CHAPTER 12

SAFETY

This chapter is a summation of safety rules concerning mechanical, electrical and electronic, hydraulic, and pneumatic equipment; and explosives, radiation, gases, vapors, chemicals, and fire safety precautions. Some of these rules and warnings have been given in applicable chapters of this book, but they can bear repetition.

All your life you have been reminded to be careful, and have been cautioned about accidents that may happen if you do not heed the warning. No doubt you have ignored some of the warnings, out as you matured you came to realize the necessity for safety rules. An infraction that might cause only a minor mishap at one time could result in a disaster another time. The chance is not worth the risk. If you are reckless about your own safety, you have no right to endanger others.

A PO 1 or C has a responsibility for impressing on lower rated men the need for the safety rules, and he must be firm in enforcing them. Frequent reminders should be given even at the risk of nagging. Nearly all accidents are caused by an infraction of safety rules, whether through ignorance of the rules, or carelessness, or recklessness. The Military Requirements necessitate a knowledge of safety rules at all levels; but at E-6 or E-7 levels, for which you are trying, supervision and teaching are also required. The GMM quals expect you to interpret safety instructions and directives, to carryon a safety program in your area, and to enforce the rules. Don't forget that a good example is the first step.

ACCIDENT PREVENTION PROGRAMS

The overall directives for safety programs are issued by OPNAV or other high level authority. Interpretation of the directives takes the form of specific instructions and directives. The application takes place on shipboard and at shore stations. You have responsibility to interpret the directives to your men, to promote the program, and to enforce rules. Safety posters, magazines, films, and other educational materials are supplied by the Navy to help get across the safety program.

NAVORDSYSCOM is increasing its efforts to achieve the goal of reduction in accidents. The measures that must be taken are:

1. Plan every job operation with adequate safety precautions and instructions.
2. Assure that supervisors, when issuing work assignments, provide specific instructions on safe working practices and procedures directly related to hazards and risks incident to the assigned job.
3. Include supervisory indoctrination and specialist training to make sure that well-developed safety training is included in each such program in accordance with approved training procedures.
4. Review activity programs for employee development in safety.
5. Continue to emphasize accident prevention through activity and poster publicity. Material is available from the Commander, Naval Ordnance Systems Command Headquarters.

Personnel failure was determined to be the chief cause of accidents, whether through unawareness of the safety precautions required for the assigned task or indifference toward hazards and risks normal to the job. Past experience indicates that accidents can be significantly

reduced by thorough instruction in safe working conditions and procedures, and giving information regarding the hazards and risks of the job.

Young people, who have the most to lose by accidents, are normally the most reckless. You have to keep reminding them of the hazards and the possible consequences to themselves and their shipmates.

SAFETY AROUND MACHINERY

Probably the first safety precaution given you dealt with mechanical things such as moving machinery, ladders, a swinging boom, and similar objects. The first rate training manual that you studied, Seaman, NAVTRA 10120, contains many safety rules that apply to working with and around machinery. Each text on military requirements reviews the rules and adds others. At the time you were striking for E-3 you were expected to remember those rules and apply them. Now that you are trying for E-6 or E-7, you have supervisory responsibility. The primary objective of the Navy supervisor is to operate with maximum efficiency and safety. Accidents reduce efficiency and increase costs. Practice with training aids that can be manipulated is suggested as a prime means in learning how to handle machinery with safety. A picture showing how the equipment operates helps to orient the learner to what happens when the machine works, but operating a model fixes the motion in mind. When you are planning a lesson on safe operation of equipment, use every means available to impress the lessons on the senses. Many films and slides are available on safety subjects. Select those most appropriate to your lesson to intensify your instruction. Closely supervised operation of the machinery is the next step in learning safe and proper operation.

You may have to instruct some of your men in the safe use of common tools in a safe and efficient manner. He needs to know this before he is ready to handle the far more complicated equipment used by a GMM. Take time to teach any of your men who are deficient in tool skill. See Tools and Their Uses, NAVTRA 10085, for material to review and self-study.

HANDLING AND STOWAGE

You have already qualified as an E-5 in supervising crews in the safe and proper procedures for transferring, handling, and stowing missile components. Now you will work with your officer in planning the handling and stowing operations. The safety of handling and stowing can be greatly bettered by good advance planning. Find out what is coming aboard, and plan how to take care of all the items. Decide who will be stationed at each position to handle the missiles and missile components. Have a practice session the day before the loading is to take place. If you are new on the ship, find out the location of all the storage spaces you will need to use, and the means of reaching them.

On Shipboard

When any explosives are to be handled (and all missiles are explosives and combinations of explosives), firefighting equipment must be readied on the deck. Check the operating condition of the equipment, and make sure that each man knows his responsibility and that he knows how to operate the equipment. It means that you have trained your en in methods of fighting fires in explosives.

The handling equipment also must be checked out before use. Examine the trolley, conveyors, tracks, dollies, and other handling equipment you will use. Before raising any missile or component off the deck, bench, or launcher, check the security of the lifting attachment by raising the component about 2 inches. This way, it will not have far to fall. You know the 5-foot-l-foot rule: if dropped 1 foot or more, an unpackaged explosive is considered unsafe and must be returned to the depot; a packaged explosive, if dropped 5 feet or more, is considered unsafe and must be returned to 'the depot. It is discussed in chapter 2 of this text and is mentioned several times in chapter 8.

It is difficult "to separate explosives safety rules from safety rules for handling equipment since what you are handling consists chiefly of explosives.

Ammunition handling equipment is operated and controlled by electric, hydraulic, pneumatic, and mechanical components or a combination of these. Thus all safety rules for each type of equipment apply in all steps of ammunition

handling. The handling equipment used with the Tartar system is a good example of a multi type missile handling system. This system employs pneumatic equipment (missile strike down fixture), electrical equipment (deck control box), mechanical equipment (missile handling dolly) and hydraulic equipment (launcher train and elevation systems). At least one hour before replenishment, prepare and examine all handling equipment to be used and operate all equipment in all steps of missile handling. Some shipboard missile handling equipment is under the cognizance of NAVSHIPS. All safety instructions and precautions for this equipment are issued by NAVSHIPS under the guidelines set up by NAVORDSYSCOM.

Safety devices should be inspected frequently to ensure they are operative. Warn personnel if any safety device is inoperative, and restore it to operating condition as soon as possible. Some safety devices may seem to be a "bother," but it is far better to be bothered or inconvenienced a little than crippled.

Safety at Shore Stations

If you are studying to make E-7, you need to know the methods of handling and stowing missiles ashore. Although some of the handling equipment is the same, shore stations make much use of motorized equipment. Forklift trucks are used to a much greater extent than on shipboard. Proper balance of loads and securing the loads are important factors in the safe operation of forklift trucks. The manufacturer's handbook gives the instructions for his equipment. A compendium of information on about fifteen different models is given in OP 2173 (Volume 1), Handling Equipment for Ammunition and Explosives Mobile Equipment. Missile handling equipment for particular missiles is covered in one chapter, and safety precautions are consolidated in appendix A. The handling equipment described for missiles is chiefly for transfer-at-sea use. Some of the forklift trucks described are large enough to handle Talos missiles. Although forklifts are not used on highways, driving rules apply. In addition, extra care is required because of the cargo. The speed limit usually is 5 miles per hour. Never permit other persons to ride on the equipment. Watch for low or narrow clearance areas, and be sure your equipment can pass through safely. Avoid bumps or sharp objects, drive around them. Guided missiles are extremely sensitive to shocks and jars.

Volume 2 of OP 2173 describes nonmobile handling" equipment such as pallets, hoisting slings, cradles, skids, strongbacks, dollies, carriers, and stands. With the use of the stream system for shipboard handling, few of these find shipboard use, but many of them are needed for handling components at shore bases where missiles are assembled, disassembled, repaired, and stored. One safety rule that applies to all-be sure that the missile or component is securely attached. The points of attachment are marked on the containers or on the missile skin.

Duty at a shore base may involve you in packaging and shipping of missiles and components. If the shipment crosses state lines, the rules of the Interstate Commerce Commission (ICC) apply, whether Navy vehicles or public carriers are used. OP 2165, Navy Ordnance Shipping Handbook, reviews rules for different types of explosives and different means of transportation. References are given so you can get the latest rules that apply to your particular activity. Discoveries of new types of explosives make new rules necessary for safe transportation. Drivers of vehicles also must be checked on their qualifications and on safety rules. OP 2239, Driver's Handbook, Ammunition, Explosives, and Dangerous Articles, sets forth the regulations.

The safety record of NAVORDSYSCOM in driving of vehicles has been better than most; let's make it better still.

OP 5, Volume 1, Ammunition Ashore, Handling, Stowing, and Shipping, is the overall text on this subject. Be sure you get the latest revision with all the changes. There have been some changes in almost every chapter of that book; the chapter on pyrotechnics is nearly a complete change from the old rules. The chapter on chemical munitions needed some additions; so have chapters on flammable liquids, flammable solids, corrosive liquids, compressed gases, and toxic chemicals. New materials have necessitated additional rules for handling and stowing those materials.

The handling equipment is not described in OP 5, but some motor truck specifications are given. Since the ICC shipping rules are constantly revised, it is best to get the shipping regulations directly when needed. The Navy Shipping Guide gives. the Navy regulations for truck shipments.

The rules for handling and stowing specific missiles are given in the OPs for those missiles. For example, OP 2979, Volume 6, Terrier/ Tartar Shipping and Handling System, describes factory-to-firing sequence, with instructions for depot operations, depot loadout, transfer to dockside, shipboard operations, transfer at sea operations, return of missiles to depots, and other phases of the entire sequence for the HT-3 missile. Volume 5 does the same for the BT-3 and BT-3A missiles.

MOVING MACHINERY

One of the most frequently repeated warning is that about launcher movement or other moving parts of the launching equipment. No one may be m the area covered by the movement of the launcher or gun turret, and to make sure that no one is there, a loud warning bell is rung and a safety observer looks over the area. It took a grisly accident to show the need for this rule. A man thought the shadow of a gun turret provided a good place to take a snooze. While he slept, the turret was activated; his head was crushed before the moving mount could be stopped. To prevent a repetition of such a casualty, you are reminded over and over to make sure that no one is in the path of moving machinery, whether it is a launcher, a crane or boom, or other powered equipment.

To make sure that no one starts the launching system while someone is working on it, set the safety switch on the EP-2 panel to SAFE and remove the switch handle. If you give the switch handle to the person who is working on the system, you can be sure no one can activate it. That takes care of the men working on the system; you still have to look out for any man who might be where he has no business, like the man in the story above.

ELECTRICAL AND ELECTRONIC SAFETY PRECAUTIONS

Volumes have been written about electrical and electronic safety, yet accidents continue to happen. More often than not, the victim of such an accident is a person who should have known the dangers of electricity, such as an electrician making repairs. Certainly an electrician is aware of the dangers of electricity, so why does he fall a victim to it? Perhaps the answer is in the old saying, "Familiarity breeds contempt." Men become careless when they work with electricity every day.

What can you do about this attitude? You can keep reminding your men of "the safety rules that must be observed in each operation. Watch your men to see that they are observing the safety rules. Check to be sure that all electrical tools are in good repair and that the end of the ground wire within the tool is connected to the. tool's metal housing. The other end must be connected to ground. The grounded type plugs and receptacles, which must be used, automatically make this connection.

Missile components must be protected against stray voltages by adequate grounding during all phases of handling, assembling, disassembling, and testing. Attach the ground straps where indicated on the containers and the missiles.

GENERAL SAFETY RULES

The following general safety precautions are applicable during all phases of maintenance and operation.

KEEP AWAY FROM LIVE CIRCUITS. - Remove all power from the equipment when conducting operations requiring no power. Under certain conditions, capacitors may retain a high voltage charge after the equipment is turned off. To avoid the possibility of electrical shock, discharge circuits before touching them.

USE SAFE TEST EQUIPMENT. - All electrical test equipment using 115-v-a-c line power is provided with a means of grounding the chassis systems through the power cable. Be sure the proper power cable is used. Do not use damaged power cables or test leads. Damaged test leads should be replaced, not repaired.

DO NOT SERVICE OR ADJUST ALONE. - Under no circumstances should personnel perform

servicing or maintenance of the equipment without the immediate presence of another person capable of rendering aid.

RESUSCITATION. - Personnel working with or near high voltages should be familiar with the methods of artificial respiration. Standard First Aid Training Course, NAVTRA 10081, describes the accepted method of mouth-to-mouth resuscitation. Charts illustrating and describing the method should be posted at a number of places on the ship. EVERYONE needs to know it. There isn't time to look it up after there has been an accident. Resuscitation should be started in seconds after an accident. After 3 minutes, the chances of revival decrease rapidly.

Safety Precautions to Observe When Testing

Do not attempt cleaning operation until all power is removed from the Guided Missile Test Set (GMTS).

Turn GMTS power off and remove tape readers before attempting lubrication.

High voltage (+ 300 v-d-c) is present at test points. Use only an insulated portable multimeter and proceed with caution.

Use caution when performing inspection, adjustments, voltage measurement, and maintenance. High voltages are present in the GMTS and the Missile Electrical System Test Set (MESTS).

Voltages up to +950 v-d-c are present in the microwave power supply chassis. Use caution when taking voltage measurements.

Remove power from the test set before attempting to remove any part of the set.

Chassis protective interlock circuits are bypassed when the BATTLESHORT switch is on. UNSAFE lamps on the panel indicate this unsafe status.

Any cabinet, chassis, or cabling damage found during inspection must be corrected before power is applied to the GMTS.

Be careful not only of what you touch with your hands, but what you touch with any part of your body. Be sure you do not brush against energized equipment, or lean against it.

Safety Around Electronic Equipment

In nearly every accident, investigation shows that it could have been prevented by observing the safety practices and procedures in chapter 9670 of the NAVSHIPS Technical Manual, and the applicable schematics, wiring diagrams, and precautions contained in the equipment manual.

Although such protective devices as interlocks, cutout switches, and circuit breakers are built into modern electronic equipment, personnel can still receive severe bums and lethal shocks under many conditions. One source of danger sometimes neglected by repairmen" with serious results is the multiple power inputs of electronic equipment. All sources of power must be turned off, including that from other equipment such as synchros and remote control circuits. For example, turning off the antenna safety switch will deenergize the antenna, but it may not turn off the antenna synchro voltages from the ship's compass or stable elements. Moreover, rescue of a victim shocked by the power input from a remote source is often hampered because of the time required to find the power source so that it can be turned off.

Another source of trouble is failure to realize that removing a unit from its normal location and energizing it while outside its normal enclosure may eliminate the protection given by built-in safety features. In such cases, special precautions are necessary to avoid accidents.

Personnel working on electronic equipment and circuits should take the time required to make the operation safe. Schematics and wiring diagrams of the entire system should be carefully studied in advance and note taken of all circuits which must be deenergized in addition to the main power supply. Electronic equipment usually has more than one source of power; all sources must be deenergized before equipment is serviced. A circuit should not be worked on with the primary power applied unless absolutely necessary. In those cases where such a procedure is necessary, the repairman should stand on approved rubber matting and keep one hand free at all times, either behind him or in his pocket.

One-hundred-fifteen volt power is not a low, relatively harmless voltage; only voltages below 30 can be considered safe. Many accidents have occurred in the Navy from 115-volt power because people often regard it as harmless and ignore safety measures.

Most of the hazards which confront the

electronics repairman are the result of careless maintenance practices or failure to observe the required precautions. The following common sense safety precautions should be observed at all times:

1. Use one hand when turning switches on or off. Keep the doors to switch and fuse boxes closed, except when working inside or replacing fuses. Use a fuse puller to remove cartridge fuses, after first checking the circuit to make certain it is dead.

2. Never work on energized circuits unless absolutely necessary. Always take time to lock out, or blockout, the switch and tag it. Locks for this purpose should be readily available; if a lock cannot be obtained, remove the fuse and tag it.

3. All supply switches or cutout switches from which power can possible be fed should be secured in the open position and tagged. The tag should read: "DANGER Shock Hazard. Do not change position of switch except by direction of _____" (the person making, or directly in charge of, repairs).

4. Never short out, tamper with, or block open an interlock switch.

5. Inform remote stations of the circuit on which work is being performed.

6. Keep clear of exposed equipment; if necessary to work on it, use only one hand as much as possible.

7. Keep clothing, hands, and feet dry if at all possible. If work must be done in wet or damp locations, use a dry platform or wooden stool to sit or stand on, and place an approved rubber mat or other nonconductive material on top of the wood. Use insulated tools and insulated flashlights of the molded types when working on exposed parts.

8. Do not remove hot tubes from their sockets with bare hands. Use asbestos gloves or a tube puller.

9. Use a shorting stick to discharge all high voltage capacitors.

10. Be aware of nearby high-voltage lines or circuits. Use rubber gloves where applicable and stand on approved rubber matting (MIL-M-15562). Not all so-called rubber mats are good insulators.

11. Do not work on high-voltage equipment alone; a safety observer, qualified in first aid for electrical shock, should be present at all times. He should also know the circuits and switches controlling the equipment and should be given instructions to pull the switch immediately in case of accident.

12. Avoid reaching into enclosures except when absolutely necessary. In such case, use rubber blankets to prevent accidental contact with the enclosure.

13. Check circuits with a meter, never with bare fingers, and avoid touching any of the metallic surfaces of the test prods. When measuring voltages over 600 volts, do not hold the test prods.

14. Turn off the power before connecting alligator clips to any circuit.

15. Make certain that the equipment is properly grounded. Ground all test equipment to the equipment under test.

16. Solvents should be used to the minimum extent possible for routine cleaning. Solvents should not be used on hot equipment due to the increased fire or toxicity hazard. See NAVSHIPS Technical Manual, chapter 9600 or chapter 9030, for instructions and safety precautions applicable to cleaning solvents.

Electrical Power Tools

1. See that all power tool cables are so located that they will not be a tripping hazard.

2. Make sure that all electrically powered tools are properly grounded. Refer to chapter 9600 in NAVSHIPS Technical Manual for information on grounding tools and equipment.

3. Wear goggles when doing work where flying particles may strike the eyes.

4. Make certain that all dangerous moving parts of the tools are guarded.

5. Instruct all operators in the correct use of power tools, the hazards present, and the safety practices to be observed.

6. When work is completed, disconnect the tool and stow in it the assigned location.

Soldering Irons

The quals requiring knowledge and experience with soldering irons and soldering techniques are

listed as requirements for the E-4, but we will list a few rules for review.

1. Always assume that a soldering iron is hot.
2. Never rest an iron anywhere but on a rack designed for that purpose.
3. Do not exert lateral pressures on pencil soldering irons. Grasp them lightly and avoid breakdown of internal insulation.
4. Do not use excessive solder because the drippings may cause bums. When excess solder collects on the iron, remove it with a rag. Do not remove solder by swinging the iron.
5. Make sure that the plug on the soldering iron cord is in good condition.
6. Hold small soldering jobs with pliers or clamps to prevent burns.
7. When cleaning an iron, place the cleaning rag on a suitable surface and wipe the iron across it. Do not hold the rag in the hand.

Rescue of Shock Victims

Prompt rescue is essential to survival in case of electrical shock. However, to avoid becoming another victim, the rescuer must first shut off the voltage or, if this is not immediately possible, he must observe the following precaution in freeing the victim from the live conductor.

1. Stand on dry insulating material and use a dry board, belt, clothing or other nonconducting material to free the victim.
2. Pull victim free of shock source by the heels of his shoes or by slack in his clothing.

Two types of injuries require prompt first aid. In case of severe electrical shock, the victim's breathing may be paralyzed and heart beat stopped; immediate artificial respiration and external heart massage may be necessary. An accident with tools may also cause dangerous bleeding which must be controlled at once. These first aid measures are described in publications issued by the Bureau of Medicine and Surgery and by the Red Cross. NAVSHIPS Technical Manual also illustrates and describes external heart massage and mouth-to-mouth artificial respiration. All personnel concerned with electronic equipment should be familiar with these first aid techniques.

HYDRAULIC FLUID AND EQUIPMENT

The hazards of hydraulics will be discussed in two phases, that is, dangers from the liquid itself, and danger from its power when it is used in machines or missiles. As you know, it does not have power of itself, but transmits power imparted to it.

HAZARDS OF HYDRAULIC FLUID

Many different combinations of materials have been tried in the search for an ideal hydraulic fluid. Water-based fluids are highly fire-resistant but are apt to cause corrosion. Petroleum base liquids are the most widely used hydraulic fluids. However, they are flammable under normal conditions and can become dangerously explosive when subjected to high pressures and there is a source of flame or high temperatures. Do not mix fire-resistant hydraulic fluids with petroleum-base hydraulic oils.

In recent years, nonflammable synthetic liquids have been developed for use in hydraulic systems where fire hazards exist. Special seals are required that will not be deteriorated by the chemicals in the hydraulic fluid.

Never permit high-pressure air to be in direct contact with petroleum base liquids in a closed system because of the danger of ignition. If gas pressure is needed, nitrogen or some other inert gas should be used.

Do not let other mixtures get into the hydraulic system, as when flushing it. Do not use diesel oil for flushing a hydraulic system; small amounts clinging to the pipes would contaminate the new supply of hydraulic fluid and could make it more flammable or explosive.

Most hydraulic fluids are free of toxic materials, but some of the fire-resistant liquids are toxic. If you spill hydraulic fluid on your skin, wash it off; some types cause skin irritation and rash. If your clothes become saturated with hydraulic fluid, change into clean clothes with no delay. Some of the toxic materials can be absorbed through the skin. Containers of hydraulic fluid of a toxic type should have a label indicating this. The label should say: DANGER, TOXIC, CONTAINS (name of substance), A VOID INHALING, SWALLOWING, OR CONTACT WITH SKIN. The toxic symbol is brown on white, with a skull in the circle.

High -Pressure Hazards

When servicing hydraulic driving gear, keep in mind that you are dealing with powerful forces. I t is the pressure transmitted by the fluid that operates the machinery. With a pressure of a ton per square inch behind it, a jet of liquid from a hydraulic pipe can cause painful damage. This could happen if there were a break in a pipe. You have been told over and over that pressure must _always be released before working on a hydraulic system, so you should not be guilty of trying to crack a pipe connection or a valve without first releasing the pressure. Pressure- regulating valves and pressure-reducing valves adjust the pressures to the desired values. Relief valves, simple or compound, drop the pressure. Dumping or unloading a system is useful for stopping the hydraulic mechanism at some point in the operating cycle without shutting off the power.

Be sure to bleed the hydraulic system to reduce accumulator pressure before breaking any hydraulic connections or servicing the ready-service ring or the hoist.

HAZARDS OF HYDRAULIC EQUIPMENT

Explosions have occurred in high pressure hydraulic systems as a result of compression-ignition of petroleum oil in contact with air. The compression-ignition (diesel action) depends on the presence of air and oil, the operating temperature, and the speed of rise in pressure. The quick release of oil under high pressure into a closed part of a system can produce the high temperature and pressure conditions that cause this type of explosion. Air-oil accumulators and air flasks used to charge accumulators are the components that present the greatest explosion hazard in the system. Accumulators and air flasks retain pressure after the pumps are shut down.

Because of this danger, nitrogen is used instead of air in the flasks in missile systems. If there are any air flasks still in use in your system, be sure to observe the following precautions:

1. Keep oil out of the air side of accumulators, and keep air out of the hydraulic oil system.

2. Prevent sudden release of high pressure into dead end parts of a system.

Whether nitrogen or air flasks are used, the temperature of the hydraulic fluid is a critical factor. A maximum of 190 degrees F is commonly given. At high temperatures the fluid decomposes and these chemical changes cause formation of sludge, separation of components of the fluid, and other changes that affect the operation of the hydraulic system. An electric spark in the vicinity of overheated equipment can cause combustion. Immediately mop up any spilled fluid, and wipe off leaks. Repair any leak as soon as possible; shut down the equipment first.

NEVER charge a nitrogen flask with oxygen or compressed air. A mixture of hydraulic fluid and oxygen is extremely explosive.

Clogged filters should be removed as soon as possible. Critical components of a hydraulic system may be damaged if the system is operated when the fluid is not being filtered. Shut down the system before attempting to remove a filter and replace with a good one. Wait for the hydraulic pressure to decay before proceeding.

Before attempting to repair a leak, shut down the system, release the fluid pressure before disconnecting any pressure line; release gaseous nitrogen and hydraulic fluid pressure before disconnecting the accumulator. Be sure the appropriate shutoff valves are closed on the associated main supply tank or the header tank.

In opening a hydraulic system to make repairs, some air is likely to become entrapped. After reassembling all parts, thoroughly bleed the system before placing it in operation.

The hydraulic power drives that operate the different parts of the launching system are very powerful. Before going into any area where you could be injured by moving machinery (launcher area, magazine, loader, spanning rail, blast doors, retractable rails, floating tracks, loader positioner, strikedown gear), set the safety switch on the associated panel to SAFE, and take the switch handle with you. Then no one can start the equipment inadvertently.

If the maintenance requires power on, station a man at the EP2 panel and another safety man at the EP1 panel (circuit breakers), establish phone communication with the two safety men,

t and work with extreme caution. There is very little space and a person could easily be crushed by moving machinery.

Blast doors and magazine doors open and close with sudden force. Do not place any part of the body in the opening of either.

Each time before equipment is moved (except at General Quarters), sound the train warning bell and get an "all clear" signal before training or elevating the launcher. Likewise, sound the loading horn before moving any of the feeder components, *each time* before equipment is to be moved. Do not enter the magazine during any loading or unloading operation.

Do not enter the train circle when the launcher train motor is running.

Do not depend on a switch alone to remove power from equipment. If the equipment is wired to a secondary power distribution system by a power cable, separate the cable from the receptacle before attempting repairs. If permanently wired in, remove the main fuses and open the power switch. Attach a warning tag to the switch so no one will close the switch while repairs are in progress.

HYDRAULICS IN MISSILES

In missile testing, the hydraulic fluid becomes heated. It is imperative that the missile be allowed to cool before attempting to bleed or disconnect a hydraulic line.

Smoking is prohibited in the immediate area while filling or maintaining the pumping unit. Any spilled fluid must be wiped up immediately.

Remove all power from the missile before connecting the pumping unit servo oscillator cable to the missile for making the test. Failure to do so will result in damage to the missile and to the pumping unit.

Prior to installation of the replacement hot-gas generator (hydraulic), check to make sure that the squib is shorted.

The turbine, gearbox, and hydraulic pump for the missile are combined in a single unit that may be replaced. Before disconnecting any hydraulic line or connection, the missile hydraulic system must be bled.

Follow the steps of the procedure exactly so as to avoid deforming the hydraulic tube (high pressure or low pressure) or damaging the seal.

Leakage of hydraulic oil may contaminate harnesses (electrical) and connectors. It may be removed with aliphatic naphtha, but this must be done in a well-ventilated and fireproof (restricted) area.

PNEUMATIC EQUIPMENT

Compressed air is used as the power source in a number of your operations, though not to the extent that hydraulic power is used. The source is the compressor plant of the ship, from where the compressed air is led by piping to many parts of the ship. NAVSHIPS Technical Manual, chapter 9490, describes the ship's compressor equipment and its uses. Other rates have responsibility for care and maintenance of the system, but users must know how to use the air at the outlets. You have used the low-pressure lines for operating pneumatic tools; the chipping hammer is probably the first pneumatic-powered tool that you used in the Navy.

SAFETY WHEN USING LOW-PRESSURE AIR

The usual working pressure is 100 psi, but repair ships and tenders use 125 psi: In some ships low-pressure air is supplied through reducing valves from a higher pressure system. The low-pressure system can be used for many purposes, including operation of pneumatic tools, cleaning electrical machinery, cleaning CO_2 indicator systems, charging pump air chambers, and operating parts of the missile launching system. Even at low pressures, an air hose should never be pointed at anyone. The pressurized air can cause serious bodily damage. Make sure that output hoses are securely connected to the tool or other equipment to be operated by compressed air.

Pneumatic Tools and Handling Equipment

Before operating a pneumatic drill, inspect the air hose and check for any leaks or damage. Blow air through the air hose to free it of any foreign material before connecting it to the drill. Keep the air hose clean and free from lubricants.

Chipping hammers should not be operated without safety goggles. All persons in the imediate

vicinity should also wear goggles. Never point the chipping hammer toward a person; the tool might be accidentally ejected and could seriously injure personnel or damage equipment. Disconnect the hose from the tool if you have to lay it down temporarily.

The same safety rules apply to the use of the pneumatic impact wrench.

The pneumatic handling equipment is usually under NAVSHIPS cognizance and NAVSHIPS publications give the instructions for use of the equipment. Air-operated chain hoists are sometimes used to replenish missiles. The Tartar loading fixture is air operated.

Air Motors

In manual operation of launchers, air motors are used instead of the hydraulic power drives. The normal safety interlocks are bypassed. Use extreme caution; specifically, never move the launcher if the blast doors are open, and never open or close the blast doors by use of the handpumps if, the launcher has been moved off the stow position by air motors. Be sure the power system is off before using the air motors.

SAFETY IN THE USE OF HIGH PRESSURE COMPRESSED AIR

The highest pressures are used in the dud-jettison units. In the Mk 108 Mod 0 dud-jettison unit, air trapped by the underside of the piston at the end of the jettison stroke is nearly 15,000 psi. This charge returns the ejector to the position it had before jettison. Air from the 10o-psi ship's supply line passes to the positioner valve, but the pressure admitted at the charging valve is 3500 psi. The charging chamber acts as. a temporary storage for the pressurized air. The high pressure air is passed to both sides of the firing valve. Air can be vented from the chamber by a bleeder valve if the jettisoning operation is to be stopped.

Operation with such high pressures makes it essential that all tubing and flexible hoses be inspected periodically for weak points. Flexible hose should be replaced, regardless of condition, at expiration date (labeled at installation). Release pressure before disconnecting any high pressure lines.

Do not direct a high pressure air jet at any part of the human body; to do so may be fatal. Keep your face clear of any air outlet, air flask, or hose.

Do not use compressed air to clean air breathers. Compressed air is not effective as a cleaner.

Before unscrewing any of the filter plugs on the dud-jettison panel, close the manual shutoff valve, and be sure that the pneumatic lines leading to the dud ejectors are vented.

Before applying air pressure, be sure that all air connectors are secure; a loose air connection is dangerous.

The missile air flask is charged in the checkout area before mating of a Terrier or Talos missile. Permit only one man in the checkout area during charging of the air flask. Remain behind protective shields while charging the air flask, and for 5 minutes after charging. Do not charge or top-off more than one missile air flask at one time in the same checkout compartment. Never exceed the maximum stabilized air pressure of 3750 psi. Refer to the manufacturer's table of flask pressures and read the pressure from the air supply high pressure outlet gage, not the missile air flask gage. Discontinue checkout during rough seas. Bleed off air pressure before disconnecting the supply line. If it is necessary to remove the plug from the air fill valve, be sure that the air fill valve does not unscrew.

Be very sure you do not use compressed air where pressurized nitrogen should be used.

Immediately report any leak to the safety officer or the officer in charge of operations.

Inspect threads of couplings before mating. Make sure they are free of dirt, oil, and physical defects. Do not use light oils, benzene, or kerosene as cleaning or lubricating agents in a high pressure air system. These oils vaporize easily and form a highly explosive mixture with compressed air. Do not use oil on gages associated with pneumatic systems, and do not use oil gages on an air system.

Do not kink a high pressure line or hose, nor strike a fitting or an air line that is under: pressure. Do not attempt to loosen or tighten any high pressure connection while the system is under pressure.

PRESSURIZING AIR FLASKS, TANKS, AND BLADDERS

Some uses of compressed air in missiles and launching systems were mentioned in chapter 7. Depot testing of missiles with a pneumatic test set is briefly described. High pressure air is used for that test. Before energizing the equipment, make sure that all hoses are connected firmly both to the test set and to the missile. The hoses require replacement at stated intervals, and oftener if found defective. Inspect them each time before using.

Be sure that there is no oil or grease near high pressure air lines or fittings. High-pressure air and petroleum make an explosive combination.

Be careful not to come into contact with any of the compressor or discharge pipes as they operate at a temperature of around 200°F. Be careful not to get in the path of high pressure air; it is extremely dangerous.

Before applying air pressure to the missile, be sure all the connections are tight and the air hoses are attached to rigid supports.

Do not remove air supply lines to the missile while air supply is pressurized. Shut off the air supply at the test station and bleed pressure from the lines before removing the line from the missile. Do not strike a fitting or an air line that is under high pressure.

Do not attempt to loosen or tighten any high-pressure connection while the system is under pressure. Personnel must be thoroughly trained and checked out on a high pressure system before being authorized to operate the system.

Anti-icing systems use an air bladder to provide pressure for the hot water tank. It is charged to 10 PSI and not over 12 PSI. While servicing or troubleshooting the anti-icing system, be sure the launching system cannot be activated.

USE OF AIR PRESSURE GAGES

Gages used to measure pressure are described and illustrated in Basic Machines, NAVTRA 10624, and in Fluid Power, NAVTRA 16193.

Dropping a gage may permanently damage the calibrated units. When gages are not in use they should be stowed in a dry place.

Do not use oil on gages associated with pneumatic systems. Keep the gages clean at all times. Do not use an oil gage on air systems.

Carefully observe sequence of operations as outlined in the procedures to prevent damage to low-pressure gages, controls, and connections.

Keep pressures within safe range by frequent checks of the gages. Don't let the pressure become dangerously high before you do something about it. Relieve the pressure by means of a relief valve or switch and then look for the cause of the trouble and remove it. Do not open or close the valves rapidly, unless authorized to do so.

Use no oil when calibrating gages. Even a minute amount of oil is an explosion hazard in a high pressure air system.

On equipments where there is an installed air pressure gage, as in the dud ejector, be sure all air supply is closed off before attempting to remove any part of the equipment, such as the filters. Close the manual shutoff valve on the jettison panel, and be sure all air lines leading to the ejector are vented.

AMMUNITION AND EXPLOSIVES SAFETY

Because of the dangerous nature of munitions, you have been reminded of safety precautions with regard to explosives throughout your Navy career You should know the cautions and warnings quite thoroughly by now, and remind those with you of the rules.

HAZARD CLASSIFICATIONS

The hazard classification of each type of explosive has been determined through tests at firing ranges, research activities, and manufacturing establishments. The combinations of explosives used in missiles have also been tested. Shipboard, you will not be concerned with meeting the regulations of the Interstate Commerce Commission (ICC) for shipment of explosives, but at a depot, you must make yourself familiar with the ICC regulations on shipment of missiles and missile components. The color code painted on the ammunition indicates its hazard classification. The specific hazard classifications

and stowage compatibility are provided in OP 5, Ammunition Ashore, and OP 1631 Ammunition Hazard Classifications, Dimensions, and Weights. Be sure you have the latest revision. OP 2165, Navy Ordnance Shipping Handbook, gives instructions for packing and marking specific items. As new items are tested, instructions are issued to cover them.

Shipboard you check the condition of the magazine where the missiles and missile components are to be stored; at a shore base you check the buildings that are to be used. Different types of structures are used for munitions of different hazard classification. The distance between buildings, distance from occupied dwellings or offices, distance from roads or streets, and other specifications must be met. If you have duty at a shore base, you need to study the regulations that apply to the explosive components that you have to stow. There are many of them, but they are necessary because of the dangerous character of the materials being handled.

STOWAGE FOR SPECIAL TYPES OF EXPLOSIVES

The assembled missiles are stowed in the missile magazine of the launching system, as you know. The extra components, or spares, are stored in magazines and lockers according to their hazard classification. Throughout the text you have been reminded where to stow or not to stow.

PYROTECHNICS

One of the most frequent reminders concerns the stowage of flash signals and flares. All pyrotechnic items are easily actuated, and must be so in order to serve their purpose, but that also makes them very dangerous. While the quantity of explosives they contain is small, they are a terrible fire hazard. When handling any pyrotechnic items, grasp them securely to avoid dropping them. Do not disturb the actuating mechanism, whether it is a tear tape, a wire, or other device.

The flash signals used on missiles are treated as pyrotechnic ammunition. Like fireworks, they are easily set off and will quickly ignite other flammables nearby. Precautions are as follows:

1. Dissipate static electrical charges before they are able to reach pyrotechnics. Sparkproof shoes, tools, and other safety items should be used when working with pyrotechnics. The flash signals used on missiles are treated as pyrotechnic ammunition. Like fireworks, they are easily set off and will quickly ignite other flammables nearby. Precautions are as follows:

1. Dissipate static electrical charges before they are able to reach pyrotechnics. Sparkproof shoes, tools, and other safety items should be used when working with pyrotechnics.
2. Stow in a dry environment at all times. Moisture quickly deteriorates these munitions, rendering them completely unserviceable.
3. Stow pyrotechnic items well away from all sources of radio energy emissions such as from radar and antenna lead-in.
4. Always have readily available sufficient and proper firefighting equipment.

BOOSTERS. - To the inexperienced eye, boosters are inoffensive looking items. Nothing could be farther from the truth; they are deadly.

1. Never jar, drop, bump, or otherwise subject boosters to shock. They are sensitive to both shock and friction.
2. Never use nails to secure covers on boxes containing boosters - use screws on wooden boxes.

FUZES. - Fuzes contain delicate mechanisms and sensitive explosives.

1. Any fuze from which the safety pin has been removed must be considered armed. No exceptions are considered.
2. A fuze dropped from a height of 5 feet or more (when packaged) must not be installed. Set it aside and dispose of it as instructed. This may involve destruction or sending it back to the factory or depot. When not packaged, a drop of 1 foot or more is sufficient to require return or, if armed, disposition in deep water.

INERT MUNITIONS. - Inert munitions in-

clude such things as wings and fins, and dummy or training missiles. The weight and mass of inert ammunition require care in handling to avoid accidents. The weight can crush a man if it falls on him. Edges of wings and fins can inflict cuts. Dents or bends can cause erratic flight of the missile.

Exercise heads without the destruct charge can be stored as inert items. When the destruct charge is assembled into it, it must be handled as class A explosive, the same as a warhead.

Liquid Propellants and Fuels

The Talos missile uses a ramjet liquid fuel which is put in at the depot. This fuel is JP-5; it is flammable and its vapors form explosive mixtures with air. It is moderately skin irritating but its main danger comes from accidentally swallowing some of the fuel. Do not induce vomiting if fuel is swallowed accidentally, except on medical direction. Clothing contaminated by the fuel should be promptly removed, and the skin washed with soap and water as soon as possible.

The fire danger comes from fuel spills, fuel in storage, or burning fuel streams. Wipe up fuel spills promptly; sand and dirt will absorb spills. Do not allow accumulation of oily rags, waste, or papers.

Do not inhale vapors of the fuel. If the area is poorly ventilated have canister type gas masks or respirators at hand.

Shipboard you are provided with only enough JP-5 fuel to top off the tanks. Handle it with the same care as larger quantities store in a cool place, free of combustibles. Take care not to spill it on yourself or on the deck. Promptly clean up spills. Wear goggles or a face shield if fuel splashing is likely to occur. Wear non- sparking or static-conductive type shoes. Do not permit open flames or spark-making equipment in fuel-handling areas. This includes smoking paraphernalia (matches, lighters).

Be sure the missile is grounded to prevent static buildup.

Hydraulic fluid, fuel, or other flammables must not be stored in or near any space where explosive components will be stored or handled.

S&A Device

Every missile has an S&A device. In the assembled missile it is attached to the center of the warhead or the exercise head. The spare S&A devices are stored in the fuze and detonator locker or magazine, each one packaged in its container. Do not subject it to rough handling. An S&A device that has been dropped 5 feet or more (in its container) must not be used. Do not use an S&A device that has been dropped 1 foot or more when out of its container. Repackage the dropped unit and request disposition instructions from NAVORDSYSCOM.

Do not test or disassemble an S&A device.

Make certain that the S&A device is in SAFE condition (fig. 12-1). If it is found to be ARMED, it must be disposed of according to instructions from NAVORDSYSCOM (disposed of in deep water).

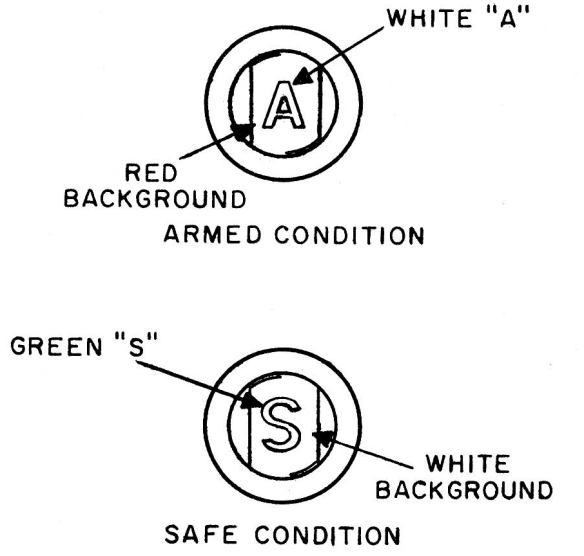
Do not attempt to force the arming mechanism into position, or tamper with it. Do not install a damaged S&A device.

The S&A device is connected to the warhead booster by a flexible explosive lead, similar to "primacord" in construction. It has an explosive-filled cup at either end for attachment. It should be handled and stored as a high explosive. Do not kink or strike the explosive lead, or try to stretch it to fit, or force it in any way.

Igniters

The igniter assembly is supported in the center of the headcap of the booster by an arming ring. It contains the ignition charge (black powder) and two ignition element diverters. In the armed condition, the squibs may be activated by electrical signals sent through contacts on the forward launching shoes of the booster. Figure 12-2 shows the ARMED and SAFE positions which you observe. Do not tamper with the arming mechanism. Handle it as a high explosive. Spare igniters are stored (in their containers) in the fuze and detonator locker. They are not tested aboard ship.

Verify that the booster arming device is in the SAFE position during all handling operations, and that the igniter assembly is in the non":



94.168

Figure 12-1.—Indicator window of S&A device; ARMED and SAFE conditions.

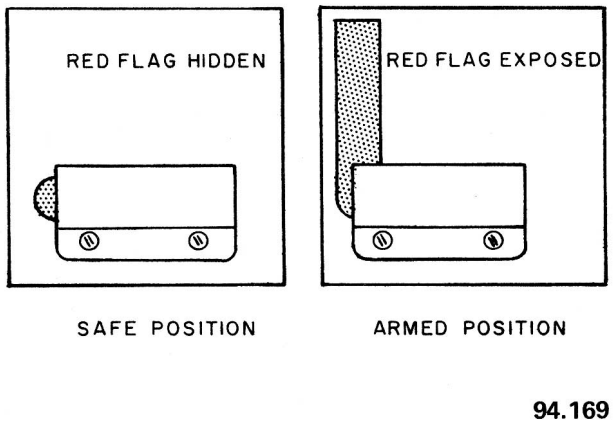


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Figure 12-2.—Igniter arm-disarm mechanism flags, SAFE and ARMED positions.

propulsive state when the booster is not mated to the missile.

Do not attempt to remove a defective igniter from a booster; request disposition instructions from NAVORDSYSCOM.

Do not apply heat to any part of the igniter assembly (welding, brazing, soldering, etc.).

Do not approach a misfire for at least 20 minutes. This time varies for different missiles; follow ship's doctrine.

INCREASE IN HAZARD THROUGH DETERIORATION

Explosives deteriorate because of moisture, heat, sun, cold (freezing), and age. The degree of damage varies with the type of explosive. To the above factors, physical damage may be added, Powdered propellant, for example, is much more dangerous than pressed propellant. It will catch, fire much more readily. It can explode. A crack in a propellant grain can cause uneven burning or it might cause it to explode instead of burn. Its behavior becomes unpredictable. That's why you must not use a booster that has been dropped. The same thing may happen to the; high explosive in the warhead; its behavior cannot be depended on. The shock of the fall can set off some of the very sensitive high explosives. A drop of only a few inches can trigger a detonator, or a fuze. Be very careful not to drop or bump any of these sensitive explosives.

Even with the best conditions, smokeless powder deteriorates with age. Its behavior becomes unpredictable. Therefore, age limits are set for missiles; the missiles are returned to a depot or factory after the expiration date.

Temperature limits are set for each type of missile. Exposure to excessive temperatures affects the explosives in the missile. Missiles exposed to excessive temperatures must not be used, but must be returned to the depot or factory for reworking. Exposure to a hot sun is one way in which missiles become overheated. This is more likely to occur on shore stations; than on shipboard, where you promptly strike down the missiles and missile components as they are delivered on the ship. Storage problems are compounded at an advance base. These are discussed in OP 4, Volume Ammunition Ashore, Advanced Bases. Instructions are included for stowage of pyrotechnics, fuzes, primers, igniters, boosters, detonators, tracers, and other components. If missiles have to be stored at such a base, they need to be given the same protection as bombs, rockets, and torpedoes. The problems will vary with the climate of the region, the shelters and the transportation

available, and other local factors.

The temperature and humidity limits for nuclear warheads are clearly defined in the Navy SWOP for each Mark and Mod. If there are nuclear warheads in any of your missiles, study the applicable SWOP and follow the regulations prescribed.

Excessive vibration can break down an explosive so it becomes dangerous. Cushioning of explosive components in containers, and blocking and bracing of containers are two methods used to reduce vibration. In overland transportation, such protection is especially necessary, but prevention of unrestrained movement is also necessary on shipboard. The missiles are secured in the trays in the ready service ring. The spare components must be securely stowed in their magazines so they cannot roll about.

SAFE TRANSPORTATION OF EXPLOSIVES

The Navy's safety record in transportation of explosives has been good; let's make it even better.

The rules for transportation of explosives and other dangerous articles are made by the Interstate Commerce Commission (ICC). The regulations are known as Agent T.C. George's Tariff (latest edition), and apply to shipments via common carriers (barges, trucks, trailers, railroad cars, boats, etc.). When you return missiles or components to be utilized, at least part of the way, and therefore ICC regulations apply, as well as Navy shipping regulations. Transportation by freight, express, or the Coast Guard (CG 108) is covered by the rules. The shipment of explosives in any form by mail is forbidden. The regulations are very comprehensive and specific. OP 5 (Volume 1), Ammunition and Explosives Ashore, Safety and Security Regulations gives thorough coverage to the rules.

Safety in transportation of explosives begins with the proper packaging. When you are preparing components for shipment, use the container designed or designated for each item and use the cushioning and blocking material made to fit the item and the container. It is not so much the quantity of cushioning used, as the fit and design of it. It is important to prevent movement of the item inside the container. A small amount of cushioning and bracing, snugly fitted, is more effective than quantities of loose material that can shift about.

During the packaging operation, safety precautions must be observed. Firefighting equipment should be at the ready. The smoking lamp is out. Handling equipment must be in safe condition. Nonsparking tools are to be used, and no spark- or heat-producing operation, such as welding, may be carried on in the space. As a general rule, metal containers should be kept grounded. Check the grounding requirements for the components you are packaging. In no case should a ground strap lie across, or be attached to, an umbilical connector of an assembly containing an explosive component. A warhead container must be grounded before inserting the warhead, and the warhead must be grounded while it is outside the container. Only authorized personnel may be in the area where the work is being done.

Motors must also be grounded during handling and packing operations. The container must be grounded before inserting the rocket (missile) motor (or opening and removing it). Do not get behind the motor, where you would be in the path of the blast in case of an accidental ignition.

Do not bring power lights or power cords near the motor. Use a safety flashlight to inspect the motor.

When packaging a nuclear warhead, follow the instructions in the applicable Navy SWOP. Mark the container in accordance with the SWOP. Containers of conventional explosives are marked according to ICC rules, This includes the hazard classification and the nomenclature.

Before closing a container, make sure that the explosive component is in the SAFE condition.

If you believe an explosive component is in hazardous condition and should not be shipped, get the approval of your officer to dispose of it in deep water, without delay.

If the container is a wooden one, use only nonsparking tools for driving the nails or inserting the screws for closing the container, and be very careful to drive the nails into the container only. If packing lists must be attached by nailing, use tacks that do not penetrate through the wood container.

The applicable OP gives the detailed pack-

aging procedure for each type of component. If the item is to be shipped by common carrier, the packaging must meet ICC standards as well as Navy standards. Pyrotechnics, for example, must be specially packaged to keep out moisture. One method used by manufacturers is to package the items in corrugated board cartons and seal out moisture with a paraffin dip. A number of cartons then are placed in an outer container of wood. Metal-lined wooden boxes may be used when there are no facilities for sealing the inner boxes.

Shipment

Whatever method of shipping is used, always make sure that the handling equipment is checked out just prior to use. Supervise the men closely and be sure there is no rough handling or dropping of any component. Do not neglect to follow up on any dropped item; the damage may not be visible to the naked eye, but it can be serious, even critical.

SHIPMENT BY COMMON CARRIER. - Many missiles and missile components are transported by truck, trailer, and/or railroad car. The components must be blocked and braced so they will not move about during transit. The quantity and type of material to be used has been computed by ICC to give a margin of safety. Follow the instructions laid down for the shipment of your packages or containers, even though the amount of blocking and bracing may seen excessive to you. It has to be strong enough to take care of contingencies that may occur.

Explosive items must not be left untended on the pier, dock, or loading platform and must not be left overnight.

The driver of the truck or other vehicle hauling the explosives must read and sign the safety instructions before he starts on his trip. He must know what to do in case of accident, breakdown, fire, or other emergency.

SAFE DISPOSAL OF DAMAGED EXPLOSIVES

Missiles deteriorate with age, and suffer damage from moisture, heat, shock, rough handling, or malfunction of components. Before the missile reaches a dangerous stage from deterioration, you package it in its container and return it to a depot for rework. Missiles damaged by rough handling, or by failure of a component, as in a dud, are also returned to the depot. Only if the missile is endangering the ship, as in a misfire that might explode on the launcher, is a missile jettisoned. No rule of thumb can be given; the danger has to be assessed on the spot and the decision made by the officer.

If the stability and compatibility of ammunition or an explosive is not known, it shall be given separate stowage, and instructions for Its disposal requested.

The preferred method of disposal of dangerous explosives is by dumping at sea, in deep water. If the material is not heavy enough, it must be weighted so it will not rise to the surface after dumping.

For routine disposal, authorization must be obtained from NAVORDSYSCOM. Explosive Ordnance Disposal (EOD) personnel and qualified graduates of the explosive Ordnance Disposal School may be called on in an emergency and, if no one is available, immediate disposal must be made by the commander and other ship's personnel. You can't wait for someone to tell you what to do in an emergency situation.

SAFETY FEATURES OF MISSILES

Most fuzes contain one or more safety features designed to prevent premature firing. When set at SAFE and packaged in containers, they are protected against stray radiation, but dropping them is always a hazard. Fuzes, primers, tracers, boosters, and detonators are all explosive hazards; they are sensitive to shock, friction, and heat. They must be handled with care at all times, and cushioned and supported against shock.

The arming plug is not added to the missile until it is in the assembly area preparatory to firing, and only one missile is armed.

The safing devices provided for explosive actuating circuits and components are designated by different terms: safety switch, arming plug, shorting clip, shorting plug, safing and arming device, etc. The purpose of each is to prevent the electrical impulse from reaching the explosive before time.

Grounding wires or straps are other safing

devices used on explosives containers and on explosive components while removing or packaging components and during tests and maintenance operations.

The safety devices on nuclear warheads are multiple. They are described in the Navy SWOPs applicable to each type.

RADIATION

Radiation dangers are of several kinds. Nuclear radiation is probably the most feared, but there is also radio-frequency (RF) or electromagnetic radiation. Electromagnetic radiation ay be further classified according to frequency as Hertzian, infrared, visible (light), ultraviolet, x-rays, and gamma rays. Cosmic radiation is a mixture, not completely identified.

NUCLEAR RADIATION

With so many of our missiles carrying nuclear warheads, many of our ship's crews live with nuclear dangers. The multiple safety devices on each weapon make accidental detonation almost impossible, but there is always the chance of human errors. The accidents that have occurred have been due to carelessness or neglect by the men handling the weapons. Neglect in checking of handling equipment has been a prominent cause of incidents. Improper procedure in removing or installing a warhead is another common cause of incidents. There has never been an accidental full scale nuclear detonation but there have been many cases of incidents. Each one is investigated and reported. When you read the reports of the investigations (your publications custodian will have them), you can readily see that observation of simple safety rules would have prevented almost all of them.

A bulletin published quarterly, Nuclear Weapons Safety, discusses various aspects of nuclear safety, safety of particular weapons, results of NTPIs and NWAIs, and analysis of incidents. Most of the issues are classified Secret. They can give you valuable information to aid your safety program, and your plans for drilling your men in safe procedures.

Detection and Measurement

The instruments used to detect and measure nuclear radiation are called Radiac instruments, meaning Radioactivity, Detection, Identification and Computation. Different types of instruments are used for different purposes. Those used to measure radiation after a nuclear attack or an accident are survey instruments. On nuclear submarines, installed equipment monitors the air continuously. Continuous monitoring of nuclear weapons storage spaces on surface ships is no longer required. Portable radiac instruments are used in the shops, assembly or checkout areas, and storage areas when anyone is working in the area. The instructions for operating the monitor are packed in the carrying case with it. Since many ships have no GMTs aboard, you will need to learn how to operate the instrument. The IC/T2-PA is a portable meter that can be plugged into an, 115-V a-c, 60-hertz outlet. It has an audible alarm that is triggered by the presence of radioactive particles in the air. Monitoring of individuals who are believed to have received some radiation is done in the medical department.

The medical department also keeps records of the amounts of radiation received by individuals. Decontamination of the ship is done by Hull Technicians and under their supervision. Control of day-to-day contamination in the missile spaces is your responsibility. Minor spills of nuclear material can be wiped up with absorbent paper and the wipes placed in the can for contaminated waste, which is later disposed of at sea. The waste may not be burned, as fire does not destroy radioactivity. Wear protective gloves while cleaning up. Other personnel should be sent out of the area until the cleanup is finished and the radioactivity is reduced to a safe level.

In case of a major spill evacuate the area, close it off, and send for the decontamination team. They will wear protective clothing and OBAs.

Protection Against nuclear Radiation

The use of protective clothing and of shelters, and the methods of decontamination are described in Basic Military Requirements, NAVTRA 10054, with regard to nuclear attacks, where there are massive quantities of radiation.

However, the same care must be exercised when the quantities of radiation are much smaller, as in a slight incident with a nuclear warhead. Constant association with the deadly nuclear giant may make you careless and complacent. Don't forget that the danger is always there, even though surrounded by numerous safeguards. Prevention is the best protection.

Peacetime Safety Rules

Fear of nuclear radiation from nuclear weapons is worldwide; every nuclear warhead is viewed as a potential cause of another Hiroshima. The need for extreme caution in peacetime operations with nuclear missiles is obvious. Safety rules were developed by all the services and were written into the Navy SWOPS and the check lists and the MRCs for each missile and nuclear weapon. The standards set up by OPNAV to be applied in all the studies setting up the safety rules were:

(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 ensure adequate security.

These criteria were observed in preparing the nuclear weapons peacetime safety rules. It was also recognized that information to the public is of great importance to allay fears. Definite rules and procedures have been established for the informational angles in case of an accident or incident. OPNAVINST 8110.16 gives those instructions. The most recent revision consolidates a number of instructions and documents on nuclear accidents and incidents. Your CO is responsible for preparing releases in case of an accident or incident, but you should be aware of what is required.

RF OR ELECTROMAGNETIC RADIATION

Chapter 8 told about the studies made under the HERO and RAD HAZ programs to discover the dangers of RF radiation to people, explosives, and fuel. The tests and studies are being continued, and any changes in the rules will be published as changes to the basic OP 3565. NAVORD has the responsibility for making the changes.

Ordnance Protection

Sources of RF radiation are the communication equipment and the radars. The majority of the ordnance systems tested have proven to be HERO SAFE and HERO RELIABLE if just a few general precautions are followed. An assembled Tartar or Talos missile is HERO SAFE, but HERO UNSAFE when being tested disassembled. Radar transmitters must be silenced during operations when missiles are HERO UNSAFE. If within the distance limits, radar transmitters on other ships must also be silenced. The minimum safe distance for a particular radar may be looked up in OP 3565, (Technical Manual Radio Frequency Hazards To Ordnance, Personnel, and Fuel). Greater stand- off distance is required for ships with large amounts of transmitting equipment, such as command ships, and communication ships.

Avoid touching any exposed firing contact, wiring, or other exposed circuitry with the hand or any metal object or structure such as a metal steering hook, or screwdriver.

To prevent accidental touching of electrical connector pins, cover the connectors with non-metallic caps.

Do not expose internal wiring or firing circuits by unnecessary disassembly.

Electrically insulate all steering hooks or loading hooks used with loading cranes, booms, burtoning wires, etc. Use nonconductive rope, strain insulators, or similar material.

When handling missiles with nuclear warheads, follow the SWOP checklist exactly.

HERO UNSAFE ordnance, such as flash signals, igniters, tracking flares, unshielded rocket motors, warheads, and exercise heads,

should not be stored in the same space with exposed electronic transmitting apparatus or with any exposed antenna or transmission line. Transport all HERO UNSAFE ordnance in completely enclosed metal cases whenever possible. Unshielded items are not permitted on the weather deck or the flight deck. As far as possible all handling should be below decks.

A missile that is HERO SAFE in the assembled state, becomes HERO UNSAFE or HERO SUSCEPTIBLE in different stages of disassembly.

The auxiliary power supply (APS) of a Tartar missile may be ignited by RF radiation when it is undergoing test or disassembly on the launcher. Stay at least three feet from the APS ports when standing in direct line with them.

Personnel Protection

The Bureau of Medicine and Surgery has established safe limits of RF radiation to humans based on the power density of the radiation beam and the exposure time of the human body in the radiation field. The nonthermal effects on the body are still being studied.

The Naval Ship Systems Command has the responsibility for determining the hazardous shipboard areas and ensuring that the RF radiation hazard to personnel is minimal, or nonexistent. All hazardous areas are posted with warning signs, and the ship's intercommunication system is used to warn personnel when the radars are operating. Observe the warning signs and avoid centering those areas. Some of these areas will be permanently marked, and others temporarily.

Fuel Hazards

Volatile fuel-air mixtures are most likely to occur near aircraft fuel vents, open fuel inlets during over-the-wing fueling, and spilled gasoline. Obviously, the most danger of fuel ignition by RF radiation is on aircraft carriers. The danger of fueling with IP-S (which you use to top off the liquid fuel container of the Talos missile) is not considered significant. The use of nonsparking equipment reduces any hazard.

OTHER RADIATION HAZARDS

You are bombarded with cosmic rays whenever you are in the open air. Whether this is good or harmful has not been proven. It is known that overexposure to the sun is harmful. Frequent suntans can cause skin cancer.

Overexposure to X-rays is a cause of cancer. Early experimenters with X-rays did not know this and many of them succumbed to cancer. Doctors now are careful not to u an excess of X-rays. Each man's medical record lists the dates when X-rays were taken, so there is no duplication or overexposure. The technicians who take the X-rays must step behind a lead curtain to protect themselves while they are taking the X-rays.

Luminescent paints that contain radium emit rays constantly. There is no record that anyone wearing a wrist watch with a radium dial received enough radiation to be harmed; the workers who painted the dials were the ones who died of bone cancer.

GASES, VAPORS, AND TOXIC MATERIALS

There are so many poisonous and toxic materials all around us, maybe we sometimes wonder how we manage to escape. We will review only those that are a particular hazard in association with military life.

CARBON DIOXIDE

The use of carbon dioxide as a fire extinguisher in missile magazines makes it an ever present hazard. The dangers were discussed in chapters 8 and 10. The use of CO_2 extinguishers, portable and installed, was discussed in Basic Military Requirements, NAVTRA 10054, in connection with damage control on shipboard. No mention is made in that text of the CO_2 installations in missile magazines. Although CO_2 is not toxic, it displaces air and kills by suffocation. Since it has no odor, a man can be overcome before he realizes what is happening to him. The warning system attached to the missile magazine CO_2 system must always be in

operating condition. If the warning system indicates that the CO_2 system has been activated, do not enter the magazine until it has been thoroughly ventilated. If it is necessary to enter the magazine before it is completely free of CO_2, be sure to wear an OBA or an airline mask. A filter mask may not be used, as it does not filter out the CO_2. Do not use a canister type gas mask. Always have a person posted outside the magazine to render assistance.

Before anyone is allowed to go into a magazine with a CO_2 installation, make sure the supply of CO_2 is shut off. Disconnect the control and discharge heads and cap the connection to the supply tanks, before entering the magazine. Just closing the valves is not enough; they can be opened accidentally. Be sure the CO_2 supply cannot be turned on while anyone is in the magazine. Immediate application of artificial respiration is necessary for anyone overcome. The standby observer must be qualified to give artificial respiration. Brain damage results if the brain is without oxygen for even a few minutes; therefore speedy resuscitation is necessary.

CARBON MONOXIDE

Carbon monoxide (CO) is odorless and colorless but its effects are deadly. It results from smoldering fires, exhaust gases, or whenever carbon burns. As little as 9 parts of gas in 10,000 parts of air will cause nausea and headache, and slightly larger amounts will cause death. It may cause headache before unconsciousness comes, but in most instances the person becomes drowsy and then unconscious. One symptom that distinguishes carbon monoxide poisoning from other types is the bright cherry-red color it often causes in the skin, lips, and the eyes and inner edge of the eyelids. Death results quickly. Before entering any space that has been closed, ventilate it, or check the air for gases, or wear an OBA or an airline mask if you must enter the space. Remove a victim to fresh air before giving artificial respiration, but it must be done quickly. Methods of artificial respiration are described in Standard First Aid Training Course, NAVTRA 10081.

EXHAUSTS FROM MISSILES

The exhaust from missiles is a double threat- from heat and from the noxious quality of the gases. The APS gas generator is classed as a fire hazard and the gases produced are toxic and may be explosive if confined.

The blowout pipe in the checkout area must be connected to the missile during checkout. If there is an accidental ignition, the exhaust is ported out through the blowout pipe.

The deck area near a launcher must be cleared before a missile is to be fired.

At all times, personnel should keep clear of the exhaust cone of a missile motor.

Keep clear of the exhaust vent of a missile magazine. If you have to pass the vent, do so quickly.

The blast doors must not be opened when there is a missile on the launcher.

MISSILE FUELS

At present none of the missiles you handle use "exotic" missile fuels. The precautions for solid missile propellants and the liquid fuel used for the Talos missile have been reviewed. The prepackaged liquid fuel used in the Bullpup missile would be a fire' hazard if a leak developed. If you have these missiles aboard, follow the rules for handling as given in the OP for the missile.

OXYGEN, HYDROGEN, NITROGEN, AND OTHER GASES

Although oxygen, nitrogen, and some carbon dioxide make up the air you breathe the safety precautions are concerned chiefly with compressed gases obtained either from ship's lines or from tanks. For stowage purposes, ALL compressed gases of ANY type are classed as dangerous materials.

So much injury and damage can be and has been caused by mistaking one gas cylinder for another that a national program has been established to make it almost impossible to confuse cylinders. The identifying features include the color code for painting the cylinders, the name of the gas stenciled along two sides of the cylinder, two identifying decals placed on the shoulder of the cylinder, and a code letter (X for oxygen). With all these ways of identifying the

contents of a cylinder, there should be no excuse for making a mistake.

OXYGEN. - Because oxygen makes explosive combinations with many substances, especially the hydrocarbons such as oils, fuels, and greases, compressed oxygen is not supplied to missile Spaces.

NITROGEN. - Compressed nitrogen in cylinders is one of the expendable materials supplied for your work. Where ship's nitrogen is available, nitrogen in cylinders is not supplied.

Although nitrogen is not toxic, it can asphyxiate you if it replaces all the oxygen in the air. It is an inert gas and does not support combustion. The rules for safe handling and stowage of cylinders of compressed gases apply.

If a nitrogen tank must be disconnected for repairs, as in the dud jettison device, be sure it is vented to the open air before you disconnect any lines.

HYDROGEN. - Hydrogen is classed as a fuel gas; the cylinders are painted yellow with a brown band at the shoulder. It is highly flammable, and will explode if it is mixed with air (5 to 75% by volume) and contacts red hot metal, sparks, or flames. It is used for underwater welding and cutting operations, and for inflating barrage balloons. Liquid hydrogen is used for fuel in some missiles. Normally, there will be no hydrogen storage cylinders in missile spaces.

WAR GASES

The different gases used against the enemy are discussed under NBC warfare in your military texts as chemical warfare. Some are intended to be deadly and others are merely incapacitating. All major nations have arsenals of these agents. Since World War I, fear of reprisal has prevented the use of fatal agents or those producing permanent disability. The use of materials that disable temporarily has increased.

G Agents

Gases that affect the nerves are called "G" gases. There are several kinds, all deadly in a short time. As part of your disaster control training, you need to recognize the symptoms they cause, as they cannot be detected with any certainty by the senses. They can be detected with a special chemical kit, but this is of doubtful value because it would delay donning of a protective mask.

CHEMICALS

Some chemicals are dangerous in themselves and others become dangerous when they contact other materials. Some may not be stored near flammable materials. For stowage purposes, they are classified as safe, semisafe, and dangerous (NAVSHIPS Technical Manual). The semisafe materials are considered safe unless the container is opened or there is leakage. Many of the acids are included in the category - they are safe unless spilled, and are not explosive or highly flammable. Trichloroethylene, which you use for cleaning, is classed as semisafe.

Dangerous chemicals include all the compressed gases and materials involving considerable fire hazard or having other dangerous characteristics, whether in containers or not. Electrolytes, both the acid and the caustic types, and many of the cleaning compounds, such as methanol, Stoddard solvent, and toluene, are listed as dangerous.

Naked lights and spark-emitting devices must not be used in compartments containing semisafe or dangerous materials. Sodium igniters must not be fought with water; therefore stowage spaces for sodium igniters must not be equipped with sprinkling systems. Other ammunitions that must not contact water are white phosphorus, smoke pots, torpedo torch pot, and flash signals. An OBA must be worn when smoke-producing chemicals or munitions are in a fire.

OTHER TOXIC MATERIALS

Many mixtures, compounds, gases, and chemicals that you use or come in contact with rather frequently are unsafe if improperly used. Among these are batteries, cleaning solvents,' epoxy compounds and their solvents, vinyl resin adhesives, and certain chemicals. Many of these materials are used in repair and maintenance work.

A few materials are so dangerous, chiefly to human life, that they are not permitted aboard ship. These are: DDT xylene emulsion, hydrocyanic acid gas, methyl bromide, and carbon tetrachloride.

Broken fluorescent lights present an additional danger of poisoning. The mercury vapor sealed into the lights is poisonous to breathe. Dust from the coating on the interior of the lights is poisonous to inhale, and is also dangerous if it gets into cuts or abrasions. A number of fatalities have been traced to cuts received while disposing of broken fluorescent lights. Place the defunct fluorescent tube in the empty container which held the replacement. Do not break it up.

BIOLOGICAL AND CHEMICAL WARHEADS

These warheads are not carried aboard ship except by special authorization from NAVORDSYSCOM or higher authority, and then they are accompanied by trained personnel. However, you must know how to protect yourself against such attacks by the enemy, or possible accidental rupture and spilling of those on board. They are built in a very rugged way and careful handling will prevent accidents with them. If you have any of these special warheads aboard, you will be given special training in detection and decontamination techniques, and handling of emergency equipment.

If any biological or chemical agents are spilled or released don a protective mask immediately and move upwind from the source. The VX nerve agents are absorbed primarily through the skin, and a mask is therefore not effective against those deadly agents.

Self-protection and first aid methods for each type of BW/CW agents are given in brief in Basic Military Requirements, NAVTRA 10054 and more fully in Disaster Control (Afloat and Ashore), NAVTRA 10899 and in Standard First Aid Training Course, NAVTRA 10081-B. In your shipboard training exercises, you will probably have to give first aid drills for simulated attacks with different types of gases.

FIRES

Fire at sea is a dreaded catastrophe. You have received training and drill in fire prevention and fire fighting since you came aboard. Now it is up to you to organize and administer a safety program applicable particularly to your missile system. Preventing and fighting fires is a big part of that program.

Some of the worst holocausts on shipboard started in the ammunition or explosives. The sprinkler systems in the magazines usually can take care of the stocks in the magazines (if they are turned on soon enough). Careless handling and transportation of explosive components is a frequent cause of explosions and fires. You learned about the use of different types of fire fighting equipment in Basic Military Requirements, NAVTRA 10054 and which was best for Class A, B, or C fires.

FIRES IN EXPLOSIVES

When the missiles are assembled and stowed in the magazine, they are protected against fire by automatic sprinkling systems, water injection systems, and carbon dioxide flooding systems, When the missiles are partially disassembled in the checkout area, you have to depend on portable extinguishers and fire hoses. On the launcher, you again have to depend on these two methods, and you may have, in addition, foam and fog nozzles.

If the missile contains a nuclear warhead, extraordinary efforts must be made to prevent detonation. Keep away any nonessential personnel and make every effort to cool the missile to a temperature below the detonation point (below 300°F). Foam spread over the entire weapon will radiate heat away from it and protect the weapon from nearby flames (if the weapon itself is not in the fire). Do not break the blanket of foam with streams of water. When fighting fire involving explosives, seeks as much cover as possible and do not expose yourself unnecessarily to intense heat, flying fragments, and possible explosions.

All personnel who have helped with the fire fighting or have been in the area must be monitored for contamination. Any who have received nuclear contamination must go through the decontamination showers. Eating, chewing, drinking, and smoking must be forbidden in the area. where contamination may be present. A decontamination team may be called to decon-

taminate the area. Any missile, nuclear or conventional, that has been in a fire must be returned to a depot.

If the fire or accident with a nuclear warhead is below decks, it is extremely important to prevent the spread of nuclear contamination to other spaces. Close the ventilation system immediately and turn off any fans in the space. You will need to hold drills so your men will know what to do in case of a fire or accident. Study the Navy SWOPs for the latest rules on what to do when a nuclear component is involved. OBAs are required for any firefighting, rescue, or salvage operations below decks in case of accident or incident with nuclear warheads.

Each ship must train teams for nuclear, biological, and chemical monitoring and decontamination. They perform in case of attacks or accidents. Special teams may be called aboard to assist and direct the shipboard teams. The widely publicized episodes in which nuclear weapons were accidentally dropped over foreign soil show the extent of responsibility and involvement Of our government. At the same time, it showed how safe the weapons are - there was no detonation although the weapons were dropped from a considerable height. However, our government is still paying damages for the one that broke open and spilled nuclear material on the farms and gardens of the area.

For nuclear accidents aboard a ship there are two broad areas of responsibility. One is responsibility for the action taken by the ship and the other is the responsibility of the appropriate commander ashore.

ELECTRICAL FIRES

General cleanliness of the work area and of the electrical and electronic apparatus is essential for prevention of electrical fires. Oil, grease, and carbon dust can be ignited by electrical arcing. Electrical and electronic equipment should be kept absolutely clean of all such deposits. Wiping rags and other flammable waste material must always be kept in tightly closed metal containers, which must be emptied at the end of the day's work. Containers holding paints, varnishes, cleaners, or other volatile solvents should be kept tightly closed when not in actual use. They must be stored in a separate compartment or locker.

In case of electrical fire, deenergize the circuit and then use the CO_2 fire extinguisher, directing it at the base of the flames. Never use carbon tetrachloride for fire fighting since it changes to phosgene (a poisonous gas) upon contact with hot metal. The application of water to electrical fires is dangerous. Foam type fire extinguishers should not be used on electrical fires as the foam is electrically conductive.

When selenium rectifiers burn out, fumes of selenium dioxide are liberated. These fumes are poisonous and should not be breathed. Deenergize the equipment immediately and ventilate the space. Do not attempt to remove the rectifier until it has cooled; a burn from a hot rectifier might result in the absorption of some of the selenium compound, with serious results.

When using the fire extinguisher, do not allow the tip to touch the electrical panel or energized equipment. The "snow" that forms on the tip should not be touched; it will burn the skin.

SUMMARY

This chapter brings together the safety precautions of all the chapters and adds some that did not fit into any particular place in the text. I t is not possible to write rules that will cover all the situations that might occur on a ship or ashore in connection with missiles and their launching equipment. The introduction of nuclear weapons added much to be learned about the effects of nuclear detonations and the best methods to circumvent or remedy the bad effects. The public disaster aspects are covered in other texts. Since GMMs are responsible for handling missiles with nuclear warheads, they must know the safety rules to avoid nuclear accidents or incidents. Much of the necessary information is beyond the scope of this text, and may be found only in the Navy SWOPS. Study them carefully and apply the rules with meticulous exactness.

Zeal in observation of safety rules should be unflagging. Don't let the desire to be popular, with your men mislead you to be lax in enforcing the rules. Temporary thoughtlessness or impatience will give way to the clear appreciation of the need for adhering to the rules at all times.