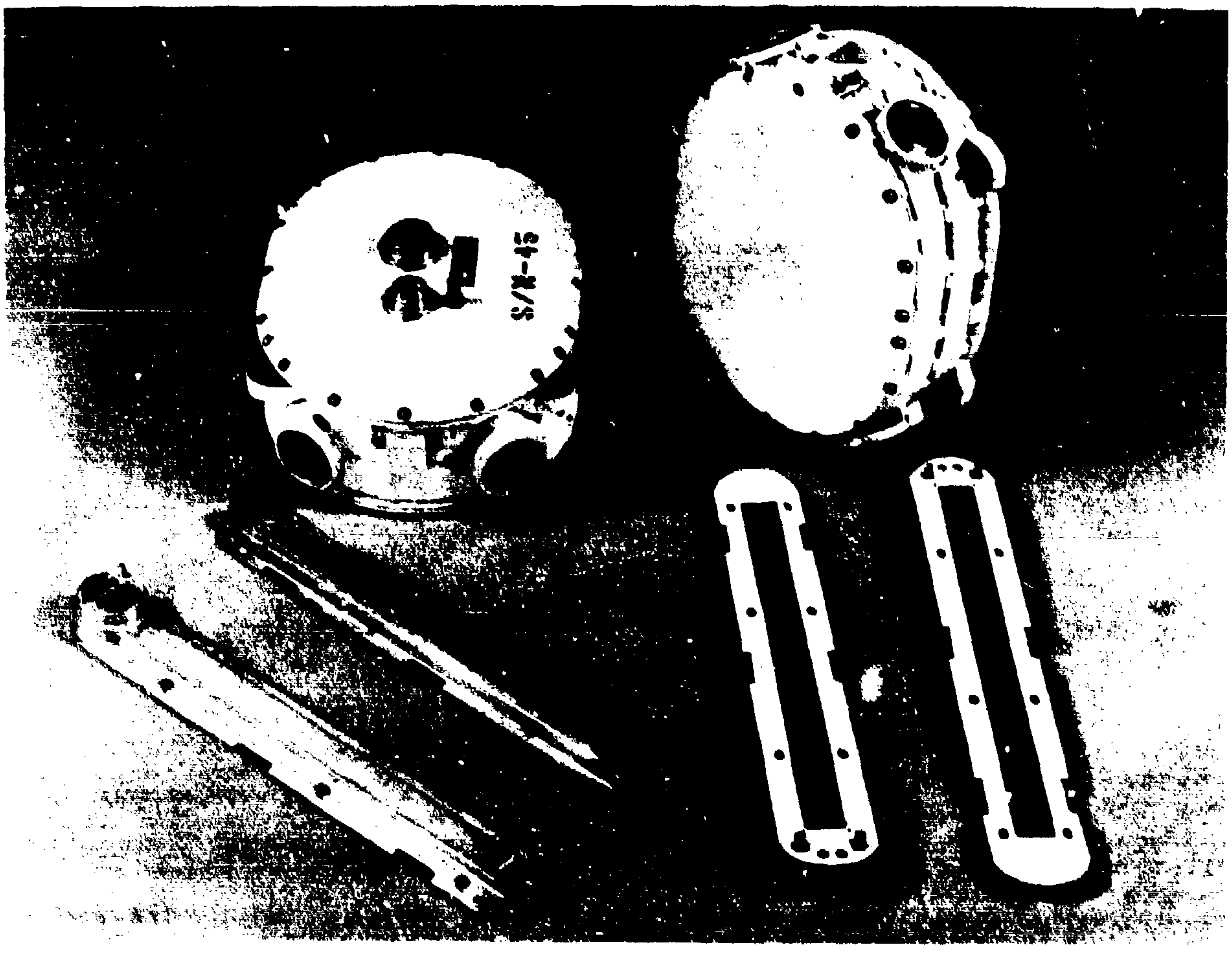


Figure 3. —Target-Detecting Device Mk 7 with antennas

to fire on loss of power in the missile, since it appeared that power loss would most likely occur on collision of the missile with the target, and in this case the warhead would be detonated immediately. During the course of the developmental flight tests, however, it appeared that the missile power supply and power wiring were not sufficiently free of momentary drop-outs and transients to permit retention of the fire-on-power-loss feature. The TDD firing circuit design was changed accordingly. For intercepts resulting in physical impacts, the TDD will usually detect the extremity of the target when it enters the detection cone and the firing sequence will be initiated. This calls for a delay of warhead detonation until such time as the missile has carried the warhead past the extremity of the target to a vulnerable area. If the missile impacts the target and causes loss of power during this computed period of delay, the TDD will go inert and the warhead will not be detonated. A contact fuze is now being designed for use in the TARTAR/TERRIER HT-3 guided missile system. This fuze, when used in conjunction with the proximity fuze, will initiate warhead action on target impact.

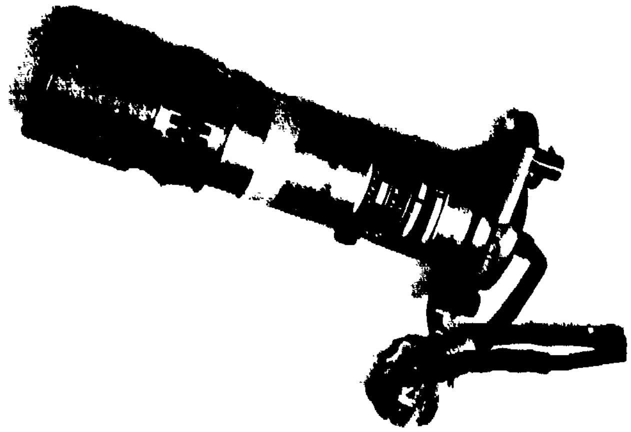


Figure 4. —Safety-Arming Device Mk 7

The S-A Mk 7 (see Figure 4) separates the sensitive initiating elements in the explosive train from the warhead booster until the missile has been launched. The device contains an acceleration sensing system which will integrate the acceleration forces supplied by the propulsion system and will arm the explosive train following booster burnout when a safe distance from the launcher has been reached. The S-A will also sense an interrupted acceleration and will return to the safe condition if acceleration is lost before the required safe distance has been reached. To accomplish this, the S-A contains a series of sequential and interlocking events which require various types of input energy to complete the arming cycle. Locking devices prevent possible accidental arming by dropping or mishandling. A safety objective during the design and development phase is to incorporate features that will result in a failure rate of less than one in a million. A series of environmental and functional tests to which the S-A is subjected is relied upon to disclose the need for any change that may improve the initial design. The S-A is released for fleet use only after a series of laboratory tests has assured satisfactory performance.

The overall reliability of the TDD Mk 7 is approximately 95 percent. This figure is based upon 240 firings (through September 1962). (CONFIDENTIAL)

DOWNGRADED AT 12-YEAR INTERVALS:
NOT AUTOMATICALLY DECLASSIFIED
DOD DIR 5200.10

Lightweight 5"/54 Caliber Gun Weapon System

The Bureau of Naval Weapons has recommended to the Office of the Chief of Naval Operations the development of a lightweight 5"/54 gun and an associated lightweight gun fire control system. The weapon system is to be designed for antiship/antishore use, and is to be installed on vessels whose air defense is provided by guided missiles. The characteristics of the proposed system are summarized below.

5"/54 Caliber Lightweight Gun

The objective of this gun development program is to make available to the fleet lightweight gun mounts which will provide a marked increase in gunfire delivery effectiveness with maximum economy in use of available ship volume, ordnance weight allowance, manning levels, construction funds, and high-premium topside space.

The 5"/54 lightweight mount design is a 50,000-pound (maximum), low-silhouette, minimum-shielded mount with no on-mount personnel. A simplified centerline cradle concept permits below-deck gun servicing and control with minimized crew strength. It consists of a new-design lightweight, high-strength, steel barrel with a loose liner, a vertical sliding wedge breechblock, a nonrotating off-mount hoist aligned with a loading cradle in the center of rotation of the mount and a 20-round, below-deck, ready-service-ring magazine. The design is optimized for installation in close proximity to missile launchers with their attendant high levels of blast, shock, and gas overpressures and incorporates features providing optimum resistance to nuclear blast overpressures and to radiation contamination. The mount is capable of continued delivery of effective fire even when the topside structure of the ship is contaminated.

Rounds are loaded manually into the below-deck, 20-round, ready-service ring and cycles into the stationary hoist. The hoist carries the complete round through a length that can be easily varied as required by hull configuration, into the center-of-rotation loading cradle. The loading cradle then swings the round into the gun housing in alignment with the breech, and ramming is accomplished. Upon firing, the spent powder case is ejected from the gun and the cycle repeated. A significant feature is that gun cycling is not dependent upon favorable gun elevation angles, and that the rate of fire can be maintained even at the highest gun elevation, contrary to most existing gun designs.

The gun design is based on the use of existing 5"/54 caliber ammunition. Accordingly, development of the gun does not generate a requirement for an ammunition developmental program. The gun will be compatible with the 5"/54 rocket-assisted projectiles when they become available.

The gun crew consists of a topside off-mount gun captain acting as a safety observer; a magazine operator below deck to control gun cycling, supervise gun servicing, and control the gun in local control when necessary; and four loaders (two projectilemen and two powdermen).

The design of the gun is such that it is fully capable of retrofit in the ship volume and base-ring diameter of the 5"/38 gun mounts. Any ship that includes the 5"/38 single or twin gun mount in its installation can accommodate this gun.

Lightweight Fire Control System (Mk 86)

The primary objective of this developmental program is to provide a lightweight, integrated fire control system to control the new lightweight guns. The system will be capable of installation in numerous ship types without compromising other design requirements.

Recent advances in radar and digital computer techniques have made possible the "track-while-scan" approach to surface fire control. The system proposed will employ a single, continuously rotating radar antenna which transmits target-position information to a digital computer. Multiple surface targets can be tracked automatically while the radar simultaneously undertakes continuous surface search. This approach allows the most efficient use of the lightweight gun in countering a multiple attack by fast, small craft. Additional advantages of the proposed system, when compared with the best system now available, will be as follows:

a. Less costly (about one-third the cost).

b. Greater flexibility in adapting to several gun ballistics.

c. More reliable because of reduced complexity.

d. Fewer operating and maintenance personnel required (half as many).

e. Requires no separate target-designation system.

f. Less weight (about one-sixth as much).

The new lightweight fire control system will consist of an aloft director on a stabilized antenna platform, a computer, radar equipment, and control console in an enclosed space below decks. The computer will be digital, and will be designed to solve two surface problems simultaneously. Reservations will be made to add rocket-assist projectile (RAP) ballistics when the RAP ammunition becomes available. The system will be effective against surface craft at speeds up to 150 knots and shore targets in both direct and indirect fire. The overall system weight will be about 5,000 pounds; the number of operators required will be three.

It is noted that the Bureau has also recommended the development of a lightweight 8"/55 caliber gun. It would be competitive in weight and volume with the 5"/54 caliber rapid-fire gun and could be controlled by the above-described lightweight Gun Fire Control System Mk 86 Mod 0.

(UNCLASSIFIED)

5"/54 White Phosphorus Projectile Release to Production (U)

E. W. Russell, Conventional Ordnance and Ballistics Branch, Missile Ordnance Division, BuWeps

Development has been completed on the White Phosphorus 5"/54 Caliber Projectile Load Mk 14 Mod 0 and its loaded and fuzed assembly in 5"/54 Caliber Illuminating Projectile Mk 48 Mod 1. Design and development of this canister-type load was accomplished by the Army Chemical Corps.

This assembly provides the 5"/54 caliber gun system with a capability for disseminating white phosphorus like that in service for the 5"/38 caliber gun system; i.e., base ejection of an agent-filled canister from the projectile body and dispersal of the agent, after a slight delay, by detonation of an axially located column of explosive.

The Bureau of Naval Weapons plans to procure 5"/54 white phosphorus projectiles this fiscal year. (CONFIDENTIAL)

Infrared VT Fuze Mark 90 Mod 0 for 5"/38 Projectile (C)

By Charles H. Miller, Project Engineer, Fuze Branch, BuWeps

(This article was published in Bulletin No. 3-62. Because of an omission in the first paragraph, it is hereby repeated in its entirety.)

Development of an infrared fuze, the VT Fuze Mk 90 Mod 0, for the 5"/38 projectile has been completed and the fuze has been released to procurement. This development was undertaken to provide a fuze with greater immunity to countermeasures and friendly interference than is provided by the radio fuzes presently in service.

Recent performance of the Mk 90 fuze in OPTEVFOR (Development Assist Program #186) was excellent. This fuze demonstrated effective performance against high-speed jet targets and also good low-altitude overwater capabilities. It is a substantially better all-round fuze than current radio fuzes for use against jet targets. It is not recommended for use against propeller planes.

Infrared fuze developments are also in progress for 5"/54 and 3"/50 gun applications. (CONFIDENTIAL)

DOWNGRADED AT 3 YEAR INTERVALS:
DECLASSIFIED AFTER 12 YEARS
DOD DIR 5200.10

Target Illumination and Recovery Aid (TIARA) (C)

By C. E. Waring, Scientific Advisor to the Technical Director and J. W. Baird, Project Coordinator, Research Department, U.S. Naval Ordnance Test Station, China Lake, Calif.

A new chemical compound, designated PR-155, that luminesces brightly when exposed to air has led to the initiation of Project TIARA (Target Illumination and Recovery Aid) at the U.S. Naval Ordnance Test Station (NOTS), China Lake, Calif. (The code name TIARA alone is unclassified.) Formulations are being developed for use in standard ordnance items for night military activities. The duration of luminescence of different formulations varies from a few minutes to a few hours. The present color characteristic is in the yellow-green region of the spectrum, and, in its pure form, PR-155 is a liquid that is lighter than water. The luminescence, which varies between 0.7 and 7.7 foot-lamberts can be clearly seen at night, and its duration can be controlled by varying the formula. TIARA, which is stable in storage in the absence of oxygen, may be varied over a range of viscosities from a liquid to a solid. For example, when mixed with paraffin wax it forms an effective marking stick, called MARSTICK. It also has been dispensed from a plastic squeeze bottle with a brush on the spout for painting.

POSSIBLE APPLICATIONS AT SEA

TIARA formulation can be used whenever it is desired to illuminate an area or an object at night (Figure 1). When

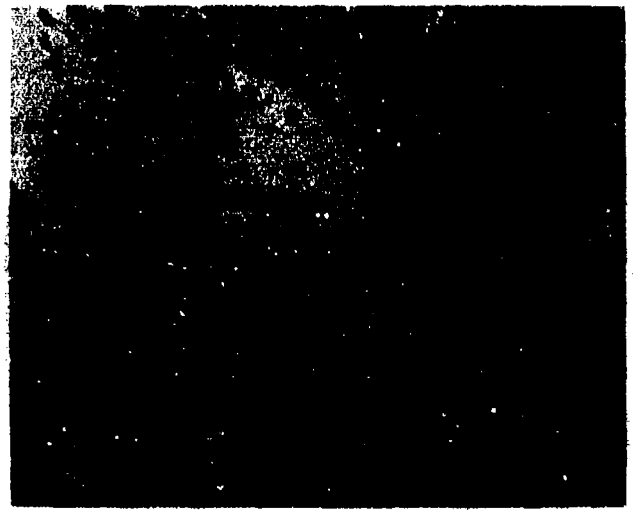


Figure 1.—Tree-burst of a TIARA-loaded M-25 hand grenade near a river at night

incorporated in standard ordnance items, TIARA can be delivered by air, by artillery, by hand, or by mines against stationary and moving targets. A detachable line of plastic containers with TIARA formulation might be dragged from the stern of a carrier to aid landing approaches. Some other applications for TIARA formulations are: (1) release by a submarine to mark certain ocean areas for purposes of pickup, resupply, or rescue; (2) use in air-sea rescue operations; (3) use as a reference point or base point (marked by a TIARA-loaded artillery projectile) when firing at night from a firing chart or a battle map in preparing for a shore bombardment or in establishing a barrage; and (4) marking a sea or land target by a carrier-based reconnaissance aircraft (carrying a TIARA-loaded rocket or bomb), enabling an attacking aircraft to identify the target.

OTHER DELIVERY METHODS AND APPLICATIONS

For land warfare, TIARA may be incorporated in mortar shells, artillery shells, hand and rifle grenades, land mines, pyrotechnic shells, rockets and rifle bullets—to be used for guiding bombers or strafing planes on target, detecting the enemy, guiding friendly patrols, marking the rear of vehicles on a night road march, marking the rear of helmets when moving to the line of defense, marking front lines and no-bomb lines, and securing against infiltration into a position (Figure 2).

A small, pocket-size bottle, silvered on the outside, then blackened to give an inside reflective effect, and containing a liquid TIARA formulation, may be used as a map light (Figure 3). When the bottle is uncapped, blown into, and then recapped, the activated TIARA composition will emit ample light for a short time through a small opening in the silver and black coatings. It may be reactivated in the same manner and reused many times.

A cloth marker panel can be saturated with the formulation and sealed in a container to be used for marking drop zones during night air deliveries of personnel or equipment and for surface-to-air visual messages (Figure 4). Six- by two-foot panels, each sealed in quart containers, have been used in demonstrations at NOTS.

TIARA marking sticks or paint can be used to mark unlighted runways, helicopter landing areas, airdrop zones, aircraft, and bundles for air dropping (Figure 5).

Figure 2.—A U. S. Marine, portraying an intruder, being exposed by detonation of TIARA-loaded device at night

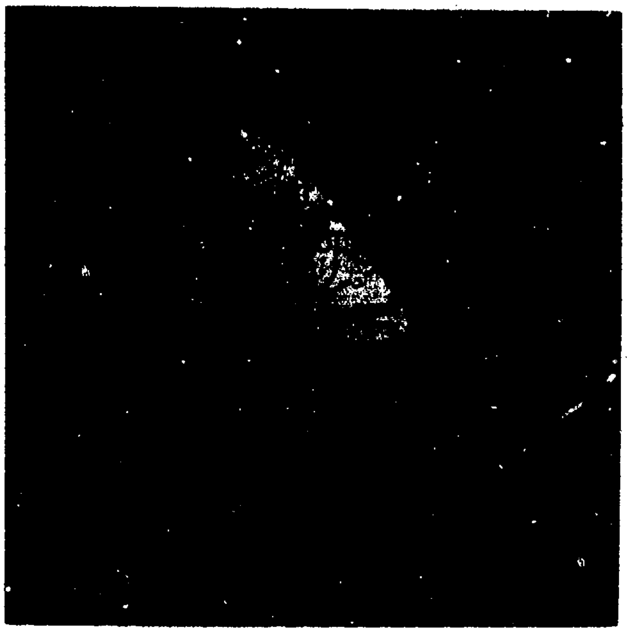


Figure 3. —TIARA formulation being employed as a map light

Figure 4. —TIARA-saturated cloth marker panel being unfolded after removal from quart-size container

Figure 5. —TIARA-painted bundles being air-dropped at night

COMBAT FEASIBILITY DEMONSTRATIONS

There have been several combat feasibility demonstrations of TIARA at NOTS during the past 8 months for Station personnel and visiting dignitaries. TIARA has been demonstrated as being feasible for use in 81-mm mortar shells; M-19 rifle grenades and M-25 hand grenades; antipersonnel and antitank mines; and on panels and air-dropped bundles. Successful demonstrations have also been presented by NOTS personnel at Fort Bragg, N. C., the U. S. Marine Corps Schools, at Fort Benning, Ga., and in Thailand.

SUMMARY

Research is continuing to improve the brilliance and duration of luminescence. New formulations that would vary from short-life high intensity to long-life low intensity are under study. The use of various dyes mixed with TIARA formulations to give luminescence of different colors is another phase of research being done at NOTS. Optimum formulations that would be applicable for use on tape and string, in aerosol form, as pastes, and as marking sticks are currently under investigation. Many other aspects of research on TIARA formulation are being considered that will lead to standard formulas for different uses and that will permit manufacture in production lots.

Some of the obvious advantages of TIARA weapon systems are: (1) it will not temporarily blind pilots as do star shells, magnesium flares, and other pyrotechnics, nor will it disclose friendly positions because only the object on which it is dispersed is illuminated; and (2) the duration of its luminescence is far greater than phosphorous-type ammunition, which is often used to illuminate a target.

(CONFIDENTIAL)

DOWNGRADED AT 3-YEAR INTERVALS:
DECLASSIFIED AFTER 12 YEARS.
DOD DIR 5200.10

If, in reading this article, you have conceived other ideas of application or delivery related to TIARA, your submissions would be appreciated. Submit them to Chief, Bureau of Naval Weapons, Navy Department, Washington 25, D.C., or to Commander (Code 50), U.S. Naval Ordnance Test Station, China Lake, Calif.

CORRECTION

The Group 4 notation that appears at the end of article entitled AUTOMATIC ANTI-JAM CIRCUITRY FOR RADAR SET AN/SPG-55A (U) on page 36 of Naval Weapons Bulletin No. 2-62 is incorrect and should be deleted. A group 3 notation, as follows, should be entered at the bottom of page 36:

DOWNGRADED AT 12-YEAR INTERVALS:
NOT AUTOMATICALLY DECLASSIFIED.
DOD DIR 5200.10

ASW—UNDERWATER

JEZEBEL Relay (U)

By E. J. Caris, Jr., and F. W. Douglass,
U.S. Naval Air Development Center, ASW Laboratory, Johnsville, Pa.

The desirability and technical feasibility of a JEZEBEL Relay was discussed in conference at the Office of the Chief of Naval Operations during the spring of 1957. The relay of unprocessed JEZEBEL signals to a remote point for analysis generally was considered to be desirable, provided that satisfactory signal reproduction could be achieved.

In 1959 the Naval Air Development Center, Johnsville, Pa., modified an existing telemetry transmitter, developed a signal compressor, and installed this relay equipment in a P2V laboratory aircraft. During a field exercise in the Key West area a temporary receiver station and an Indicator Group AN/AQA-3 were installed in the hangar with the receiving antenna on the hangar roof. This experimental equipment, which utilized four subcarriers transmitted in the 265-megacycle telemetry band, demonstrated the feasibility of relaying JEZEBEL signals. A useful range of 90 miles, with the aircraft operating at 5 000 feet, was achieved. Post flight comparison of the AN/AQA-3 charts disclosed no visible degradation of the JEZEBEL signal.

The success of this experimental equipment was the basis for a VS/CVS JEZEBEL relay development program, currently being prosecuted at the Naval Air Development Center. This system is designed to provide the relay link between a number of carrier-based VS (submarine, search, attack) aircraft, such as the S-2 (S2F) tracker, and the ASW carrier.

International agreements on spectrum allocation required that the previously used telemetry band be vacated and future telemetry systems be designed to operate between 2,200 and 2, 300 megacycles. A theoretical analysis indicated that satisfactory relay system performance could be expected to a range in excess of 100 miles. Accordingly, a system is being developed which will permit evaluation of the relay concept in the new frequency band. A block diagram of this experimental VS/CVS JEZEBEL Relay system is shown here in Figure 1.

This system provides the simultaneous relay of 16 signals, 4 from each of 4 aircraft. Four subcarriers are transmitted on the same radio frequency (RF) by each aircraft. The relay system may be extended to accommodate additional aircraft by the allocation of transmission frequencies and installation of base station receivers and signal processing equipment. Four aircraft were considered necessary to evaluate the possible mutual interference and simultaneous multisignal processing capability.

Signal transmission is accomplished by double frequency modulation (FM); that is, the acoustic signal from each channel of the Radio Receiving Set AN/ARR-52 frequency-modulates one of the four subcarriers. These subcarriers are then combined to frequency-modulate the RF carrier in the exciter. This equipment employs the Armstrong system of FM and the exciter may be crystal controlled on any assigned frequency. The exciter output is in the 225-megacycle range and the frequency is multiplied by nine in the first two tripler stages in the RF amplifier. The final stage is a power amplifier which provides a nominal 15 watts. The output signal is fed to the co-linear, ground plane antenna through a short coaxial cable. The antenna, installed on the underside of the aircraft fuselage, provides a directional pattern in the vertical plane and has

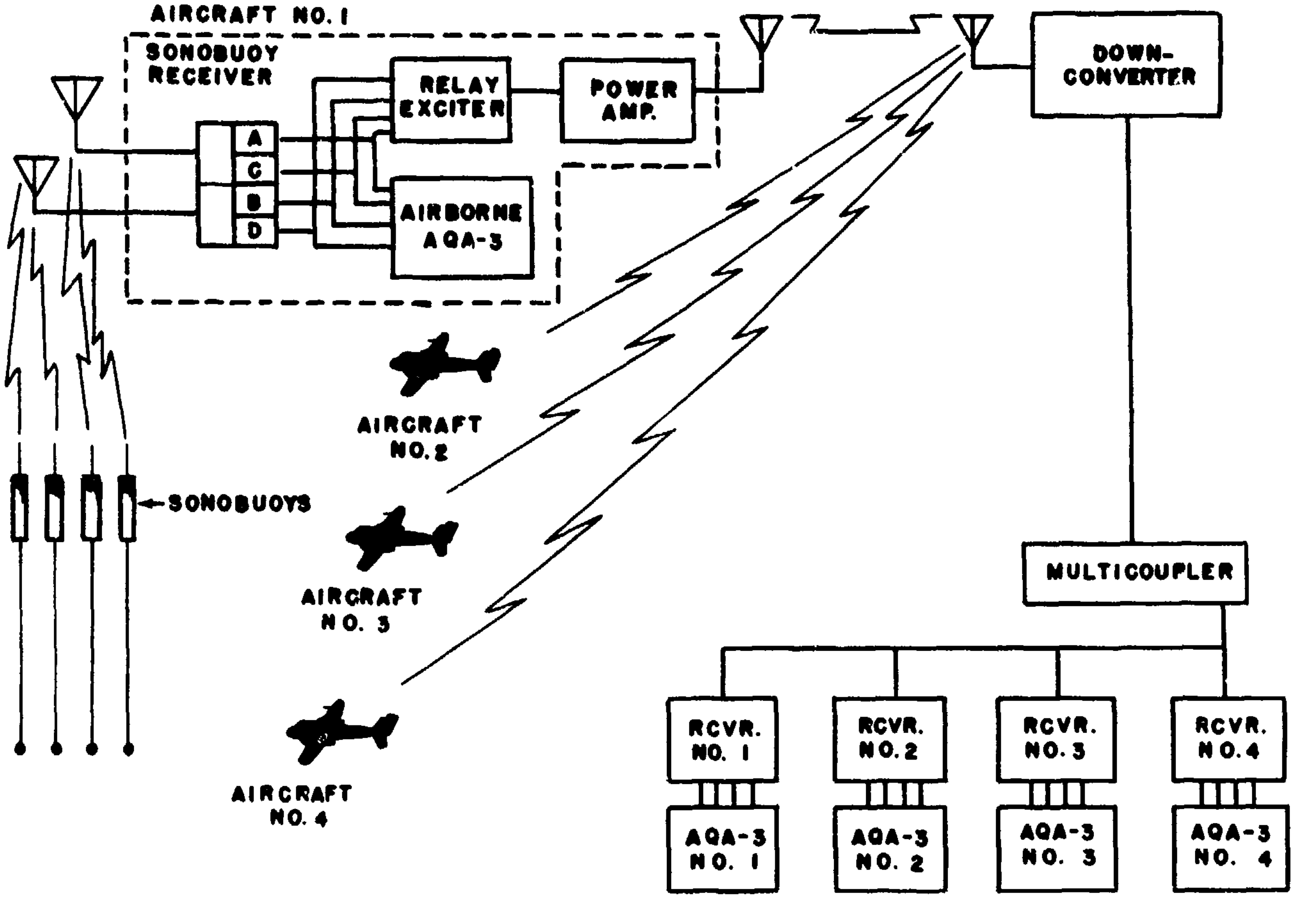


Figure 1. —VS/CVS JEZEBEL Relay System

about 6 db gain, relative to a dipole. The antenna characteristics were chosen to obtain the best signal-to-noise ratio at maximum range. The airborne relay equipment weighs about 45 pounds and occupies about 1-1/2 cubic feet.

The shipboard receiving station is comprised of an antenna, a down-converter, and the receiver rack which contains the receivers, multicoupler, power supplies, subcarrier demodulators, filters, and amplifiers. The antenna is mounted at the masthead, approximately 180 feet above the water line. The down-converter is located topside, as near as possible to the antenna, and heliax cable is used to connect the down-converter output to the receiver rack. The four subcarriers from each receiver discriminator are filtered to eliminate interchannel crosstalk, and additional limiting and filtering is employed to obtain the best possible signal-to-noise ratio. The audio signals are connected to the four AN/AQA-4(V) recorders where all 16 signals are simultaneously displayed.

This relay equipment was delivered to the Naval Air Development Center during the spring of 1962. Upon completion of performance tests in the ASW laboratory, flight tests were conducted, using a roof-top antenna. After experiencing a number of difficulties, normally associated with experimental equipment, ranges in excess of 100 miles were achieved consistently. These results were encouraging since the receiving antenna height was only about 65 feet and the transmission path was over land.

The transmitting equipment is now installed in four operational S-2D (S2F-3) aircraft and the receiver is installed in USS KEARSARGE (CVS-33). The Fleet Investigation Project issued by the Chief of Naval Operations is intended to prove the technical feasibility of a satisfactory JEZEBEL Relay in the 2200- to 2300-megacycle band and to determine the operational usefulness of such a VS/CVS JEZEBEL Relay system. Additional information, concerned with the final equipment design, is expected from engineering analyses of the results of the evaluation. Although the existing equipment is experimental, incorporation of a few modifications can result in an equipment suitable for production.

The Fleet Operational Investigation of the VS/CVS JEZEBEL Relay equipment is intended to determine if:

a. Better maintenance and adjustment of equipment aboard ship will improve target detection.

b. Redundancy of observation will assist detection and classification.

c. More and better trained analysts and a larger catalog of signatures will provide more positive classification on board the ship.

d. The better environment and supervision on board ship will produce more alert watch standers.

e. A relatively simple retrofit program can provide the JEZEBEL capability in aircraft that are without signal processing equipment.

f. Availability of relayed signals will permit better coordination of individual ASW units.

g. The system will allow decisions to be made on a more senior level in a less tense atmosphere. (CONFIDENTIAL)

DOWNGRADED AT 3-YEAR INTERVALS:
DECLASSIFIED AFTER 12 YEARS.
DOD DIR 5200.10

Evaluation of Underwater Sound Signals

By A. P. O'Sullivan, Mechanical Engineer, Head, Explosives Branch,
U. S. Naval Underwater Ordnance Station, Newport, R. I.

The design and evaluation of explosive devices for the Navy is the direct re-·onsibility of the Bureau of Naval Weap- . This responsibility in turn has been delegated by the Bureau to various field stations which oversee the design and evaluation of specific items. The responsibility for the design and evaluation o´ ‾derwater sound devices used by the F for explosive echo-ranging has ·n assigned to the U. S. Naval Underwater Ordnance Station (NUOS), Newport, R. I.

When a new design involving explosive devices is conceived, various tests are required to prove the design. These tests are conducted in two phases:

1. Development

2. Evaluation

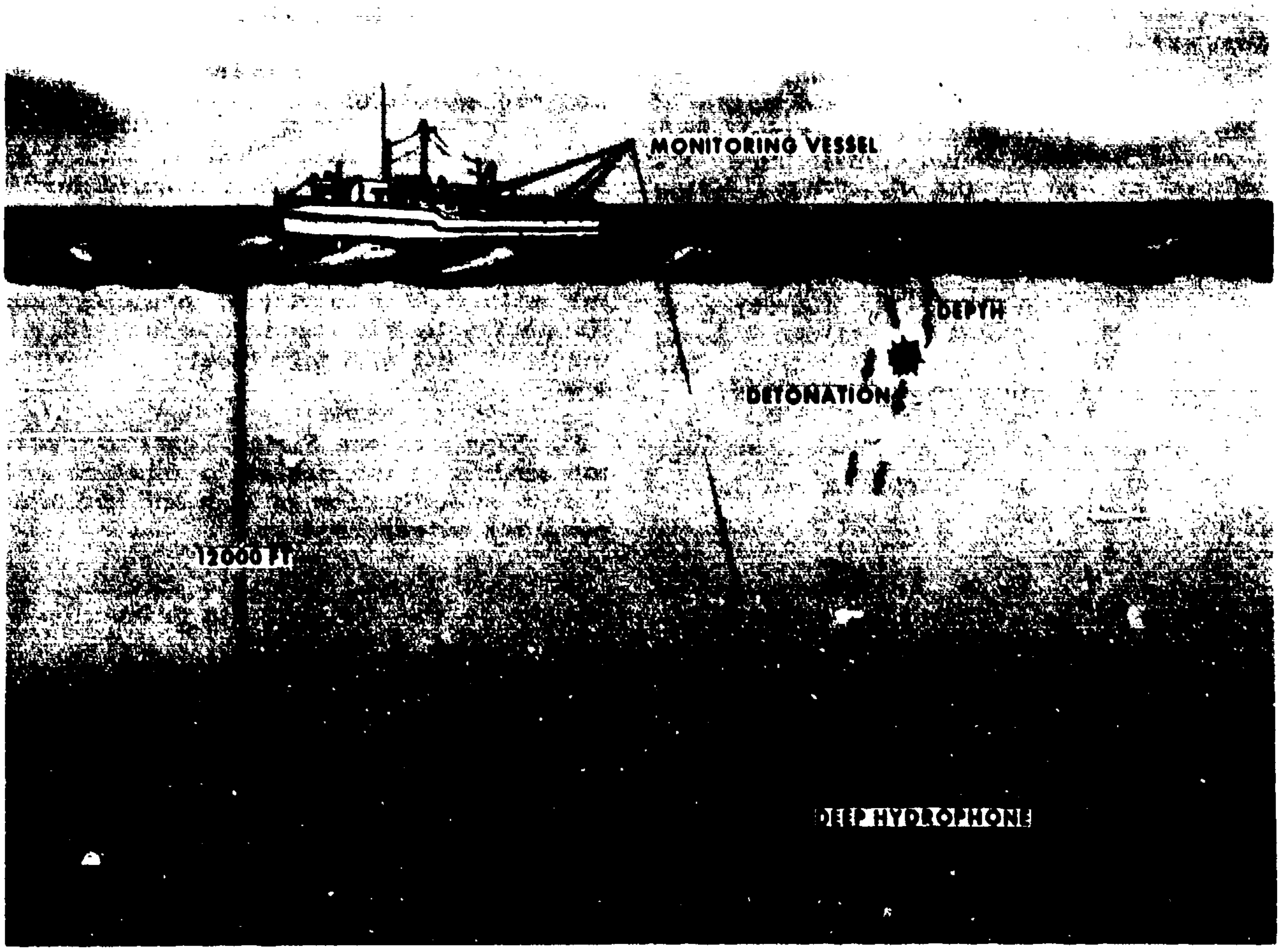


Figure 1. —Typical sea test of underwater sound signal

Regardless of the phase, however, two governing factors are always kept in mind. These are:

1. The reliability of the device to function consistently within design specifications.

2. The safety of the device when handled and used under different operational environments.

In all cases, the safety and reliability of the item interact constantly and control the design parameters. During the development phases, such tests as explosive-train reliability are conducted wherein the explosives to be used are tested in varying quantities and under different conditions. These tests establish the quantities of explosives to be used and the method of initiation. At the same time tests to establish "out-of-line" safety of the design are conducted to insure against untimely detonation and to provide safety to operating personnel.

Once the design has been established and preproduction models manufactured, the future of the design rests in the hands of the evaluating group. In the case of the underwater sound signal, from 20 to

30 different tests are conducted to insure adequate reliability and safety. Such factors as compatibility with aircraft launching systems, safety to submarines engaged in fleet exercises, and depth of detonation of the unit must be established. Considering that sound signals under development and in the fleet have firing depths that vary from 21 feet to 18,000 feet, contain multiple depth settings, are electrically or hydrostatically initiated, and contain either point or line charges, it is easy to see that the evaluation tests must encompass many parameters. The following are typical tests conduc.ed:

1. Preliminary Inspection to insure that tests samples are manufactured in accordance with design drawings.

2. Inert Functional Tests conducted in pressure vessels in the laboratory to establish the arming and firing depths of the design.

3. Fungus Tests to insure the ability of the design to withstand the effects of tropical environment.

4. Temperature and Humidity Tests to insure the ability of the design to withstand adverse climate conditions of temperature and humidity (-65° F. to ±160° F. at 95 percent R H) and to insure long-term storage capabilities.

5. Salt Spray Tests to determine the effects of moist, salt-laden air upon the safety and reliability of the design.

6. Transportation Vibration to insure the safety and reliability of the design when subjected to vibration experienced in transit.

7. Aircraft Vibration to insure safety and reliability of the design when stowed and carried in aircraft dispensers under operational conditions.

8. Jolt to insure the safety and ruggedness of the device.

9. Jumble to insure the safety and ruggedness of the device.

10. Forty-foot Drop to insure the safety and ruggedness of the device.

11. Four-foot Drop Test to insure the safety of the design when dropped during handling.

12. Pressure and Leakage Test to insure the watertight integrity of the design and its ability to withstand water pressure if the launching aircraft should go down at sea.

13. Temperature Firing Tests to insure the ability of the design to function with design specification at high and low temperature extremes.

14. Land Firing Tests to establish the ability of the firing train to function by high order.

15. Wind Tunnel Tests to establish the aeroballistic characteristics of the design.

16. Sinking Rate Tests to establish the sinking rate of the design and its ability to attain operational depth with specified time.

17. Rack Compatability to insure the ability of the device to be launched from aircraft dispensers.

18. In-Air Trajectory aircraft launching tests to insure in-air stability of the device and to determine water entry characteristics.

19. Static Detonation Tests to establish the safety and reliability of the explosive-train fuzing system.

20. RF Energy to insure the ability of electrically initiated devices to withstand the effects of radio frequency that may cause premature detonation of the device when being prepared for operation.

21. Signal Deployment to insure proper deployment of line charge in the water.

In addition to those previously listed, tests are also conducted to insure the safety of submarines taking part in fleet exercises. These are conducted to insure that the unit will not fire prematurely while sinking to firing depth if hit by a submarine. Another test conducted to insure submarine safety is a pressure-distribution study conducted at various signal attitudes and simulated submarine speeds to determine if the signal will fire if lodged in the submarine superstructure. Because these tests insure proper signal design, the Commanding Officer of the submarine can safely bring his craft to the surface to dispose of the signal.

As in all evaluation programs, the final proof of the ability of the signal to function within design parameters is its use under actual service conditions. Tests are conducted at sea, Figure 1, with the signals launched from fleet aircraft. During these tests, the firing depth of the unit is determined, as well as its in-air stability and firing reliability. Hydrophones are lowered to depths of 12,000 feet to record both direct and surface-reflected sound waves to monitor detonation, to compute firing depths, and to determine the time from water entry to detonation.

Research in the field of explosives is continuing constantly. Their use as an energy source is being utilized more each day. It can be stated that explosives are an excellent source of energy. By their nature, however, they are also a potent source of danger. For this reason it is essential that explosive devices be evaluated thoroughly to insure their safety as well as reliability. (UNCLASSIFIED)

SUBMARINE SMOKE AND ILLUMINATION SIGNAL MK 66 MOD 0, MK 67 MOD 0, MK 68 MOD 0

(Material in this article was adapted by R. W. Szypulski, Missile Ordnance Division, BuWeps, from an article submitted by Naval Ammunition Depot, Crane, Ind.)

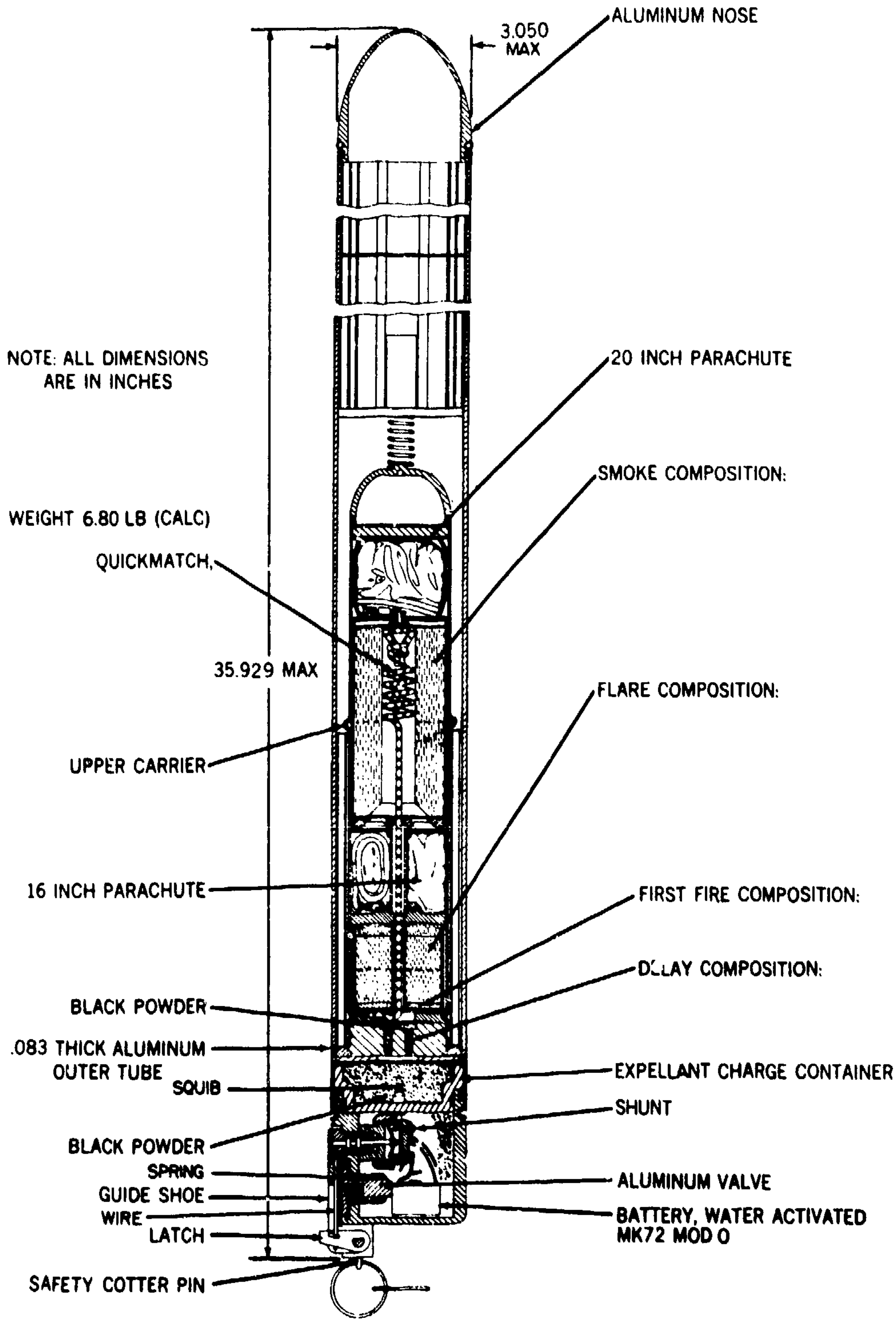
Submarine Smoke and Illumination Signals Mk 66 Mod 0 (red), Mk 67 Mod 0 (green) and Mk 68 Mod 0 (yellow) are day/night signals (see accompanying illustration) that produce a parachute-lowered aerial display of colored smokes and flares. These signals are intended to replace the Mks 51, 52, and 53 family of signals.

These new signals are the result of Naval Ammunition Depot, Crane efforts to combine the signal portion of the Mks 51, 52, and 53 (reported in Bulletin No. 2-61, APR-JUN 1961) with the Fuze of Submarine Location Marker Mks 21, 22, 23, and 24 (reported in Bulletin No. 4-60, OCT-DEC 1960). This combination decreases unit cost by replacing the expensive fuze and increases safety by utilization of a fuze that is actuated by the environment after it has left the submarine.

All developmental effort is complete. Signals have been scheduled for an operational evaluation by Operational Test and Evaluation Force in the second quarter of fiscal year 1963 with estimated introduction to the fleet by end of calendar year 1963.

Current instructions and uses for the replaced signal apply for the new signals. Additional technical information and fleet handling instructions will be available in Ordnance Pamphlet (OP) 3135 Volumes 1 and 2 (Classified Supplement).

(UNCLASSIFIED)



Submarine Smoke and Illumination Signal Mk 66 Mod 0, Mk 67 Mod 0, and Mk 68 Mod 0

Hydrogen Peroxide Surveillance

By Saul Wolf, Research Mechanical Engineer,
Naval Underwater Ordnance Station, Newport, R. I.

Every hydrogen peroxide solution decomposes at some rate governed by its temperature and the presence of contaminants. Because even container walls act as a mild contaminant, continuous surveillance of the peroxide in U. S. torpedoes is the accepted practice. Peroxide solutions, when kept free of gross contamination, can be stored quite safely. When contaminated severely, however, these solutions undergo a self-accelerating decomposition which causes gas generation a thousand or more times that of normal storage. Vents which are adequate for normal decomposition, can not handle this great volume of gas, and the resulting buildup of pressure can cause explosive rupture of the tank.

Even in the light of our present knowledge of the chemistry, handling, and storage of hydrogen peroxide, a few "incidents" with Torpedo Mk 16 have been reported in RUDTORPE's (Report of Unsatisfactory or Defective Torpedoes or Equipment). The peroxide in one Torpedo Mk 16 Mod 7, for instance, was discarded because of an indicated high decomposition rate. The torpedo was found to have a broken check valve between water and Navol compartments, providing a possible route for contaminants. Four Torpedoes Mk 16 Mod 7 and three Mk 16 Mod 6 were "steamers."[1] Preventative measures now in effect eliminate the possibility of the occurrence of steamers. Problems with Torpedo Mk 16, both apparent and real, have been attributed to the use of hydrogen peroxide. In reality, these problems have arisen out of the valving system, which was designed using the best knowledge available at that time. Additional knowledge now available will prevent similar problems in future peroxide torpedoes.

[1] A steamer is a torpedo in which an air check valve malfunction allows pressure to rise from peroxide decomposition, causing the delivery valve to open into the decomposition chamber, the peroxide to be decomposed therein, and steam and oxygen to be emitted from the exhaust valve.

The possibility of gross contamination, although small, will continue to exist, and it should be kept in mind that the peroxide concentration in future torpedoes will be 90 percent instead of the 70 percent used in the Torpedo Mk 16. It is estimated that the normal decomposition rate of 90 percent peroxide is roughly twice that of the 70 percent peroxide. To guard against hazards resulting from overactive peroxide, one or more of the following methods must be used: surveillance, contamination prevention, pressure relief.

SURVEILLANCE

When hydrogen peroxide decomposes, its products are oxygen, water, and heat. In principle, the decomposition rate may be determined by measuring any one of these quantities:

1. Rate of heat evolution.

2. Rate of oxygen liberation.

3. Rate of peroxide concentration change.

A study of the first of these methods revealed that it is uncertain whether a suitable thermal reference for a torpedo can be developed. This is the only drawback to the heat-evolution surveillance method.

The rate of oxygen liberation may be measured quite simply either directly by volume flow measurement or indirectly by measuring the rate of pressure rise. Several transducers were proposed for measuring rate of pressure rise, but even the most promising would take an unacceptably long time (from 5 to 20 hours) between actuations.

Volume flow measurement as practiced on Torpedo Mk 16 involves using a bubble meter and Indicator Panel Mk 25. A modified bubble meter, Figure 1, for future peroxide torpedoes would provide the following advantages:

1. Short time-interval between actuations.

2. Fleet familiarity with the entire bubble-count process.

3. Basic equipment already installed on board ships.

Techniques are not yet available for detecting and measuring the small change in peroxide concentration which exists even at high decomposition rates.

CONTAMINATION PREVENTION

In the next planned peroxide torpedo, porous teflon plugs in the vent lines, Figure 2, as well as careful surveillance during loading would prevent or lessen post-loading contamination.

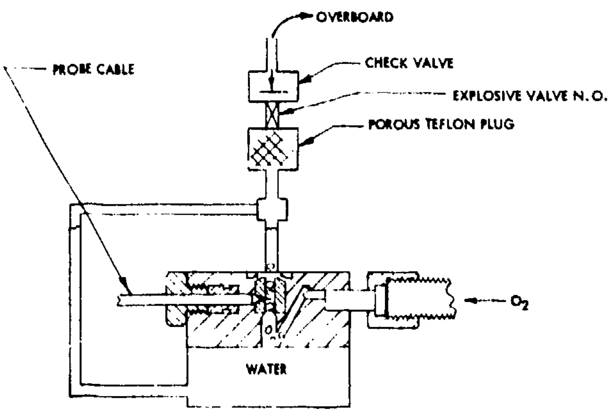


Figure 1. —Modified bubble meter

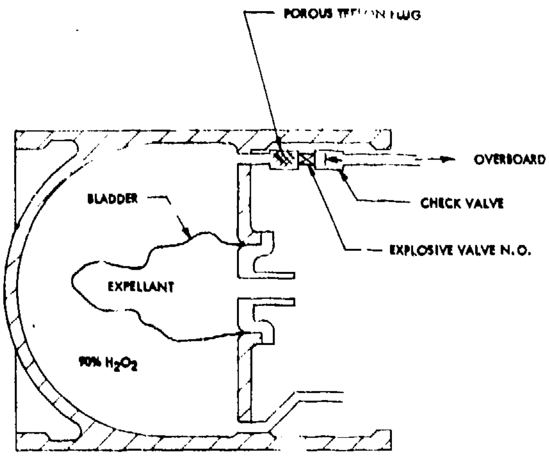


Figure 2. —Contamination preventative means

PRESSURE RELIEF

If excess activity and pressure buildup still occur after every precaution has been taken, a simple, reliable device for relieving excess pressure, Figure 3, could be made available for installation in all future peroxide torpedoes. With this device any excess pressure would cause a rupture disc to burst. The active peroxide would be emitted, in spurts of decreasing frequency, through the poppet valve. From the valve it would enter a decomposition chamber, leaving as oxygen and water vapor. The logical approach would be to use the combustion system decomposition chamber for this additional purpose. Even under the most adverse conditions, the tank should empty itself before dangerously high pressure could build up.

There are two distinct differences between the accidental "steamer" (Torpedo Mk 16) previously described and the pressure relief method. First, steaming to relieve pressure would be pulsed, allowing adequate time for disposal procedures (during this time only a small fraction of peroxide will have been expelled as steam). Secondly, the exhaust path will not be over, around, and through oil-covered gearing and valving, etc., so that

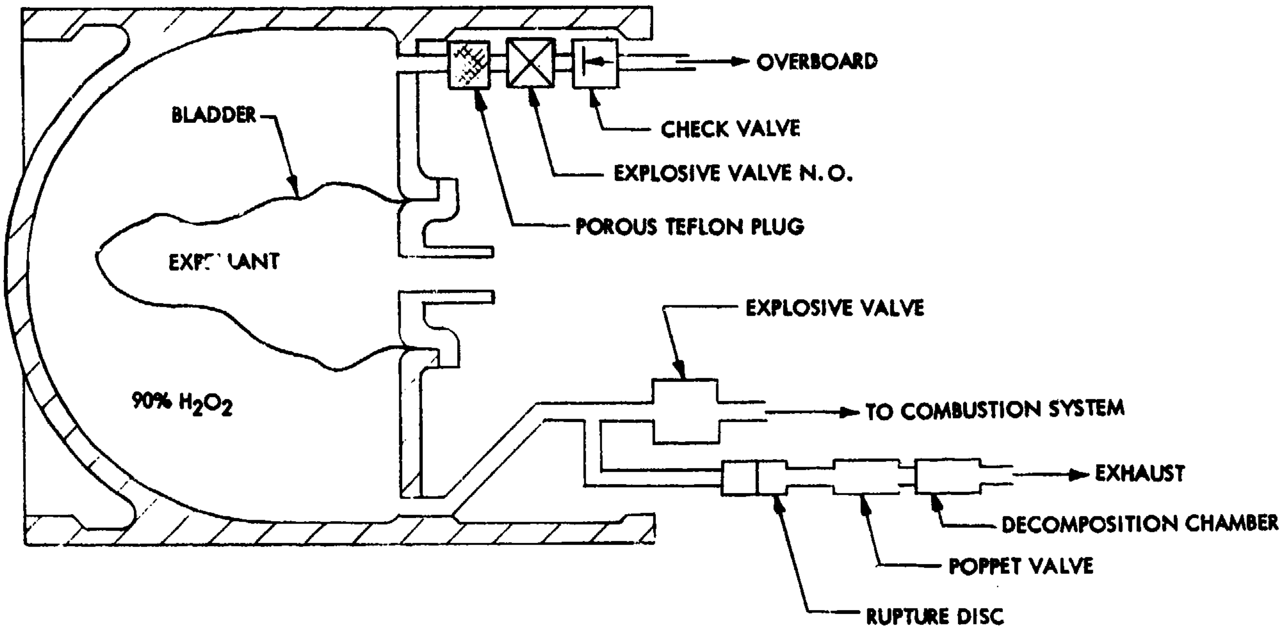


Figure 3. —Pressure relief method

no exhaust products other than oxygen and water vapor are expected.

Acceptable protection against overactive peroxide may be achieved by a combination of contamination prevention and either surveillance or pressure relief. The latter method is apparently the more reliable and certainly the more positive. It eliminates both need for auxiliary equipment on board ship and spurious excess rate warnings. Most important, it makes disposal a matter of convenience rather than necessity.

The pressure-relief device is being incorporated into a research vehicle for feasibility demonstration prior to specification for the next planned developmental peroxide torpedo. As a backup, the modified bubble meter will be developed.
(UNCLASSIFIED)

Propulsion System for Deep-Operating Torpedoes (U)

By John F. Brady, Head, Applied Science Department,
U. S. Naval Underwater Ordnance Station, Newport, R. I.

As torpedoes run to greater depths, the pressure at which exhaust gases can be discharged increases, and severe losses in performance result. (This is entirely analogous to placing a restriction in the exhaust of any engine.) Figure 1 shows typical loss in performance with depth of weapons currently under development.

Table 1 lists possible solutions to the depth problem.

TABLE I

DEEP-DEPTH TORPEDO PROPULSION POSSIBILITIES

A. Electric Systems
   1. Battery power
   2. Wire transmitted power

B. Depth Independent Thermal Cycles
   1. Vapor cycles
   2. Gas cycles

C. Depth Compensated Thermal Cycles
   1. High inlet pressures
   2. Reduced back pressures

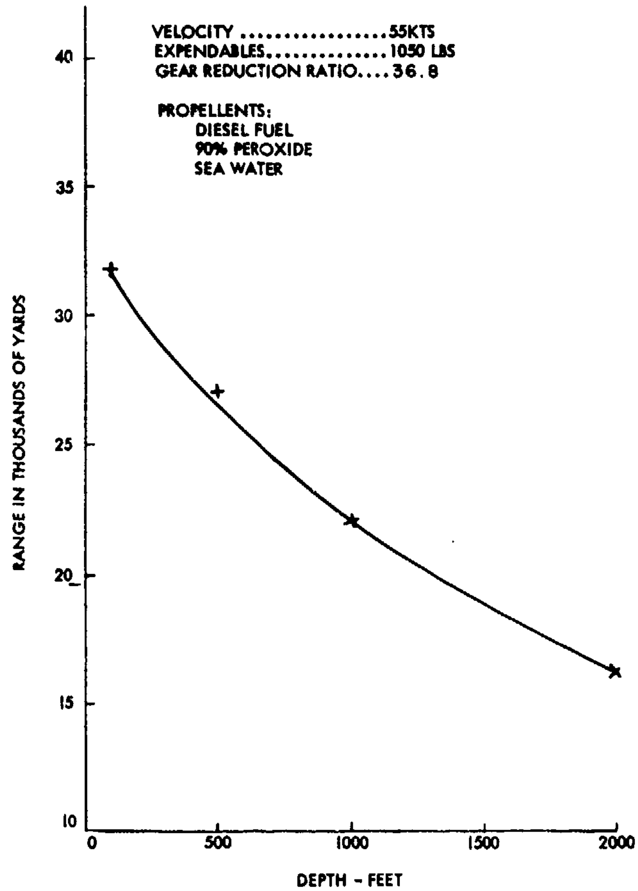


Figure 1. —500 shaft-horsepower gas turbine (range vs. depth)

ELECTRIC SYSTEMS

Electric systems are attractive for deep-operating torpedoes since environmental pressure has little if any effect on their performance. Battery systems have been used with good success in Torpedoes Mks 18, 27, 28, 35, 37, and 45. While battery systems have met performance requirements thus far, they are believed incapable of giving the energy densities required to combat the targets of the 1970's. Torpedo power requirements and range requirements are increasing drastically.

The use of wire guidance in torpedoes has led to investigation of the feasibility of feeding power down the same wire. These investigations have shown that relatively large amounts of power can be transmitted down small wires if the voltage is high enough. Direct-current power is preferred as it is easier to insulate, has no corona, is more efficient, and allows for superimposing alternating current control signals.

Figure 2 shows the amount of power that can be transferred to a 48-knot, 21,000-yard torpedo as a function of wire size. Note that the wire size used in the Torpedo Mk 37 is adequate for transferring 50 kw. To make such a system operate, a reliable high-voltage d.c. motor is required (3,000 volts for 50 kw. and 10,000 volts for 500 kw.). A shipboard high-voltage power supply is also needed. A program has been initiated at the Naval Underwater Ordnance Station, Newport, R. I., to develop an experimental low-power system.

DEPTH INDEPENDENT THERMAL CYCLES

One can visualize a small-scale, stationary steam power plant squeezed into

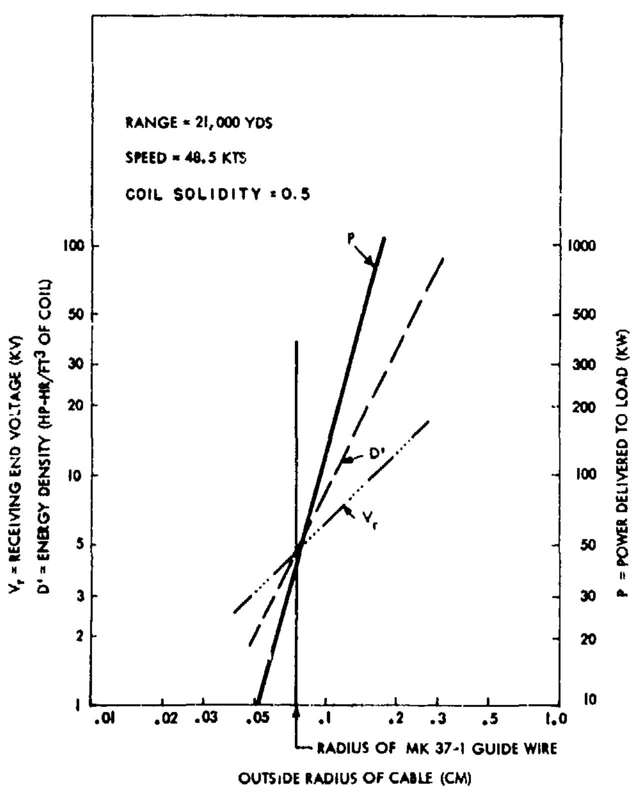


Figure 2. —Power transfer as a function of wire size in a wire-guided torpedo

a torpedo. Figure 3 shows such a vapor cycle called Rankine for its inventor. Energy can be supplied in the boiler from a number of various sources. Gas cycles such as Stirling, Brayton, or Erickson might also be used, but there is less experience in their development.

DEPTH COMPENSATED CYCLES

The loss of performance with increase in exhaust pressure can be minimized by increasing the pressure at which gases are submitted to a prime mover. Physically, this is done by making the machine smaller (also a desirable objective provided efficiency can be maintained).

Figure 4 shows how increase in inlet pressure to a machine (by reduction in nozzle area) can reduce its flow ratio requirements at deep depth. For depths to about 2,000 feet, such an approach has merit. For high performance at depths such as 6,000 feet, reduction of back pressure seems more promising.

The usual approach in reducing exhaust pressures is to apply a condensation process. In a stationary steam power plant a large surface condenser is used. For torpedoes where size is limited and where there are large amounts of gas (CO_2) in the exhaust, use of condensing ejectors or "Condensuctors" appears to be a better solution.

As shown in Figure 5, the condensuctor is a static device in which high-velocity sea water mixes with the power plant exhaust. A condensuctor shock occurs across which there is considerable pressure rise. As shown on Figure 5, the pressure rise is a complex function dependent upon design and operating conditions.

The pressure rise across such a device is shown in Figure 6 for various sea water supply pressures. Also plotted in Figure 6 is a "no pump" line. This is the line where the sea water supply pressure needs to be equal only to the condensuctor discharge pressure (ambient sea pressure).

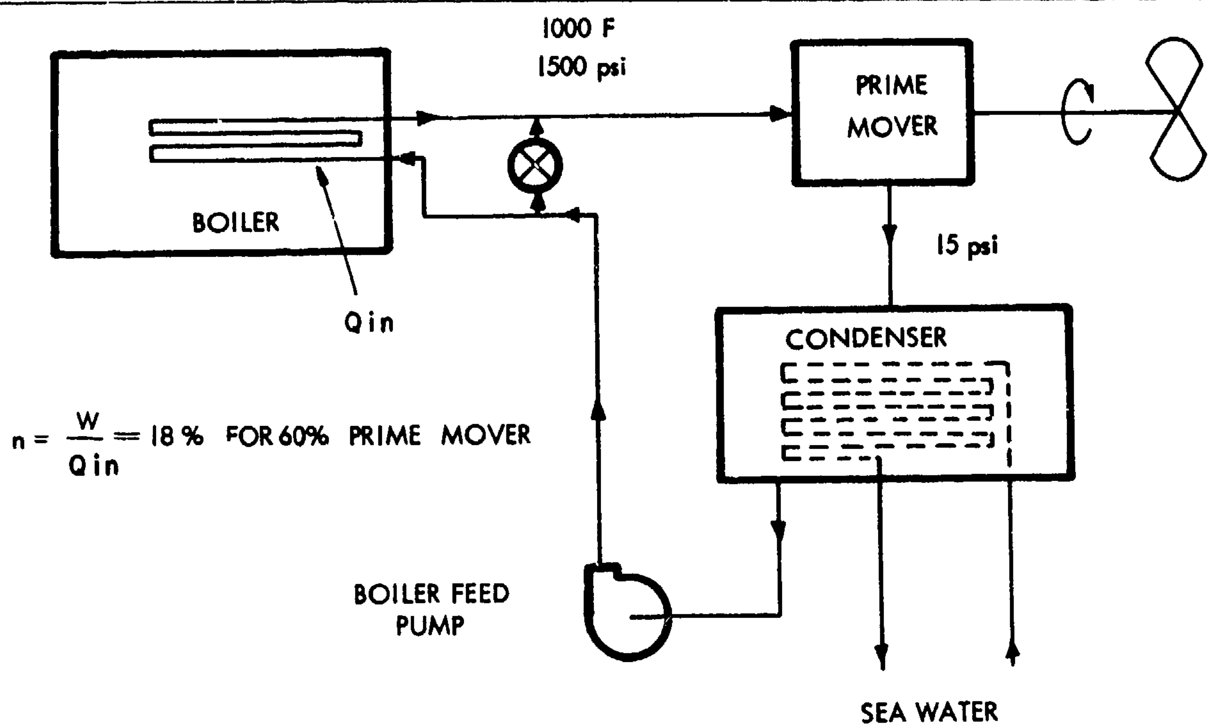


Figure 3. —Rankine stationary steam power plant (schematic)

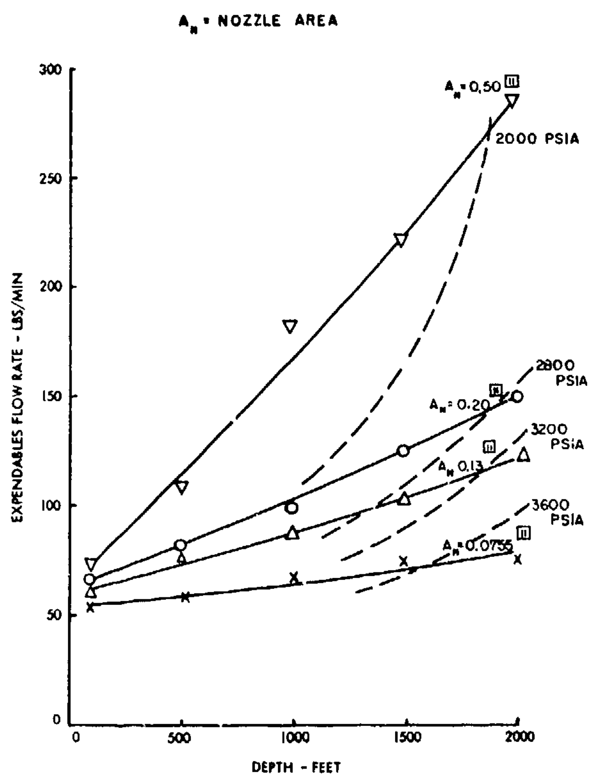
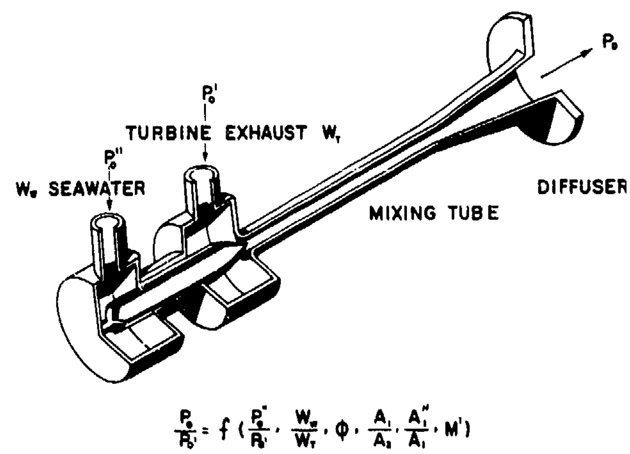


Figure 4.—Expendables flow rate vs. depth



$$\frac{P_0}{P_0'} = f\left(\frac{P_0''}{P_0'}, \frac{W_s}{W_T}, \phi, \frac{A_1}{A_1}, \frac{A_1''}{A_1}, M'\right)$$

Figure 5. —Back pressure reduction system

For such cases the sea water does not have to be pumped into the system. It is evident that exhausts having small quantities of gas are desired, for the data indicate that with all condensible products no sea water pump will be required (ϕ = % noncondensibles by weight.)

Figure 7 shows how the flow rate versus depth curve may be lowered by using a

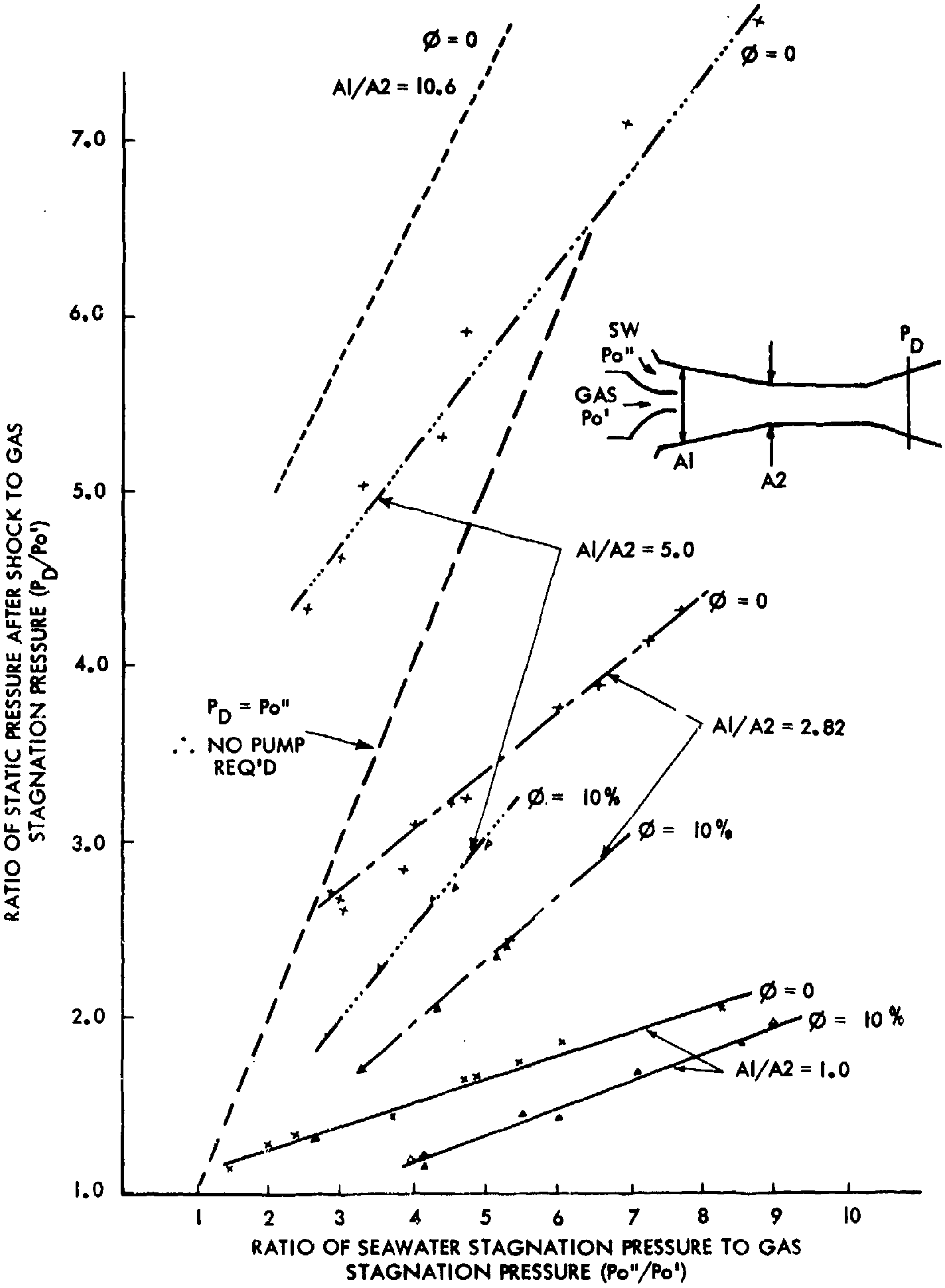


Figure 6. —Condensuctor pressure rise for various sea water supply pressures

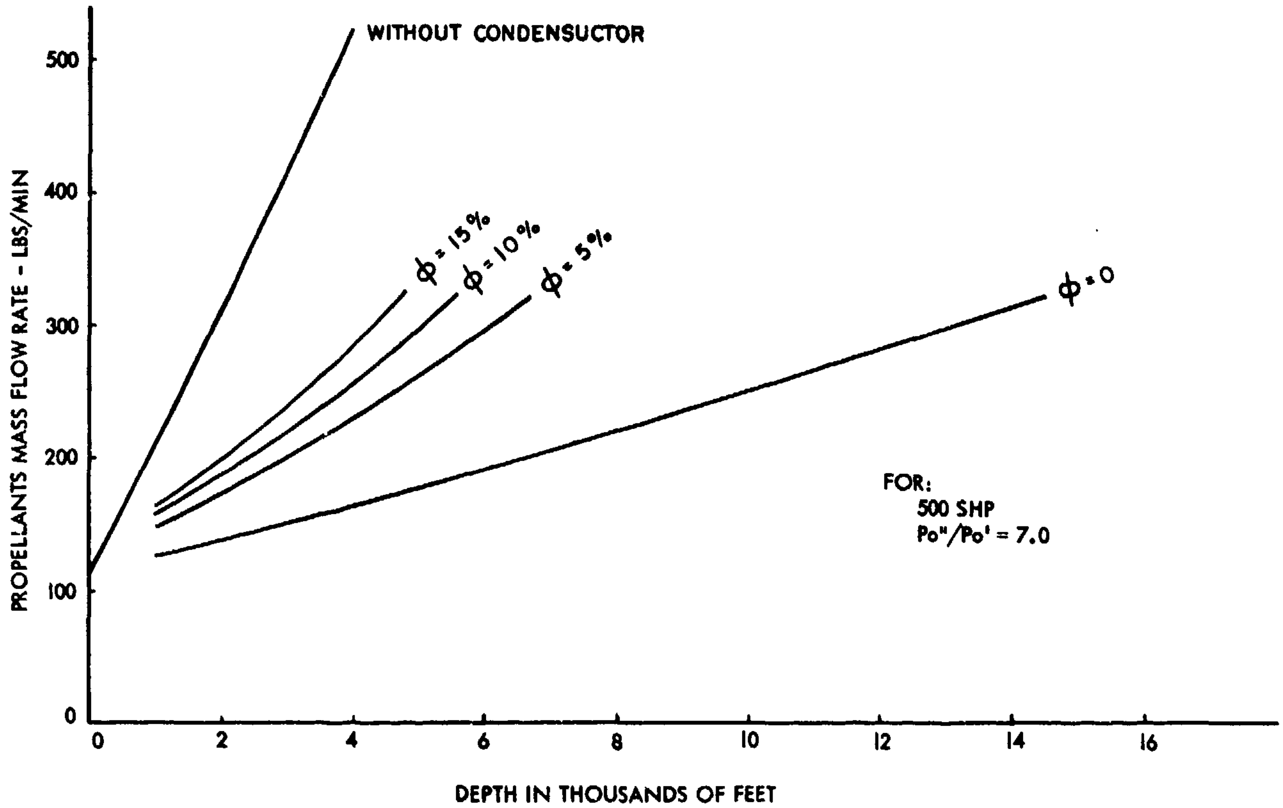


Figure 7. —Propellants mass flow rate vs. depth

condensuctor and again emphasizes the importance of exhausts having minimum quantities of noncondensibles. It is noted that application of a condensuctor to a system having 15 percent condensibles will allow it to run at about twice the depth with the same flow rate. The capability of a system, having all condensible products, to operate satisfactorily with a condensuctor to depths in excess of 10,000 feet is also apparent.

SUMMARY

The deep-depth torpedo propulsion problem can be solved electrically or thermally. Electrically, power down the guidance wire looks attractive, provided a high voltage motor can be developed. Thermally, depth insensitive cycles can do the job if the complexity problem can be solved. Depth compensated systems using condensuctors also look attractive if suitable propellants with condensible products can be formed and the condensuctor principle applied successfully to torpedoes.

(CONFIDENTIAL)

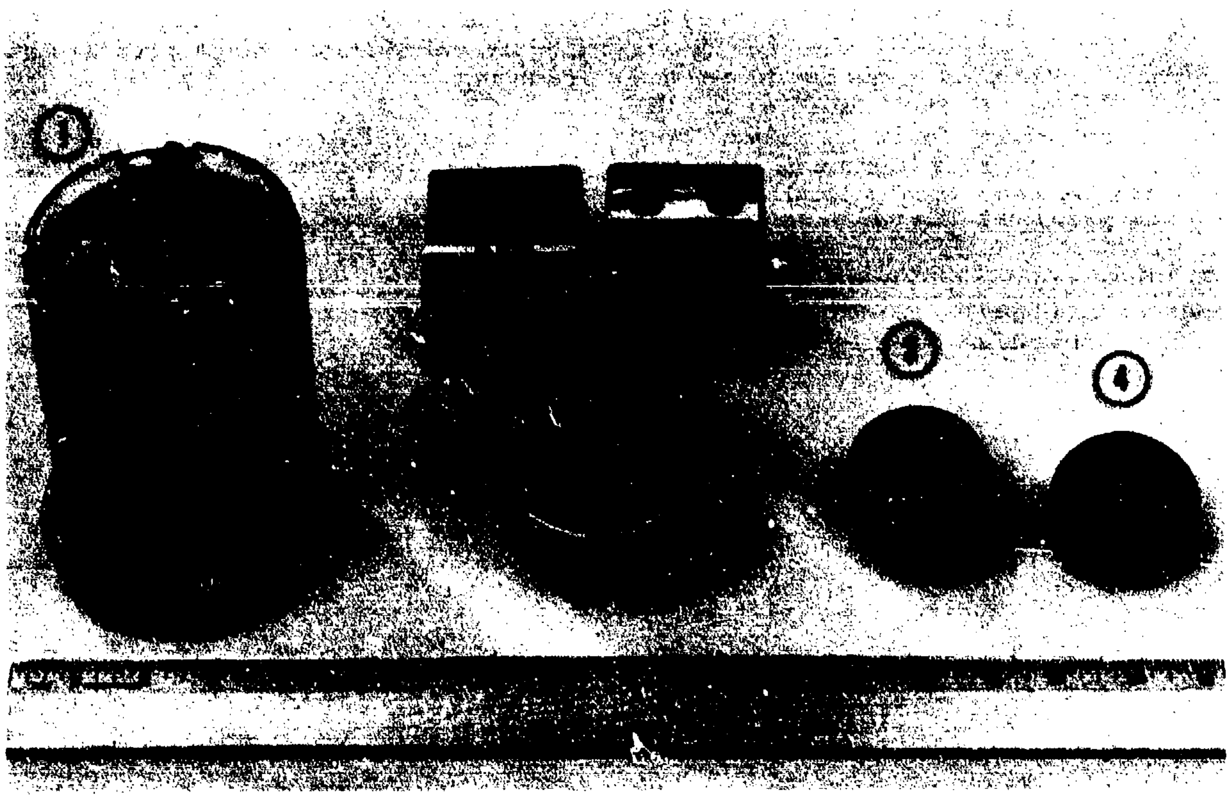
DOWNGRADED AT 12 YEAR INTERVALS:
NOT AUTOMATICALLY DECLASSIFIED.
DOD DIR 5200.10

Underwater-Mine Fire Recorder Mark 17 Mod 0
Tiny, Rugged Time-Lapse Indicator

By John V. Koman, U. S. Naval Mine Engineering Facility, Yorktown, Va.

As long as anyone can remember, the lack of an accurate, compact, dependable, long-range time-of-fire recorder has enforced an undue admixture of guesswork in data gathered from underwater-mine tests. This, of course, has hampered laboratory-conducted tests. It has also imposed quite stringent limits on the quality of data collected through the Fleet Service-Mine Test Program, a continuing series of worldwide combat-oriented exercises designed to provide CNO with data on mine reliability and warfare readiness for reference in formulating war plans, and BuWeps with guiding factors for the management of its mine-materiel maintenance programs.

Two recorders are now in use: a makeshift modification of the CD-12 clock-delay mechanism formerly used as a safety device in some U. S. mines, and a similar mine clock of British design. But each has proved unreliable and ineffectual



Progress from bulky 10-day jury-rigged CD-12 to compact time-of-fire recorder: (1) modified CD-12 clock delay mechanism; (2) British Mark III clock-delay—actually two are used in parallel for best reliability; (3) prototype of new recorder; (4) preproduction model of Underwater-Mine Fire Recorder Mark 17 Mod 0 in the role of fire recorder, and that is why BuWeps authorized the Naval Mine Engineering Facility at Yorktown, Va., to develop a recorder designed specifically for the purpose. That was in mid-1959.

The result is the instrument shown in the accompanying illustration. Designated Underwater-Mine Fire Recorder Mark 17 Mod 0, it measures a mere 2 x 1-1/4 inches and weighs only 3 ounces including a self-contained battery. The battery is a 1-1/2-volt, dime-sized cell which powers a jeweled movement that drives a gear train terminated by five calibrated read-out dials. The dials indicate from 1/100 to 9,999.99 hours elapsed time per cycle, and cycles repeat automatically. This means that, in contrast to a 10-hour capability for the devices now in use, the only time-limiting factor for the new recorder is the life-span of the battery, which is good for one full year.

Accuracy, too, is expected to be excellent. Preproduction models in the Mine Engineering Facility's Labs, even without pre-test adjustment, have run more than a year with a total error of only two hours.

In other laboratory tests the new recorders, installed in air-laid mines, have proved capable of withstanding quite severe two-phase water-entry shocks: a first phase of 6,000 g's for .02 to .04 milliseconds, and a second phase of 450 g's for 15 to 20 milliseconds. These are the greatest shocks expected in mine exercises.

The primary application of the new recorder will be in regularly scheduled fleet service-mine tests, for which an adequate supply of production models is expected to become available by the end of this year. Because of its unusual design characteristics, however, this tiny recorder could also prove useful in a great number of weapon test applications. It is waterproof. It must be started by hand before mounting but, being electrically driven rather than electrically wound, it stops instantly upon disconnecting two external leads, with the result that it is easily adaptable to the timing of virtually any electrical or mechanical operation. Its integral six-hole flange provides easy mounting.

A manual of operating and service instructions (a NAVWEPS OP) is now in preparation. Meanwhile, activities interested in more information on this instrument are invited to contact the Mine Engineering Facility at Yorktown, Va.

(UNCLASSIFIED)

NUCLEAR WEAPONS

Nuclear Weapon System Safety Studies

By R. B. Lane, Head, Nuclear Safety Study and Acceptance Branch, BuWeps

The search for increased nuclear weapon safety is a continuous process. The current operational requirement to maintain a high state of readiness and to provide immediate nuclear retaliatory capability makes it mandatory that a balance be achieved between operational capability and safety consideration.

In the spring of 1958, the Chief of Naval Operations requested the Bureau of Ordnance to conduct studies to determine what operational rules should be imposed on peacetime operations of nuclear weapons systems. The first of these studies was made by the Special Weapons Division of the Naval Ordnance Test Station and the Naval Air Special Weapons Facility, both located at Albuquerque, N. Mex. Through several changes occuring since the early studies, these activities have been merged and now exist as the Naval Weapons Evaluation Facility, Kirtland Air Force Base, Albuquerque. This organization continues to be largely responsible for arranging for the studies however, the study group has been expanded to include Field Command, Defense Atomic Support Agency; Atomic Energy Commission; and Fleet representation. In order to clarify and standardize the requirements and procedures for the safety studies and to satisfy the interest of all of the participating agencies, the following directives were issued: DOD Directive 5030.15, SECNAV Instruction 3020.2, OPNAV Instruction 8020.9, BUWEPS Instruction 8020.1, and BUSHIPS Instruction 9900.3. The term "nuclear safety" as considered for the safety studies is "Safety against the unauthorized or inadvertent events, involving nuclear weapons which may result in loss or serious damage, detonation, or radioactive contamination."

Operational safety studies are formal studies conducted on all nuclear weapons systems for investigating the safety of the entire weapon system, throughout the stockpile-to-target sequence (STS) from acceptance of the weapon by the Navy up to and including launch or release of the weapon, to determine if the required nuclear safety standards are met. This includes weapons, weapons handling equipment, weapon control and monitoring equipment, launchers, bomb racks, release system, and storage and transportation facilities. The studies usually consist of an initial study, a preoperational study, and operational reviews. The overall objective of all of these studies is to insure that there is adequate nuclear weapon system safety throughout the Navy portion of the STS.

The Initial Safety Study is a study conducted as early as significant data are available. The study group examines all of the material, design features, procedures, and operational concepts available at the time of the study which will affect weapon safety during the STS. The primary purpose of the study is to identify deficiencies of the system with respect to safety, and/or to provide guidance for any further development which may be required to enable the system to meet the safety standards. In some cases what might be called preinitial studies have been conducted to point out possible problem areas prior to weapon system design.

The Preoperational Study is a study conducted just prior to the expected operational date of a nuclear weapon system. During this study the study group examines all material, manuals, procedures, and operational concepts existing at the time of the study which will affect weapon safety throughout the STS. This study also includes an evaluation based on observation of actual operations required in the assembly, mating, testing, and preparation for employment. As a part of the preoperational safety study, the group prepares a set of proposed operational rules which are used by OPNAV as the basis for preparation of the Operational Safety Rules to be formally processed. No peacetime operations are allowed without approved Operational Safety Rules.

An Operational Review considers the adequacy and suitability of safety features in the weapon system design and procedures throughout the STS, and the adequacy of the Approved Safety Rules. The review consists of an examination of the operational history of the weapon system and the examination of the material, manuals, and procedures in use at the time of the review which affect weapon safety during any portion of the STS. This review is made approximately one year after the rules are approved.

A Special Review investigates: (1) unsafe conditions revealed by operational experience, and (2) modifications, alterations, and retrofits which might affect nuclear weapon safety. A special study must be conducted to prepare any proposed changes to approved Safety Rules.

To insure that certain vital areas are considered in peacetime operations with nuclear weapon systems, the system together with the proposed Safety Rules, must be applied against a set of safety standards. As a minimum the standards will be applied as follows:

1. There will be "positive measures" to prevent weapons involved in accidents or incidents or jettisoned weapons from producing a nuclear yield.

2. There will be "positive measures" to prevent deliberate arming, launching, firing, or releasing except upon execution of emergency war orders or when directed by competent authority.

3. There will be "positive measures" to prevent inadvertent arming, launching, firing, or releasing.

4. There will be "positive measures" to insure adequate security.

In the preceding paragraphs we have referred to "The Safety Study Group." Actually there is no permanent safety study group but the members are rather an "ad hoc" group, composed of individuals appointed by the representative organization to study a particular system. For the Navy safety studies the group consists of the following members:

Safety Study Group Chairman (Naval officer from the Naval Weapons Evaluation Facility)

Field Command, Defense Atomic Support Agency representative

Atomic Energy Commission representative

Fleet representative

Operational Test and Evaluation Force representative

Marine Corps representative (as appropriate)

U. S. Army representative (as appropriate)

U. S. Air Force representative (as appropriate)

In addition to the above members there are advisors as follows:

Bureau of Ships

Bureau of Naval Weapons

Sandia Corporation (as appropriate)

Naval Weapons Evaluation Facility (technical representative)

Atomic Energy Commission Laboratories (as appropriate)

Fleet Marine Force (when required)

Other interested agencies.

After completion of a study, the Naval Weapons Evaluation Facility issues a report which describes the system, discusses the deliberations of the study group, and lists the recommendations and the proposed safety rules. These reports are distributed to all agencies participating in the study plus agencies which will be involved in the review or approval of the rules. Each agency comments on the recommendations and either concurs with these or attempts to refute the recommendations or offer proposed changes either to equipment or to operational procedures which will correct the deficiencies pointed out.

After reviewing the Navy comments on the safety studies, the Chief of Naval Operations prepares a Joint Chiefs of Staff (JCS) Paper which proposes the rules under which the particular system will be operated. The JCS Paper must be concurred in by the Chief, Defense Atomic Support Agency, who is briefed on the system by his own safety group. After agreement has been reached between the Navy and the Defense Atomic Support Agency, the paper then goes to the Chairman, Military Liaison Committee Assistant Secretary of Defense for Atomic Energy) where it is again reviewed and, if found satisfactory, sent to the Joint Chiefs of Staff who approve the proposed rules. After approval by the Joint Chiefs, the rules are sent to the Secretary of Defense for approval. At this stage the Secretary of Defense can issue an interim approval of operations under the proposed rules, but before final approval the rules are coordinated with the Atomic Energy Commission. For weapon systems involving flying there is one more step necessary. These rules must be approved by the President.

Subsequent to approval the Operational Safety Rules are promulgated to the operating forces by CNO directives and are mandatory for use until a Defense Emergency or comparable state of readiness is declared by a designated commander of a unified or specified command.

(UNCLASSIFIED)

TERRIER BT-3A(N) Nuclear Safety Studies (U)

By Lt. Comdr. O. C. Chisum, Warhead Branch Head,
Missile Ordnance Division, BuWeps

Safety studies of the TERRIER BT-3A (N) Weapon System, consisting of an Initial Safety Study, three Pre-Operational Studies, and three Special Studies, have been conducted by combined AEC/DOD TERRIER Nuclear Safety Study Groups. These groups consisted of representatives from Commander in Chief, Atlantic Fleet; Commander in Chief, Pacific Fleet; Atomic Energy Commission (AEC); Commander, Operational Test and Evaluation Force; Field Command, Defense Atomic Support Agency; and Commanding Officer, Naval Weapons Evaluation Facility (NWEF), Kirtland Air Force Base, Albuquerque, N. Mex. The representative from NWEF was Chairman of the group. In addition to these members, observers from Bureau of Naval Weapons, Bureau of Ships, and Sandia Corporation participated in the studies.

As a result of these safety studies, a number of significant changes have been made. Some of the more important changes are:

1. The Y-STOP device provides an electrical interruption in the loading sequence. It consists of a locked switch and electrical interlock which prevents the movement of a BT-3A(N) missile from the assembly area to the launcher until the operation is enabled by unlocking an unique control switch on the EP-4 or EP-5 panel. A missile in the assembly area is identified as an X, Y (nuclear), or Z type by means of the identifying diode circuit in the missile. This information is relayed to the launcher control system through the identification contacts on the missile. The effectiveness of the Y-STOP control is dependent on missile identification by the identifying diode system. To insure proper administrative control, the key for the Y-STOP switch is kept in the custody of the ship's commanding officer or his designated representative.

An additional protection against an inadvertent launch of a BT-3A(N) missile results from the provision that war reserve BT-3A(N) missiles are not to be used in training exercises and are not placed on the launcher in peacetime.

2. Color coding and nomenclature. All weapons must be color and word coded so that they can be identified visually as nuclear or non-nuclear.

3. Arming tool custody. Physical custody of the nuclear-warhead-section arming tool must be maintained by the ship's commanding officer, or his duly authorized representative.

4. Weapons Direction Equipment changes include:

a. Improved light covers on monitor display lights on the Missile Control Panel in the Weapons Control Station. These covers are less subject to breakage and will permanently identify light functions on the panel.

b. Redesigned missile-select switches to minimize the possibility of inadvertent selection of a missile with a nuclear warhead. These unique switches are spring loaded and require pressure on the knob before turning to the BT-3A(N) missile selection.

c. Installed mechanical guards on appropriate BT-3A(N) controls of the missile control panels.

d. Increased brightness of missile display lights by replacement of lamps.

On 7 August 1962, as a result of these studies, the Chief of Naval Operations issued a proposed set of Nuclear Safety Rules for the TERRIER BT-3A(N) and its use on the Guided Missile Launching System (GMLS) Mk 10. This action was a significant milestone. The implementation of these Safety Rules and their ultimate approval by the Secretary of Defense will result in approval for peacetime operations with the TERRIER BT-3A(N) missile when launched by Guided Missile Launching System Mk 10 in DLG-9, -16, and -26 classes; CVA-63 class; and CG (N)-9, DLG(N)-25, and DLG(N)-35 ships. (CONFIDENTIAL)

DOWNGRADED AT 3-YEAR INTERVALS:
DECLASSIFIED AFTER 12 YEARS.
DOD DIR 5200.10

Index to Atomic Weapon Data

By Lieut. (jg) Lewis H. Zielsdorf, USN, Document Support Branch, Nuclear Applications Division, BuWeps

The first atomic weapon test made it apparent that there was an urgent need for a program to foster the mutual exchange of weapon data information between the Atomic Energy Commission (AEC) and the Department of Defense (DOD). In 1951 the Division of Military Applications of the AEC proposed the formation of a committee to consider the establishment of such a program. This proposal led to the establishment of the Cooperative Weapon Data Indexing Committee and development of the Weapon Data Index (WDI). This has grown to ten activities and organizations being authorized to maintain WDI catalogues.

The WDI contains abstract cards on all pertinent technical and scientific reports issued by the DOD, AEC, and other government agencies, which relate to the design, development, manufacture, storage, utilization, delivery, performance, and effects associated with atomic weapons and atomic weapons explosions. It also includes reports of studies which are pertinent to these fields, such as aircraft and missile characteristics, detection of explosions, target evaluation, control measurements, vulnerability, radiological warfare, protective devices, civil defense plans and construction as well as selected basic research in these fields. Previous use of the WDI by naval personnel and contractors has revealed considerable interest and success in finding information on the subject areas of effects of nuclear radiation on electronic components, high altitude nuclear weapons effects, nuclear weapon system safety, kill probability, nuclear weapons effects on aircraft, and air crew protection.

The WDI consists of a file of 3" x 5" cards which contain complete bibliographical information for the report plus an abstract describing its contents. Cards are filed in the WDI by subject, personal

SWC TN 60-36 (Rpt. & Card: UNCLASSIFIED)
Illinois Inst. of Tech., Chicago. Armour Research Foundation
DESIGN AND ANALYSIS OF FOUNDATIONS FOR PROTECTIVE STRUCTURES, Interim Technical Report. K. E. McKee. September 1960. 112 p.
Laboratory experiments and theoretical studies are correlated on the behavior of footings subjected to time-dependent forces. Two- and three-dimensional experiments have been conducted on small footings in the laboratory to observe their behavior and to obtain quantitative information. An apparatus was developed for applying dynamic forces to the footings. This apparatus, which is relatively simple, has made possible the application of loads having various rise times, decays, and durations. Force-time and displacement-time records have been obtained in forms suitable for analysis, and

1. Blast Loading
2. Dynamics
3. Military Facilities
4. Shelters
5. Soil Mechanics
6. Structural Elements
I. Personal Author
II. Corp. Entry
III. Contract AF 29 (601)-2561
IV. Project 1080
V. Report No.

(Con't on back)

WEAPON DATA INDEX 202-61-SWC-11(1)

Typical Weapon Data Index card

author, corporate author, contract, project and report short title. Example I shows a typical WDI card with its multiple entries and report abstract. The multiple entries enable the WDI user to find pertinent information regardless of the frame of reference he uses to conduct the search. There have been approximately 15,000 reports abstracted for the WDI as of 30 June 1962. The number of abstracted reports plus the scope of the abstracting makes the WDI a valuable information guide to literature in the nuclear weapons field.

The WDI is available to all Naval personnel, facilities, and contractors that require information in the nuclear weapons field. The sensitive security classification of the WDI necessitates that the person have a minimum of a Secret clearance and a valid need to know. Requests to use the WDI should be forwarded, via appropriate channels, to the Bureau of Naval Weapons, Attn: RRNU. The requests should contain the person's clearance, area of interest, and statement of need to know.

The Navy's WDI is located in the Bureau of Naval Weapons, Washington 25, D. C. There are other WDI catalogues located throughout the country at the following activities and organizations:

Air Force Special Weapons Center, Kirtland Air Force Base, Albuquerque, N. Mex.

Division Technical Information Extension, Atomic Energy Commission, Oak Ridge, Tenn.

Field Chief, Defense Atomic Support Agency, Albuquerque, N. Mex.

Chief, Defense Atomic Support Agency, Washington 25, D. C.

Lawrence Radiation Laboratory, University of California, Livermore, Calif.

Los Alamos Scientific Laboratory, Los Alamos, N. Mex.

Picatinny Arsenal, Dover, N. J.

Sandia Corporation, Albuquerque, N. Mex.

Sandia Corporation, Livermore, Calif.

It is suggested, where possible, that personnel arrange to use the WDI located closest geographically.

The Navy's reports are presently being abstracted by the Chief, Defense Atomic Support Agency. Any Navy activities or contractors originating reports that fall within the scope of the WDI are required to forward two copies of the report to Chief, Defense Atomic Support Agency. BuWeps Instruction 8110.2 of 13 October 1960 covers the Navy's use and responsibilities for the WDI. (UNCLASSIFIED)

ASTRONAUTICS

ANNA 1-B Geodetic Satellite Successfully Launched [1]

At 3:08 a.m. on 31 October 1962, a two-stage Thor-Able-Star rocket launched the new ANNA geodetic flashing-light satellite in a northeasterly direction from the Atlantic Missile Range and lofted it into orbit with an apogee of 632 n. mi. and a perigee of 583 n. mi. This is an excellent orbit with an inclination of 50.15 degrees to the equator. The orbit time is 107.9 minutes. The booster system is identical to that used in the past in the Navy TRANSIT navigational satellite program.

The 350-pound, 36-inch sphere contains optical, radio ranging and radio doppler instrumentation. Designed to mark positions on earth, the instrumentation locates the center of the earth's mass, and measures the strength and direction of the earth's gravitational field. Flashing from altitudes ranging from 583 to 632 miles, the lights will be visible to stellar cameras at slant ranges of more than 1,000 miles. The lights receive their energy from the satellite's solar cells through an internal battery system. The lights are triggered from the ground through a satellite-borne memory and clock system, flashing on command in pairs, and in sequence. Each sequence consists of five flashes with 5.6-second intervals between flashes. Each flash is of one millisecond duration. The stored energy is 100 watt-seconds. The intensity of the light along its optical axis is 8,000 candle-seconds.

Initially, measurements will be made with all three instrumentation tools at several continental U. S. locations where stations are located to observe simultaneously the emissions of the three systems. A careful and detailed comparison of these data is expected to provide a definitive measure of the accuracy of each system and to indicate the best way of combining the three types of data. When this calibration phase is satisfactorily completed, a number of ground stations will be established in various locations outside the continental U. S., and the operational phase of the project will be started. In addition, information on times at which the lights are to be flashed will be made available to interested astronomers and geodesists throughout the world so that they can make observations of the optical system.

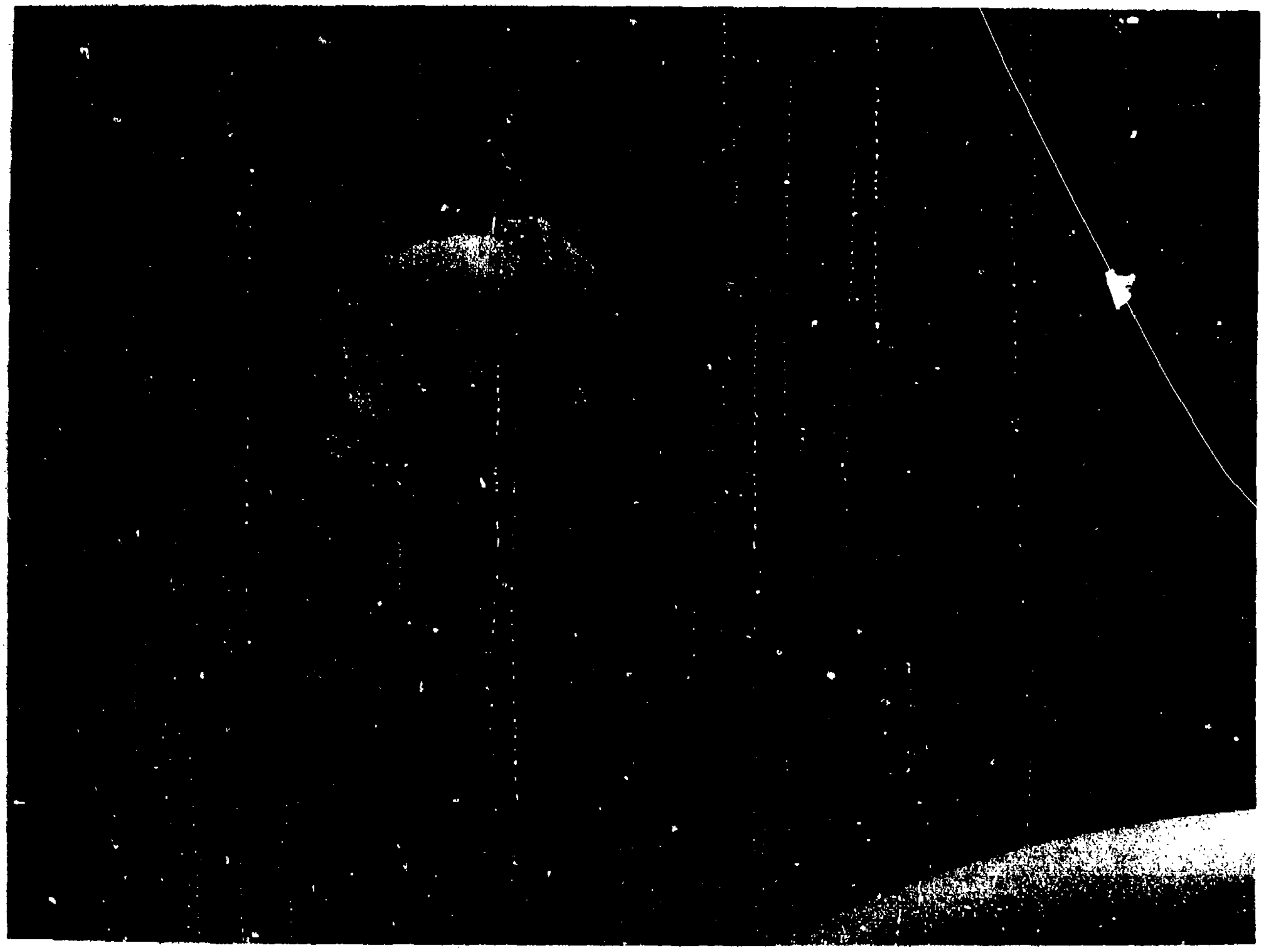
In addition to the geodetic systems instrumentation, the satellite contains several experiments to test the environment and the attitude of the satellite.

The first ANNA satellite launched 10 May 1962 did not achieve orbit because the second-stage rocket failed to ignite.

Project ANNA derived its name from the agencies which originally collaborated on formulating the program, or which were expected to participate actively in the observation program, i. e., Army, Navy, NASA (the National Aeronautics and Space Administration), and Air Force. The Defense Department geodetic satellite ANNA program is under Navy management, with the overall direction by the Navy's Bureau of Naval Weapons. Technical direction and responsibility for development of the satellite has been assigned to the Applied Physics Laboratory of The Johns Hopkins University.

(UNCLASSIFIED)

[1] An article entitled "ANNA—Geodesy from Art to Science" was published in Naval Weapons Bulletin No. 2-62, pp. 65-70.



ANNA 1-B geodetic research satellite in orbit

Off Into Space by Van and Crane

Project Gemini Test Run to Employ Unique Methods in Simulating Extended Space Mission

A highly unusual experiment in simulated space travel is scheduled to take place at the Air Crew Equipment Laboratory (ACEL) of the Naval Air Material Center, Philadelphia, Pa., during November and December 1962.[1] The test program will include:

1. Fourteen days of simulated space flight in the bio-astronautic test facility of the Air Crew Equipment Laboratory.

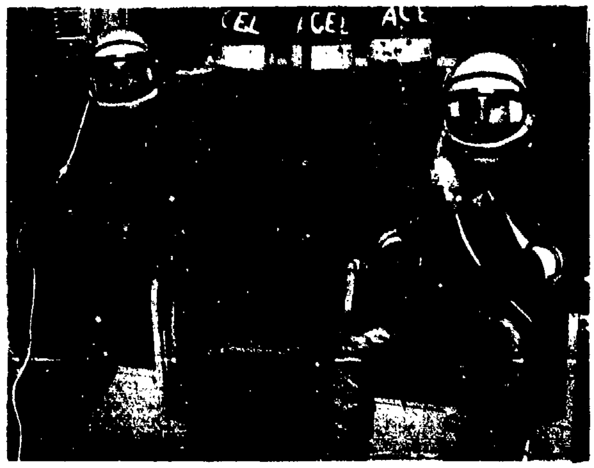
2. Two rides in the centrifuge at the Aviation Medical Acceleration Laboratory (AMAL) of the Naval Air Development Center, Johnsville, Pa.

3. Four trips by van across the city of Philadelphia.

4. Four hoistings by crane for each of the test subjects while enclosed in an 1,100 pound barrel (pressure capsule).

The last two events are definitely not part of the simulated trip profile, but they are essential elements of a plan to utilize the combined facilities of ACEL and AMAL in what will probably be the most comprehensive experiment yet conducted into the human factors involved in future space travel. In the past there have been exhaustive tests to determine the effects of acceleration on the human body. Other tests have investigated the problems of extended exposure to low pressures and a pure oxygen atmosphere. Now, for the first time, these problems are to be thoroughly investigated in one simulated space mission.

The primary objective of this experiment is to evaluate the effects of the launch and reentry accelerations typical of the Gemini flight profile combined with breathing an artificial atmosphere of 100

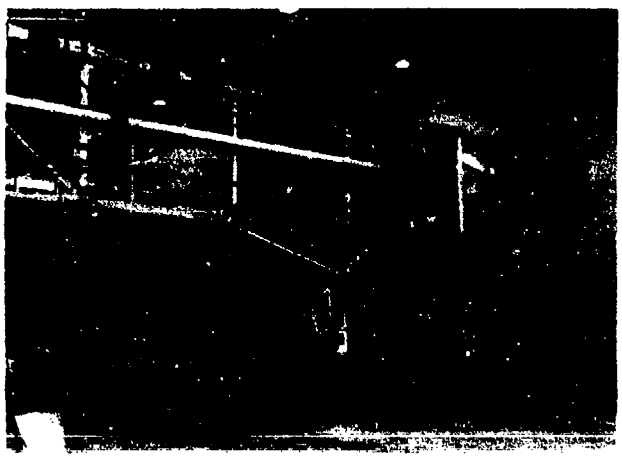


Two test subjects are shown seated in specially equipped van for initial trip from Air Crew Equipment Laboratory where simulated space journey will commence

Not exactly in orbit, but definitely up in the air. Pressure capsule and test subject are transferred from van to loading ramp at Aviation Medical Acceleration Laboratory (AMAL), Johnsville, Pa.

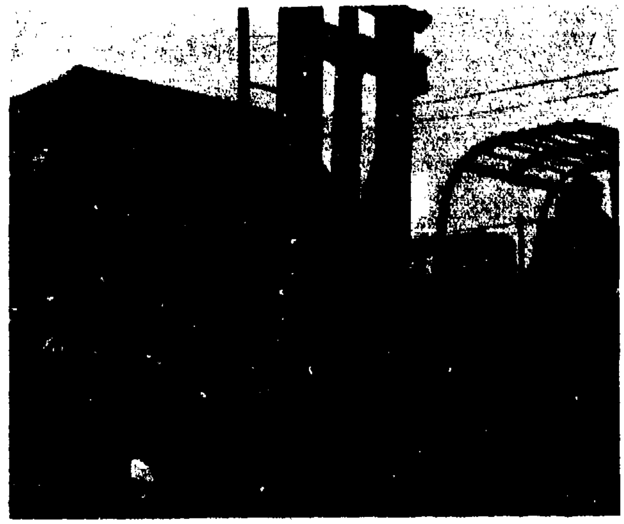
[1] This study was completed in November 1962.

percent oxygen at low pressure for a long period of time. This primary investigation centers on the problem of atelectasis (a collapsing of portions of the lungs) brought on by conditions of high acceleration, low pressure, and 100 percent oxygen. The doctors and scientists are seeking to determine if atelectasis will be a serious hazard to future astronauts, and how this condition can be avoided or remedied on extended space missions in the future. In addition, they are seeking to determine whether an astronaut's performance will be adversely affected under the test conditions. For this purpose, each test subject's ability to perform such duties as might be required of future space pilots will be measured periodically during the course of the test.



Pressure capsule is shown attached to centrifuge at AMAL. Centrifuge will be used to simulate acceleration of launch and reentry for simulated space mission

In preparation for this Project Gemini test, nine carefully selected Navy and Marine pilots were ordered to report to the Air Crew Equipment Laboratory during the latter part of October 1962. These nine pilots were chosen from a group of astronaut candidates who had been selected by the School of Aviation Medicine at Pensacola, Fla. Three were test pilots over 30 years of age, while six were pilots under 30 who recently had graduated from flight training. All of the group are volunteers. Upon arrival at ACEL, the



Standard fork lift takes turn as GEMINI test propulsion vehicle as capsule is loaded on van for return trip to Air Crew Equipment Laboratory, Naval Air Material Center, Philadelphia

pilots moved immediately into special quarters to permit their semi-isolation during the preliminary briefings and physical examinations preceding the simulated mission. This isolation was necessary to reduce the chances of infectious illness occurring among members of the group which might interrupt the test or invalidate the data obtained.

After 9 days of semi-isolation and 3 days of complete isolation, the nine pilots will be ready for "launching." Because the facilities are limited, the pilots must be "launched" individually, at 1-day intervals, until six have joined the simulated mission in space. Only six will be used in this experiment, the additional pilots serving as backups for the others during the launching phase.

Each "launching" has been carefully planned to simulate as closely as possible an actual flight into space for each of the test subjects. Each pilot will eat a special low-residue diet for three days prior to his launching. On the day of his launch, he will don his pressure suit at ACEL and begin breathing pure oxygen four hours in advance of the simulated launch. Sensors will be applied to his body which will transmit data on his respiration and heart-rate. These will be monitored continuously during the entire period of the test—in the space chamber, centrifuge, van, and crane. When the pilot has been completely wired and monitored, and is breathing pure oxygen within his pressure suit, he will be ready for the first leg of his long "journey" into space—by van to the Aviation Medical Acceleration Laboratory, Johnsville, Pa., about 25 miles away.

Upon arrival at AMAL, the subject will enter a pressure capsule which has been mounted on the centrifuge. This capsule is a large, barrel-like container, weighing about 1,100 pounds, in which the pressure can be regulated to simulate any altitude. The container is then sealed and the pressure reduced to 5 p.s.i. absolute, or about one-third atmosphere, corresponding to about 27,000 feet altitude. The pressure capsule and subject then will be accelerated as would be expected in an actual space launching of the future. This acceleration will be in two pulses of about 60 seconds duration each, 7 g's peak acceleration. These acceleration pulses correspond to the thrust of the booster and main rocket engines.

Upon completion of the acceleration phase, the pressure capsule and enclosed subject will be removed from the centrifuge by crane and loaded on the van for the return trip to ACEL. Intricate equipment will provide for constant monitoring of and communication with the subject while the capsule is being moved, and the capsule will be maintained at a constant 5 p.s.i. and 100 percent oxygen during this period. It must be conceded, however, that it will be impossible to maintain the illusion of smooth, weightless space travel during this phase of the operation.

Upon return to ACEL, the pressure capsule will be removed from the van and attached to the bio-astronautic test chamber, in which the atmosphere will be identical to that within the capsule—5 p.s.i. absolute and 100 percent oxygen. The test subject then will leave the couch and enter the test chamber through a specially designed opening which avoids any exposure to the outside atmosphere. He will find the test chamber outfitted and provisioned as a space vehicle would be for an extended orbital flight; i.e., with all of the essentials, including oxygen, water, and low-residue foods, but very few of the comforts of life.

One of the pilots will be launched in this manner each day, until the population of the ACEL space research chamber reaches six test astronauts plus two attending flight surgeons. It should be noted that conditions will be very crowded in the test chamber at this point; all facilities must be carefully scheduled on a 24-hour basis in order to accomplish the experiment. The test astronauts will adhere to a very tight schedule while in the test chamber. For 4 hours daily, each will man a simulated control console designed to measure certain performance functions, such as tracking ability, arithmetic computational ability, attentiveness, short-term memory, and problem-solving ability. In addition to these psychological tests, there will be many physiological measurements; e.g., electrocardiograms, arterial blood samples, multiple physical exams, and even chest X-rays will be taken at regular intervals. Physical exercise and sleep will complete the daily program.

The two attending flight surgeons will face perhaps the most demanding schedule of all. In a day which contains only 24 hours, even in space, they must find time to conduct 18 complete physical examinations (three per test subject), take 14 blood samples, 42 electrocardiograms, 18 bacterial cultures, and numerous other tests, in addition to supervising all activities within the test chamber, and protecting the safety of all who are embarked upon this experiment.

An interesting facet of the tests is the provision which has been made for X-rays of the test subjects while within the bio-astronautic test chamber. The high voltage of the equipment, combined with the low pressure, 100 percent oxygen, and lack of space, preclude the use of X-ray equipment within the test chamber. Since the test conditions will not permit the participants to leave the chamber, it was necessary to develop a way to accomplish the X-rays from the outside. A thin aluminum disc was built into the walls of the chamber for this purpose. X-rays will penetrate this disc, and thus, with the equipment remaining outside, the required X-rays can be made of the subjects within the chamber.

Another problem to be investigated is that of accumulation of gaseous impurities within the closed atmospheric system of a space vehicle. The Aeronautical Materials Laboratory at the Naval Air Material Center has developed a rapid, accurate, and extremely sensitive method of determining gaseous impurities within the test chamber to obtain further data on this most critical problem. The Aeronautical Materials Laboratory method employs infrared spectrophotometric analysis and makes possible rapid identification and quantitative measurement of gaseous contaminants, whether introduced by human or mechanical processes.

Fourteen days after the launching of the first astronaut, he will be returned to "earth." To bring him back, the initial launching procedures will be reversed. The pressure capsule will again be attached to the space chamber. After the first pilot enters the capsule, it will be sealed and loaded on the van for another trip to Johnsville. There at AMAL, the capsule will be attached to the centrifuge, and subjected to a typical reentry deceleration—one pulse of 2 minutes duration, 11.2 g's peak acceleration. Assumed to be safely back on earth, the first test subject will emerge from the pressure capsule, remove his pressure suit, and breathe the normal atmosphere (of the Philadelphia area) for the first time in over 14 days. He will then board a van for his final trip from Johnsville through Philadelphia to ACEL, but this time he can enjoy the scenery.

As in the case of the launching, the reentries will be repeated daily until all six astronauts are returned to "earth," and ACEL. There, final physical examinations and debriefings will conclude the data-collecting part of the Gemini test run.

Project Gemini is the code name assigned to what is to be our next major space program, the successor to Project Mercury. The goal of Project Gemini is to put two American Astronauts into space on a 14-day orbital flight sometime in 1964. The Project Gemini test run to be conducted at ACEL is one of the preliminary experiments leading to the Gemini orbital flight. It is admittedly an ambitious venture, intended to simulate in every possible detail an actual mission into space. It employs unique methods to utilize the combined facilities of two nearby Navy laboratories to accomplish this mission, which neither laboratory could accomplish by itself. It is confidently hoped that this bold experiment will provide answers to some of the vital problems facing our future astronauts of Project Gemini.

UNCLASSIFIED

WEAPONS SHORE ESTABLISHMENT

NAFI's Microelectronics Program

From U. S. Naval Avionics Facility, Indianapolis, Ind.

The rapidly growing complexity of electronic gear, the need for greater reliability at lower production cost, and the requirements for better performance of many more functions in the same or even reduced space and weight allowances, have encouraged the development of microelectronics techniques.

The U. S. Naval Avionics Facility, Indianapolis, Ind. (NAFI), has been studying advanced electronics technologies for the Bureau of Naval Weapons since early in 1959. These studies have covered both the weapon research and development area and the manufacturing technology development area.

NAFI's efforts have been coordinated closely with those of other Navy laboratories and field stations through the Navy Panel on Microelectronics. Of the many approaches studied, it was decided that integrated thin-film circuitry would provide the broadest technical competence for early application in weapon systems at NAFI. This decision was based upon several factors, such as: the basic processes were well known in both Navy and industrial laboratories; vacuum deposition has a potential of producing extremely reliable circuits; lead time and cost reduction can be realized; circuit development restrictions are not too stringent and a nearly one-to-one correspondence to conventional circuitry exists.

Excellent flexibility and evolution potential exist in the geometry of thin film plus active elements (transistors, diodes, etc.). There are three areas of complexity in this integrated thin-film design: the complexity of the attached active elements; the complexity of the resistive, capacitive, inductive, and interconnection conductive elements of the thin-film panels; and the complexity of the back panel or subsystem interconnections. The burden designed into each area is determined by a trade-off to obtain maximum reliability at lowest cost.

As a Bureau of Naval Weapons Industrial preparedness measure to accelerate the availability of microelectronics for military equipment, NAFI contracted for the development of the thin-film laboratory technique into a firm manufacturing technology. As a result of this contract, the Navy has complete specifications for a system, outlining materials, process technology, and fabrication machinery and process controls for thin-film microelectronics. In addition, two automatic pilot manufacturing facilities are available, one at NAFI and one at the contractor's plant. Additional industrial firms have indicated an interest in establishing compatible facilities.

Pilot manufacturing machines being assembled at the contractor's plant

Typical thin-film circuits deposited in the laboratory at U. S. Naval Avionics Facility, Indianapolis

The Bomb/Missile Computer Mk 9 developed by U. S. Naval Ordnance Test Station, China Lake, Calif. (NOTS) has been selected for conversion to this thin-film process. Work has started on converting the functions of this computer into a binary digital mechanization and adapting it to thin-film design. This program is planned to produce final prototypes of a general purpose data-processor with a memory section which can be programmed to handle either the Bomb/Missile Computer Mk 9 solutions or other functions as required by future light attack applications. Pilot production of this computer will serve to evaluate the machinery and the thin-film process.

NAFI is continuing extensive laboratory and engineering work and coast-to-coast surveys of the state of the art of various microelectronics approaches, with emphasis on the techniques of forming functional circuit blocks from single crystal semi-conductors. (UNCLASSIFIED)

RECENTLY ISSUED ORDNANCE PUBLICATIONS

A list of recently issued ordnance publications is included to keep the fleet informed of new and revised publications that have been distributed for the Bureau.

The publications that are listed here were distributed during the period from 15 September 1962 through 15 December 1962.

The security classification and document group number assigned under the Automatic Downgrading and Declassification System (DOD Dir 5200.10) are shown in the right-hand column.

NAVWEPS OD's may be ordered by any approved and convenient requisitioning method from the Commanding Officer, U.S. Naval Ordnance Plant (CTDO), Iroquois Station, Louisville 14, Ky.

All other publications listed here may be obtained by requisitioning in accordance with instructions in NAVSANDA Publication 2002.

NAVAER and NAVWEPS aviation publications are listed in NAVSANDA Publication 2002, Section VIII, and should be ordered in accordance with instructions in that publication.

(NOTE: Aviation publications and items in this list should NOT be ordered directly from Chief, Bureau of Naval Weapons.

NAVWEPS OP's Ordnance Pamphlets	Title	Date	Classification
OP 0 (32nd Rev) . .	Index of Ordnance Publications	1 Oct 62	Unclassified
OP 5 Vol 3 CH 2	Ammunition Ashore, Advance Bases	1 Dec 62	Unclassified
OP 805 (1st Rev) CH 5	5-Inch Twin Gun Mounts Mks 28, 32, and 38 All Mods; Description and instructions. . .	15 Sep 62	Unclassified
OP 868 CH 12 . . .	5-Inch 38 Cal. Single Mount Mk 37	15 Sep 62	Unclassified
OP 895 (1st Rev) CH 6	Assemblies, 5-Inch 38 Cal. AA Mount Mk 30 Mod 50; Description and Instructions. . .	15 Sep 62	Unclassified
OP 1480 (2nd Rev)	VT Fuzes for Projectiles and Spin-Stabilized Rockets (U)	1 Jun 62	Confidential (Gr 3)
OP 1912 (1st Rev)	20mm Feed Mechanism Mk 7 Mod 0; Instruction Manual . .	15 Oct 62	Unclassified
OP 1940B (1st Rev)	Gun Sight Mk 31 Mods 1, 2, 3, 4, and 5 Amplifier Mk 121 Mods 1, 2, and 3; Overhaul	1 Nov 61	Unclassified

NAVWEPS OP's Ordnance Pamphlets	Title	Date	Classification
OP 2385 Vol 1 (3rd Rev) CH 1	Launching Group Mk 16, Launcher Mk 112, Power Control Panel Mk 198, Launcher Captain's Control Panel Mk 199; Description, Operation, and Maintenance	5 Oct 62	Unclassified
OP 2385 Vol 1 (3rd Rev) CH 2 . .	Launching Group Mk 16, Launcher Mk 112, Power Control Panel Mk 198, Launcher Captain's Control Panel Mk 199; Description Operation, and Maintenance	5 Oct 62	Unclassified
OP 2385 Vol 1 (3rd Rev) CH 3. .	Launching Group Mk 16, Launcher Mk 112, Power Control Panel Mk 198, Launcher Captain's Control Panel Mk 199; Description, Operation, and Maintenance	5 Oct 62	Unclassified
OP 2385 Vol 3 CH 1	Launcher and Missile Simulator Mk 6 Mods; Description, Operation, and Maintenance . . .	15 Oct 62	Unclassified
OP 2456 Vol 7 . . .	Battery Alinement for DDG-2 Class Ships	15 Nov 62	Unclassified
OP 2472 IPB Vol 1	Guided Missile Launcher Feeder Mk 9 Mods 0 and 1; Illustrated Parts Breakdown	1 Jul 62	Unclassified
OP 2472 IPB Vol 2	Missile Launching Control Mk 7 Mod 0; Illustrated Parts Breakdown	1 Jul 62	Unclassified
OP 2472 IPB Vol 3	Auxiliary Equipment for Guided Missile Launching System Mk 9 Mod 0; Illustrated Parts Breakdown.	1 Jul 62	Unclassified
OP 2476	Computer Mk 108 Mods 0 and 1; Description, Operation, and Maintenance.	15 May 62	Unclassified

NAVWEPS OP's Ordnance Pamphlets	Title	Date	Classification
OP 2477	Computer Mk 110 Mod 0; Description, Operation, and Maintenance.	15 May 62	Unclassified
OP 2555	Amplifier Mk 140 Mods 0, 1, and 2, and Test Set Mk 339 Mod 0; Description, Operation, and Maintenance	15 Jul 62	Unclassified
OP 2722 (1st Rev).	21-Inch Submerged Torpedo Tube Mk 64 Mods 1 and 2; Description, Operation, and Maintenance.	1 Jun 62	Unclassified
OP 2876	Degaussing of MSC and MSO Minesweepers (Military Aid Program) (U)	1 Nov 62	Confidential (Gr 3)
OP 2885	Computer Mk 59 Mod 6; Description, Operation, and Maintenance.	30 Jun 62	Unclassified
OP 2899 Vol 1 . . .	Missile Transportation and Storage Guide (Transportation Guide) (U)	1 Nov 62	Confidential (Gr 3)
OP 2899 Vol 2 . . .	Missile Transportation and Storage Guide (Storage Guide)	1 Nov 62	Unclassified
OP 2969 (1st Rev).	Marker, Location, Marine Mk 25 and Mods Adaptor Kit, Marine Marker Mk 34 Mod 0. . .	1 Jun 62	Unclassified
OP 3135 Vol 1 . . .	Signal, Smoke and Illumination, Submarine, Mks 66, 67, and 68, Mods 0	1 Sep 62	Unclassified
OP 3135 Vol 2 . . .	Signal, Smoke and Illumination, Submarine, Mks 66, 67, 68, Mods 0	1 Sep 62	Unclassified
NAVWEPS OD's Ordnance Data			
OD 9398 CH 22	Fire Control Maintenance Notes	15 Sep 62	Unclassified
OD 9398 CH 23	Fire Control Maintenance Notes	1 Oct 62	Unclassified

NAVWEPS OD's Ordnance Data	Title	Date	Classification
OD 25487	Weapon Equipment List for Submarine Tender, AS-33 . .	14 Jun 62	Confidential (Gr 4)
OD 26153	Weapon Equipment List for Command Ship CC-2 Class . .	18 Sep 62	Confidential (Gr 4)
OD 27000	Weapon Equipment List for Utility Landing Craft (Assault), LCU(A)	30 Nov 62	Unclassified
Explosive Ordnance Disposal Bulletins			
EODB 00.	Index of Army TB ORD's, Navy NAVWEPS EODB's Air Force TO's Covering Explosive Ordnance Disposal Procedures (U)	31 Aug 62	Confidential (Gr 3)
EODB 217	Explosive Ordnance Disposal Procedure for Torpedo Mk 37 Mods 0 and 1 (U).	14 Sep 62	Confidential (Gr 3)
EODB 291 CH 1 . .	Explosive Ordnance Disposal Procedure for Drill Mine Mk 49 Mods 0, 1, and 2 (U)	14 Sep 62	Confidential (Gr 3)
EODB 292 CH 1 . .	Explosive Ordnance Disposal Procedure for Drill Mine Mk 10 Mod 3 (U)	14 Sep 62	Confidential (Gr 3)
EODB 309	Explosive Ordnance Disposal Procedure for Guided Missile, Air-to-Surface, YASM-N-7b W/Liquid Rocket Engine and Fuze Mk 312 Mod 0 (BULLPUP B) (U)	22 Oct 62	Confidential (Gr 3)
Miscellaneous			
Report 1488 (Vol 3)	Handbook of Supersonic Aerodynamics, Section 8 Bodies of Revolution	Oct 61	Unclassified

U. S. GOVERNMENT PRINTING OFFICE : 1963 O - 674622

DEPARTMENT OF THE NAVY

NAVAL SEA SYSTEMS COMMAND
2531 JEFFERSON DAVIS HWY
ARLINGTON VA 22242-5160

IN REPLY REFER TO

5720
Ser 09T23Z/99-0279

From: Commander, Naval Sea Systems Command (NAVSEA 09T2)
To: Defense Technical Information Center (DTIC)
Attn: Bill Bush

Subj: DTIC DOCUMENT AD NUMBER C960224; NAVAL WEAPONS BULLETIN, OCT-DEC NO. 4-62, DEC 1962

1. Based on the requirements of the Freedom of Information Act, we reviewed the subject document and made it available for public release.

2. Please make the necessary changes in your database to reflect the current status of the document.

3. Contact Jan Zacharias at (703) 602-3841, extension 503 if you have any questions or concern about the foregoing.

Sincerely,

Judy Wise

JUDY P. WISE
Head, Freedom of Information
and Privacy Program Division
By Direction of the Commander

Completed 1-21-00
au