is considered to be the threshold of potentially dangerous R.F. radiation. Power densities approaching or exceeding the above figure are at present found primarily in the highly concentrated narrow beams of the high gain type antennas used for radars. A definite hazard exists from such radar beams, especially since the advent of fire control and missile guidance radars which can be depressed to low angles and are mounted at low levels on shipboard, thus making it probable that the main beam may be directed at personnel on the various decks. Other possible sources of high power density fields that could be hazardous are waveguide openings and feed horns during servicing or repair operations. The following precautions should be taken to insure that personnel are not exposed to power densities exceeding the 10 mw/cm^2 safe working level:

(a) Visual inspection of feed horns, open ends of waveguides and any opening emitting high energy R.F. electromagnetic energy will not be made unless the equipment is definitely secured for the purpose of such an inspection.

(b) Personnel engaged in servicing radar equipment who are required to remain in the vicinity of the primary beam should wear wire mesh goggles or other approved types.

(c) Aircraft employing high power radars shall be parked, or the antenna rotated, so that the beam is directed away from personnel working areas.

(d) When operating or servicing a shipboard radar, operating and maintenance personnel shall observe all R.F. radiation hazard signs posted in the operating area to insure that the radar is operating in such a manner that personnel on deck or in the superstructure are not subjected to hazardous levels of R.F. radiation.

(e) All personnel shall observe R.F. hazards warning signs which point out the existence of R.F. radiation hazards in a specific location or area.

2-15-17 X-RAY RADIATION HAZARDS FROM HIGH VOLTAGE ELECTRONIC EQUIPMENT.

a. General. When high velocity electron beams strike metal or other materials, x-rays are produced. The operation of some electronic devices depends on the acceleration of electrons, and when the accelerating voltage approaches or exceeds 15,000 volts the production of x-rays may become a hazard to personnel. Examples of such electronic devices are magnetrons, klystrons, thyratrone, cathode ray tubes and high voltage rectifier tubes. Currently, radars are about the only electronic equipment that use sufficient voltage on these devices to constitute a hazard. The x-rays produced by accelerating

potentials on the order of 15,000 volts are not hazardous beyond a foot or so from the source and do not require elaborate shielding to make the device safe for nearby personnel. However, as the accelerating potentials become greater than 15,000 volts, the x-rays produced have much greater energy and the difficulty of providing adequate shielding increases appreciably.

b. Servicing Electronic Devices That Produce X-ray Hazards. When performing preventive or corrective maintenance on electronic devices that produce hazardous x-ray radiation as an undesirable by-product, the following precautions should be observed by maintenance personnel:

(1) Observe all warning signs on the equipment and all written safety precautions in the instruction manuals for the equipment that deal with x-ray hazards.

(2) Do not jumper interlocks that permit the servicing of operating equipment with the protective x-ray shielding removed, unless such procedures are called for in the instruction manuals.

(3) Be sure to replace all protective x-ray shielding when servicing is complete, so that operating personnel or others will not unknowingly be subjected to harmful x-ray radiation.

(4) When bench testing x-ray producing electronic devices be sure that adequate x-ray shielding is provided to protect all personnel in the testing area.

(5) Determine the latest safety precautions to be observed by maintenance personnel, including the use of the latest approved dosimeters, by consulting the ship's safety officer on shipboard or the industrial hygienist at shore installations.

2-15-18 WORKING ON ANTENNAS.

a. Cautions to Personnel. Division officers shall caution all men in their division not to venture or work close to an exposed radio or radio antenna unless it is first determined from the proper authority that the antenna is not and will not be energized. (See also article 2-15-16.)

b. Working Aloft. Before any work may be done on antennas aloft, authorization must be obtained from the Commanding Officer. While antennas are energized by transmitters, men shall not be permitted to go aloft except by means of ladders and platforms rendered safe by grounded hand rails or similar structures (and men shall be cautioned about smoke stack gases). Before sending men aloft, except as noted above, the Commanding Officer shall direct the communication

watch officer to secure the proper transmitters in order to render this area safe, and shall notify the engineering duty officer that men will be working in a prescribed area aloft in order that the engineering duty officer may take the necessary precautions to prevent the boiler safety valves from lifting. Until he has received a report from the communication watch officer that the proper transmitters are secured, the Commanding Officer shall permit no man to go aloft. After the work has been completed, a report shall be made to the Commanding Officer, and his authorization must be obtained before the circuit is again energized.

c. Danger From Rotating Antennas. Radar and other antennas which rotate or swing through horizontal or vertical arcs may cause men working aloft to fall. Therefore, the motor switches which control the motion of these antennas should be secured or locked in the open position and suitably tagged before men are permitted to ascend or go within reach of the ~~Antenna~~ ANTENNA.

d. Antenna Poles. To secure antenna pole guys, see article 2-6-5 for rigging precautions and article 2-6-7 for wire rope safety.

e. Safety Belts. Safety belts shall be worn by all personnel climbing radio antenna towers and radiators and other types of towers over 30 feet high. Where ladder climbing safety devices are provided on such towers, a special safety belt shall be provided with an appropriate connection and shall be used by workmen when ascending or descending the tower. Such a special safety belt and connection shall be in accordance with specifications given in the "Safety Equipment Manual," NAVEXOS P-422. Except when the ladder safety device is used, the safety belt shall be tied off to a life line when working from ladders at heights of 10 feet or more above the ground and/or deck.

f. Antenna Tower Ladders and Platforms. Fixed ladders and platforms on antenna towers of all types shall be constructed in accordance with the latest issue of American Standards Association Safety Code for Fixed Ladders, A14.3, and as further specified in ship's plans.

2-15-19 CATHODE-RAY TUBES. Cathode-ray tubes are highly evacuated. These tubes shall be handled with extreme care. If a cathode-ray tube is broken, the relatively high external pressure will cause the tube to implode (burst inwardly), which will result in metal parts and glass fragments being expelled violently.

a. Handling. In handling, the tube shall be removed and replaced in the packing box with extreme caution (do not drop). The tube face, particularly the rim, must not be struck, scratched, or subjected to more than moderate pressure. When a cathode-ray

tube is removed from a unit, it should not be allowed to remain exposed to damage or shock on work benches, etc., but should be immediately placed in the container provided for that purpose or in the container that held the replacement tube.

b. Maintenance. Maintenance or installation personnel shall wear safety glasses and gloves when handling cathode-ray tubes. When removing or inserting tubes in equipment sockets, use only moderate pressure; do not jiggle the tube or stand directly in front of the tube face. Any securing clamp around the rim or face of the tube shall be carefully secured.

c. Disposal. Defective tubes shall be stored or destroyed in such a way that no damage results to personnel. In addition to the danger involved in implosion, the inner coatings of some tubes are poisonous if absorbed into the blood stream.

2-15-20 RADIOACTIVE MATERIALS USED WITH RADIAC EQUIPMENT. There is a large variety of types and sizes of radioactive material used in calibrating or checking radiac equipment. The use of the larger sources is restricted to authorized radiac repair facilities. Prior to using a new source assigned to such a facility, the person in charge of the facility shall review its installation and operational procedures with cognizant health or safety personnel and receive from these or other appropriate local personnel authority to install and use the new source. Areas where these sources are used shall be restricted to authorized personnel only and shall be adequately marked. Smaller sources, although also of possible danger, are supplied with equipment for the purpose of field checking the instruments. Proper use or handling of these sources is covered in the technical manuals for the equipment with which they are supplied. If these instructions do not cover the proposed use of the source under consideration, its proposed use should be referred to local health or safety personnel. Even in storage, radioactive materials may be harmful to personnel and may expose unprocessed photographic and radiographic films and papers. Precautions must therefore be observed constantly to protect personnel and vulnerable materials from these radiations. More detailed information on the handling and storage of radioactive material and the safety precautions to be observed is contained in NAVMED P-5055, "Radiation Health Protection Manual," and various Bureau of Standards Handbooks, particularly Numbers 42, 48, 59, and 69.

2-15-21 ELECTRON TUBES CONTAINING RADIOACTIVE MATERIAL.

a. General Precautions. The handling, storage, monitoring, and disposal of electron tubes containing radioactive material shall be in accordance with the procedures of NAVMED P-5055.

b. Monitoring. Areas where electron tubes containing radioactive material are stored should be monitored once each week. Where the maximum permissible level of radiation is exceeded, the stocks of tubes should be broken down into smaller quantities or moved to other areas where personnel exposure is reduced to permissible levels. Areas, such as floors, shelves, bins, and benches, where electron tubes containing radioactive material are stored or handled should be wipe tested every six (6) months. When required, decontamination should be accomplished in accordance with NAVMED P-5055.

c. Handling. The hazard of handling electron tubes containing radioactive material individually is primarily that of contamination of personnel and surrounding material with radioactive fragments resulting from breakage. In the event of breakage, approved methods of monitoring, decontamination and disposal shall be employed. Under no conditions should unauthorized persons handle broken or unbroken electron tubes containing radioactive material.

d. Storage. Areas where electron tubes containing radioactive material are stored shall be conspicuously marked with the radiation warning symbol approved by the Atomic Energy Commission. Unauthorized personnel should not be allowed in the area.

e. Disposal. Broken and useless unbroken tubes containing radioactive material, such as radiac spark gap, TR, glow lamp, or cold cathode tubes should be treated as any other radioactive waste material and disposed of in accordance with instructions issued by the Atomic Energy Commission or the cognizant bureau or office of the Navy. Spark gap, glow lamp, and cold cathode tubes which contain radioactive radon gas are preferably disposed of intact. If breakage of such tubes is considered necessary, it should be done under a ventilated hood. Any equipment or tools used in crushing tubes or handling the resultant radioactive waste should be thoroughly cleaned after each use. Material that cannot be effectively decontaminated should be disposed of.

2-15-22 ELECTRICAL APPARATUS.

a. Repairs. All electrical wires and apparatus shall be treated as dangerous and must be worked on by qualified personnel only.

b. Shock. Precautions should be taken against working in a position in which a shock or slip might place the body of an employee in contact with exposed electrical, energized parts.

c. Insulated Floor. Any areas in and around high voltage equipment shall be provided with an insulated floor surface and shall be clearly marked with high voltage warning signs.

d. Artificial Respiration. Persons working with or around high voltages should familiarize themselves with artificial respiration methods.

e. Interlock System. Where guarding of high voltage equipment can not be made effective, a suitable interlock system should be used. If the nature of the work is such that an interlock system cannot be used, then personal protective equipment such as rubber gloves, insulated tools, etc. shall be employed with a helper standing by to cut off the power.

f. Burns. Do not touch high frequency circuits, as the arcs may cause deep burns.

g. Connections. Connections shall not be made or broken while the circuit is energized. Turn the power off first.

h. High Frequency Fields.

(1) Do not place parts of the body in strong high frequency fields. They produce heat at a high rate.

(2) Rings, watches, bracelets, and other metal objects should not be worn close to high frequency fields as they may become hot in a short period of time.

(3) Areas in or around high voltage equipment shall not be used for thoroughfares, storage space, or working space.

i. Cathode Ray Tubes. Cathode ray tubes must be kept in the original cartons until installed in a piece of equipment. Tube mounting operations should be isolated to protect other employees and the operators should wear face shields, leather aprons, and gloves.

PART 2
GENERAL SAFETY PRECAUTIONS

CHAPTER 16
POWER TRANSMISSION

SECTION I - MECHANICAL POWER TRANSMISSION APPARATUS

SECTION II - BOILERS (FIRED PRESSURE VESSELS)

2-16-1 **UNINTENTIONAL TURNING OF ENGINES.** Precautions against the unintentional turning of an engine must be carefully observed before overhauling operations are begun.

a. Main Engine Clutch. Electric, pneumatic, mechanical and/or hydraulic clutches when installed shall be disengaged.

b. Jacking Gear.

(1) The jacking gear should be engaged on an engine which is connected to a propellor shaft by a hydraulic clutch, if:

(a) the main motors in the compound drive have been started,

(b) the ship is underway.

(2) Prior to the start of repair work, jacking gear and/or shaft securing devices shall be engaged on ships with main motors and generators, or straight drive and/or reduction geared engines.

(3) When jacking gear has been engaged, the electric controls shall be locked out and tagged.

2-16-2 RELIEF VALVES.

a. As Trouble Indicators. If one of the relief valves on the working cylinders or on an air compressor blows several times, the engine or air compressor is to be stopped and the trouble corrected.

b. As Safeguards Against Fire and Explosion. Pressure relief mechanisms shall be fitted on enclosures where the ignition of oil vapor may possibly occur. The designated dimensions and adjustments are to be strictly followed.

c. Locking. Relief valves are never to be locked in a closed position except in case of emergency.

2-16-3 AIR LINES. When the engines are stopped, starting-air and spray-air lines must be vented. Serious accidents may occur if the pressure is left on.

2-16-4 FUEL OIL AND LUBE OIL STRAINERS. Fuel oil and lube oil strainers shall be adequately guarded to prevent spray of oil from striking hot surfaces such as boiler fronts, steam lines, generator and/or motors.

2-16-5 RECIPROCATING STEAM ENGINES.

a. Warning to be Sounded. Before an engine is moved by steam, a stand clear warning is to be sounded. Sufficient time

should be allowed for co-workers to heed this warning before the engine is started.

b. Jacking Gear. When an engine is under steam, or when it has a vaccum in the condenser, the jacking gear must be engaged before a worker may enter the crank pit.

2-16-6 ELECTRIC PROPULSION INSTALLATION.

a. Entering Cubicle.

(1) De-energize exposed conductors before introducing any part of the body into the control cubicle or other propulsion equipment.

(2) Do not enter the propulsion control cubicle when buses are energized unless it is necessary to observe the operation.

(3) De-energizing safety switches shall be installed on cubicle and/or controller doors and shall not be rendered inoperative.

b. Starting Engines.

(1) Inspect electrical machinery for loose bolts, improper clearances, shorted connections, broken insulation, or damaged parts.

(2) Disengage the jacking gear before starting the engines.

(3) Do not attempt to force the switches closed against the action of the mechanical interlock.

c. Care of Equipment.

(1) Do not allow water to drip or spray on electrical equipment from vent outlets, open hatches, or condensation on pipes and cables. Baffue plates should be installed when deemed necessary.

(2) Securely fasten removable covers and access doors to power panels, control cabinets, and switchboards.

2-16-7 FIRE PREVENTION AND FIRE FIGHTING.

a. General. Chapter 2-15 of this Instruction, "Electricity and Electronics", and MSTS Damage Control Manual and local instruction, should be studied for an understanding of fire prevention and firefighting.

(1) Maintain CO_2 fire extinguishing equipment at hand and ready for instant use.

(2) In case of fire, shut off the machinery and de-energize the line circuits.

(3) Never use water or foam solution to extinguish the fire unless the circuits are de-energized and the fire gets out of control. Since water and foam solutions are electrical conductors, they may spread the fire.

(4) Close the ventilating systems in the affected compartments.

(5) If the fire is in a compartment adjacent to one of the engine rooms on a diesel propulsion ship excessive smoke and gases may be removed by starting the engines and drawing engine induction air from the compartment where the fire is located.

(6) Exercise precautions against smothering personnel when using firefighting equipment.

(7) Determine the cause of the fire and take corrective measures.

b. Fire Extinguishers in Turbo-Electric Propulsion Installation. Turbo-electric propulsion installations have a carbon-dioxide system for extinguishing fire within a propulsion generator or motor. Portable or semi-fixed carbon-dioxide systems can be used to fight fire in propulsion control cubicles and cables.

c. Fire in Propulsion Generator or Motor. In case of fire in the propulsion generator or motor, observe the following precautions:

(1) Report the fire to the propulsion control room watch engineer.

(2) De-energize the equipment and reduce the speed as quickly as possible.

(3) If motor-drive ventilating blowers are installed on the machine in which the fire has occurred, the blowers should be secured.

(4) If fixed system is not installed remove the covers if necessary on the affected machine and admit carbon-dioxide through the openings to extinguish fire.

2-16-8 PUMPS.

a. Adjustments. Major adjustments should be made with machinery stopped. Caution must be observed when adjusting glands with machinery in operation.

b. Catch pans. Catch pans shall be provided under all fuel oil and lube oil pumps. Pans shall be kept free of oil.

2-16-9 RECIPROCATING PUMPS. The following precautions are to be observed in connection with reciprocating pumps.

a. Jacking Bar. Never use a jacking bar to start a pump while steam valve to the pump is open.

b. Boiler-Feed Pumps. Do not use boiler-feed pumps for any purpose other than the service of the boilers or the use of feed water except in an emergency.

c. Opening Steam Cylinder. Before opening a steam cylinder or steam-valve gear, be sure the drains are open and the steam and exhaust root valves are wired closed.

d. Opening Water Cylinder. Before opening the water cylinder or valve chest of a pump which handles water at a temperature in excess of 120° F., make certain the suction and discharge valves are wired closed and the cylinder and valve cheses are drained.

2-16-10 CENTRIFUGAL, PROPELLER, AND ROTARY PUMPS.

a. General Operating Procedures.

(1) Test relief valves of positive displacement rotary pumps to determine whether they function at the designated pressure.

(2) Never attempt to jack a pump by hand while the steam valve to the driving unit is open.

(3) Do not tie down, or in any other manner make inoperative, the overspeed trip or the speed-limiting or speed-regulating governors.

(4) Check the speed-limiting and speed-regulating governors at least quarterly to determine that they are set to limit the speed of the unit to the rated speed under rated conditions.

(5) Check the overspeed trip in accordance with current regulations or at least quarterly to determine that it is properly set. Overspeed trips should be set to shut off steam to the unit when the rated speed is exceeded by ten per cent.

(6) Be sure the rated speed is not exceeded by more than five per cent for any condition of loading.

(7) Make certain that glands on pumps carrying petrolem products or other hazardous liquids are in good condition and not leaking.

(8) If guard from around pump coupling has been removed pump must be stopped while making adjustments.

b. Rotary Pump Discharge Valves. Never operate a positive displacement rotary pump with the discharge valve closed unless the discharge is protected by a properly set relief valve of sufficient size to prevent a dangerous rise in pressure.

c. Centrigugal and Propeller Boiler Feed Pumps. Do not use boiler feed pumps and other pumps in the feed system for any purpose other than boiler or feed water service, except in an emergency.

2-16-11 PUMP PRESSURE-REGULATING GOVERNORS. Personnel will maintain the same dilligence while operating machinery with automatic control devices as when operating machinery which does not have such devices.

2-16-12 EQUIPMENT. Adequate safeguards shall be provided for all moving parts of equipment used in mechanical and/or electrical transmission of power.

2-16-13 GEARS AND FRICTION DRIVES.

a. Encasement. Gears and friction drives should be completely encased. In gears where this is impracticable, a band guard shall be provided with side flanges extending inward beyond the roots of the teeth.

b. Spoke Hazard. Where there is a spoke hazard, the gears must be enclosed on the exposed side.

2-16-14 SPROCKETS. Sprockets, wherever located, must be completely encased, and the chain must be substantially guarded.

2-16-15 BELTS.

a. Specifications for Guards. If the guard or enclosure is within four inches of the belt, it shall not be less than six feet in height. Openings in the guard which are wider than one-half inch are to be protected by substantial material, such as wire netting of not more than one-half inch. Mesh is to be constructed of wire not smaller than No. 16 gage U.S. Standard.

b. Inclined Belt Guards. Except where the lower run of an inclined belt is at least six feet and six inches from the floor, the belt must be completely guarded to that height.

c. Pannel Support. A pannel in a guard that is wider than 42 inches shall be supported across its width.

d. Overhead Belt Guards. An overhead horizontal belt with a lower run which is less than 7 feet from the floor or platform level must be guarded on the bottom and sides to a height not less than 6 inches above the lower run of the belt. However, in no case is it necessary for the guard itself to be more than 7 feet in height.

e. Passageways. Pulleys which are of a size and location to permit passage between the upper and lower runs of the horizontal belt shall be provided with standard railing. A substantial passageway which is guarded on the sides and top must be constructed. If such guard is not provided, all space traversed by the belt must be completely barred against passage.

2-16-16 SHAFTING. Vertical and inclined shafts shall be encased with stationary guards to a height of 6 feet from the floor or platform level. Horizontal shafting which is less than 6 feet from the floor or platform level shall be encased with stationary guards over all rotating couplings outside of shaft alley.

2-16-17 GENERAL STANDARD GUARDS.

a. Uprights. The uprights used for supporting the guards should be made of angle iron 1 x 1 x 1/8 inch to 1 1/2 x 1 1/2 x 3/16 inch, iron pipe 3/4 inch to 1 1/2 inch inside diameter, or construction of equivalent strength. The sizes should vary between these limits according to the weight and size of the guard, its location in relation to aisles, and the possibility of its being damaged by moving equipment.

b. Fastenings. The filling material should be fastened to the supports in the following manner: 3/4 inch by 1/8 inch flat iron fastened to the angle by means of 3/16 inch bolts or rivets placed at intervals not exceeding 10 inches, or wooden strips 1 inch by 1 inch fastened to angles by means of 3/16 inch bolts. Other methods providing equivalent strength may be used.

2-16-18 GENERAL.

a. Testing.

(1) A hydrostatic test shall be conducted after each renewal of any pressure part and at any other time considered necessary by the Coast Guard inspector or ship's Chief Engineer. All tests shall be in accordance with those laws prescribed by the applicable Coast Guard Regulations.

(2) The straight portions of tubes in water-tube boilers shall be inspected regularly to detect deflection.

(3) The boiler steam gages shall be tested at regular intervals as required by applicable Coast Guard Regulations or as recommended by the ship's Chief Engineer.

(4) The drain from the oil heater shall be inspected at least once each hour.

(5) The permanently installed steam-smothering pipes to the boiler shall be examined and tested by steam at each shut down.

2-16-19 OPERATING PRECAUTIONS.

a. Watch and Equipment Requirements.

(1) Equipment.

(a) Wear goggles with dark lenses, number 1.5 to 3 shade, or suitable shaded fireproof face shields when working near or looking through furnace doors of boilers in operation.

(b) Personnel lighting-off shall be equipped with a torch with flash guard and must wear long-sleeved shirts or arm protection.

(2) No one shall stand a fireroom watch until he is thoroughly familiar with the precautions contained herein.

b. Boiler Operation.

(1) Prior to Lighting-Off.

(a) Operators should be familiar with boilers, piping, safety and other associated equipment.

(b) Checks and Tests.

1 All pressure gages should be tested and all the alarm warnings should be checked, such as:

a high and low water level

b low supply air pressure in the accumulator

c low steam flow

d forced draft air failure

e high steam temperature.

2 If a solenoid valve is provided with motor driven blowers to shut off the oil supply to the burners, should the blower fail, its operation should be checked.

3 Check all dampers, hand controlled from forced draft fans and combustion control dampers through stack.

4 Check bypass dampers of air heaters to see that they open and close properly.

5 Check position of burners and cones and see that all air control dampers on furnace fronts open and close properly.

6 Check feed water regulators, also see if remote reading gages are connected to boiler and that generator is filled and ready for operation.

7 Check oil piping, burners and tips.

8 Check the combustion control system to see that all strainers are clean and filters renewed; dirt, oil or moisture may cause faulty performance.

9 Clean suction and discharge strainers.

10 Check torch and extinguishing pot for lighting off boilers.

11 Check fire extinguishing system to see that it conforms with Coast Guard requirements.

12 Open boiler steam drum vents.

13 Open all superheater vents and superheater drains.

14 Check to see that water column shutoff valves are open.

15 Ease all main steam valves off seats and close hand tight.

16 Start filling boiler through auxiliary feed system to just above the bottom of the gage glass, using distilled water which has been tested.

17 Inject initial charge of chemicals for water treatment as recommended by the manufacturer. Protective equipment provided at boiler treatment stations must be worn by personnel for each treatment.

18 Inspect drains for open valves as boiler fills.

IMPORTANT:

KEEP SUPERHEATER VENT AND DRAIN VALVES OPEN AT ALL TIMES UNTIL STEAM FLOW THROUGH THE SUPERHEATER HAS BEEN ESTABLISHED.

(2) Lighting-Off.

(a) Never light-off a boiler on "automatic" control; use either "direct manual" or "remote manual".

(b) Fuel oil to the burners should be circulated to raise its temperature sufficiently to reduce its viscosity to about 150 s.s.u. The temperature of the fuel should never be raised above the flash point in any part of the system except between the heater and the atomizers.

(c) The forced draft blowers should be started with the dampers and burner registers open and the furnaces shall be blown out for at least five minutes before lighting-off in order to purge the furnaces of all explosive vapors. Failure of the oil to light-off immediately increases the gases in the boiler so unless the furnace is again purged of gases with the forced draft blower, a flareback or an explosion may result.

(d) Use a torch and stand to one side out of line of a possible flareback when lighting-off. A torch should be used when lighting additional burners.

(e) The burner designated as No. 1 on the ship should be lighted first. The smallest burner tip should be used in order to dry out the brickwork gradually and raise steam slowly. The burner in use should be rotated as designated in order to raise the temperature of the boiler uniformily.

(f) When steam issues forcibly (about 25 psi) from the steam drum vent, close this vent.

(g) The length of time consumed in bringing the unit up to the superheater pressure varies for different boilers and should be known for each ship. At least this length of time should be taken under normal conditions. Forcing the boiler too rapidly when raising steam may result in damage to the superheater tubes through overheating.

(h) When boiler pressure has reached 15 pounds the superheater drains may be throttled but the vents should remain wide open. This procedure conserves the feed water while maintaining a

protective steam flow through the superheater. While raising steam, make regular inspection for steam or water leaks.

(i) Raise the pressure gradually and when it reaches about 75 per cent of the allowable working pressure check the safety valves with the relieving gear. See that the safety valves blow and seat properly.

(j) On separately fired or controlled superheat boilers the superheater side burners should never be lighted until a flow has been established through the superheater. A burner should never be lighted on the superheater side unless one or more burners are in operation on the saturated side.

(k) When cutting in, blow the gage glasses and check for the proper height of water, so there will be no chance of carry-over when the boiler is cut in. It should be remembered that the water level will rise as boiler pressure is raised. CAUTION:

1 Do not allow the water to pass out of sight in the gage glass and do not blow the water beyond the center of the glass, because as the boiler is cut in on the line there will be a drop in water level unless the feed is maintained accurately.

2 Surface blows, if fitted, should be used to lower the water level.

3 Bottom blows are normally used to lower the solid contents of the boiler and except in emergencies should not be opened while the fires are lit.

(l) When the pressure approaches working pressure, crack the desuperheater outlet valve and open slowly to warm all auxiliary piping. Open the drain valves to remove all water from the lines and then begin the regular procedure of starting the plant.

(m) In cutting in any boiler it should be remembered that the objective is to prevent water hammer in the steam line and to avoid thermal shock. When ready to cut in a boiler on the main steam line all drains should be checked to see that they are open and all water drained from the line. If another boiler is already on the line and a stop-check valve is fitted in the steam manifold, the valve stem should be slowly backed off to provide full opening for the check valve. When the boiler pressure is ten to fifty pounds below the pressure in the main header the bypass around the main boiler stop valve should be opened slowly to warm the line and to equalize the pressure on both sides of the main stop valve. The main stop valve may then be opened and the boiler will cut itself in automatically with the non-return valve when boiler pressure reaches line pressure.

(n) In case a non-return valve is not fitted, the boiler stop valve should be opened slowly when the pressure in the boiler and the steam line are approximately equal.

(o) If there is no other boiler cut in on the main steam line, it is advisable to raise the steam pressure on the whole steam line when raising steam on the boiler, making sure that all drains are open.

(3) Watch Observations.

(a) Water Level.

1 When taking over a watch, blow the water gages and note the return of the water in the glass. Be certain of the water level at all times. Do not be misled by a dirt marking on the gage which may look like the surface of the water. Do not depend entirely upon remote water level indicators, automatic alarm devices and automatic feed water regulators.

2 If there is any question about the water level use the try cock. One-half glass of water shall ordinarily be carried.

3 If the water goes out of sight in the bottom of the gage glass, kill the fire, utilizing quickest means available, immediately close the steam stop valve, and allow the boiler to cool slowly; then drain the boiler completely and open it for inspection. Do not feed cold water to a boiler that has had low water until the boiler has cooled.

4 Steam.

a Check the water on steaming boilers to try cocks at least once each watch and before connecting a coiler to the line.

b Blow down the water glasses before connecting a boiler to the line.

c Remember that a fall in steam pressure may indicate low water.

(b) Oil.

1 Oil and Water Mixture.

a Do not use oil from a tank in which a considerable amount of water is mixed with the oil unless a high suction connection is provided.

b When an atomizer sputters, shift the suction to the stand-by tank or another storage tank. A sputtering atomizer indicates water in the oil.

2 Minimize the fouling of oil heaters by using as few heaters as possible. Recirculate the oil through the used heaters for a short time after securing the burners.

3 Maintain the prescribed fuel-oil temperature; do not exceed it.

(c) The fuel-oil suction and discharge strainers shall be cleaned at least every eight hours, and oftener if necessary.

(d) Boiler settings shall be examined daily for external air leaks. Cracks, blisters, or other dangerous conditions in joints, tubes, seams, or blow-off connections are to be reported to the proper authority immediately.

(e) Panting.

1 Boiler damage in the form of loosening brickwork and casing buckling can be the result of "panting". Panting is normally caused by insufficient air and immediate increase of the air supply will usually stop it. It has been noted that leakage due to a loose air damper has caused mild panting which if allowed to continue can cause considerable damage.

2 Whenever a brick drops from the furnace wall, the boiler should be cut out if practicable. If necessary to continue the boiler in operation burners adjacent to the location of the brick should be cut out to avoid damage to the boiler casing.

(f) Communications.

1 Prior to blowing tubes, testing whistle, or lifting safety valves, bridge should be advised so as to forewarn or evacuate personnel from the stack area.

2 Prior to turning over propellor check should be made with bridge to prevent injury to personnel swimming or working over the side near propellor.

2-16-20 MAINTENANCE AND REPAIR PRECAUTIONS.

a. Adequate ventilation in Dead Fireroom. Men should not be permitted to work in a dead fireroom unless adequate ventilation is provided. Special precautions should be taken to insure an

adequate supply of fresh air in a dead fireroom if the boilers in that fireroom are connected to the same smoke pipe as steaming boilers in another fireroom.

b. Fire Sides or Water Drums of Dead Boilers. Never allow men to enter fire sides or water drums of dead boilers until they have been examined and well ventilated to remove all toxic or explosive gases. Also, before they enter the boiler the master fuel oil valve and all stop valves should be closed and wired and the ship's metal "Men In Boiler" sign hung in a conspicuous place.

c. Signs. Each vessel should be equipped with a metal sign marked "Empty Boiler". This sign should be hung in front of the boiler in a conspicuous location whenever a boiler is empty to prevent accidental damage from dry firing. In addition, the master fuel oil valve and stop valves to such boiler should be kept locked.

d. Removing Manhole Plates. Before attempting to remove boiler manhole plates see that the boiler drains are open even though you know the boiler is cold. Both pressure and vacuum must be relieved by opening drains or vents before removing manhole plates.

e. Connecting Valves. To prevent accidental opening, close and secure by locking or wiring and tagging all connecting valves to boilers when men are working therein.

f. Applying Pressure to Valve on Open Boiler. There is always danger that steam may leak to an idle or open boiler through a leaky bottom blow valve when the bottom blow valve of another boiler connected to the common bottom blow line is opened. This same danger exists with respect to stop valves, feed valves, etc. If pressure is to be applied to any valve on an open boiler, no one should be allowed in the boiler until pressure has been applied to the valve and its tightness is positively assured.

g. Control Valves of Steam-Smothering Systems. Lash in closed position the control valves of steam-smothering systems while men are working in the vicinity thereof, and remove the lashings when the work is finished.

h. Safety Valve on a Dead Boiler. When a safety valve on a dead boiler is opened for repair there is possibility of steam from another boiler safety valve, which has lifted, entering the dead boiler through the open valve. Never allow men to enter the water drums of a boiler in which the safety valve is opened.

i. Procedure Before Opening Valve. Never assume that the stop valve of a dead boiler has been secured by the other watch.

The engineer on watch shall determine which boiler, if any, is cut out before opening any valve. There may be a man working in one of them.

j. Removing Valve Bonnet or Packing. Make sure that there is no pressure on a valve before attempting to remove a valve bonnet or the valve packing. Master valve leakage or back pressure from an unexpected source may be sufficient to cause injury. If any doubt exists slack off securing nuts about one turn and "break" the joint before removal of the bonnet.

k. Lighting. Naked lights should not be used in an open boiler. Electric leads of portable lights should be thoroughly insulated, and the portable lighting fixture should be of the water-tight type with guard. Hand electric flashlights are preferable. The same precautions should be observed when using portable electric lights in the presence of fuel, oil, gasoline, kerosene, or other flammable vapors and gases; namely, inspect for and renew defective insulation before use. Flammable vapors should be removed by ventilation before performing work. (See Chapter 2-9)

l. After Boiling Out. Before men are sent into a boiler after boiling out, the boiler should be thoroughly ventilated.

m. Personal Protective Equipment. Men cleaning a boiler should be equipped with goggles, dust respirators, and heavy leather-palm gloves and safety type extension lights.

n. While Men are in Boilers. While men are working in boilers, a man should be stationed outside to help in case of an accident.

o. Using Steam Hose. When using a steam hose for cleaning or other purposes, one man should always stand by the cut off valve.

p. Turbining Tubes. When turbining tubes keep clear of the rotating brush.

q. Fusible Plugs. Fusible plugs in fire-tubes boulers shall be examined when the boiler is cleaned and shall be renewed as prescribed by current Coast Guard Engineering Regulations.

r. Deposits on Heating Surfaces. Boilers shall also be regularly examined for deposits on their heating surfaces or for grease or other foreign matter in the water. Boilers showing any such irregularities should be cleaned at the first opportunity and should not be used until cleaned except in an emergency.

s. Supervisor's Inspection. After cleaning and repairing

operations have been completed and before removing warning signs and lockout tags, the supervisor in charge shall make a thorough inspection of the boiler. He must make certain that tools, scraps, and foreign materials have been removed and that work has been completed. He must determine that no member of the crew is inside the boiler before closing the steam drains and headers.

2-16-21 SHIPYARD REPAIR PERIODS. Shipyard repair periods are critical periods where the major hazards found within the marine industry are performed practically simultaneously. Because of this acute exposure to potentially injurious conditions, it is felt necessary to highlight certain hazardous conditions that have been previously mentioned in other parts of this Instruction in order to emphasize the need of extreme caution and immediate corrective action.

a. References. Procedures not specified are treated in detail in U. S. Department Of Labor Safety & Health Regulations for Ship Repairing, BuShips Technical Manual and Coast Guard Regulations.

b. Shipyards.

(1) During repair periods, when repair work is being performed, hazards are encountered from burning, welding, refurbishing installations and other operations that require continual surveillance and remedial actions by ship's personnel to maintain a safe ship free of fire and/or accidents. It must be emphasized because of these situations that the Master is responsible for his ship at all times. Delegation of authority and responsibility to subordinates shall not relieve the Master of his responsibilities.

(2) In an effort to eliminate fire and personal hazards repeatedly observed around the ship during repair periods, all MSTS shore division directors and heads of offices are directed to instruct their representatives who service the ships to be extremely alert to the hazards encountered. Should an unsafe condition, practice, or procedure be observed, it is to be reported immediately to the ship's Master, cognizant department head or the on-board maintenance & repair representative for corrective action.

c. Conditions and/or Practices of Concern.

(1) All roads, piers and drydock accesses, shipboard passageways and work areas shall be adequately illuminated.

(2) Ships' Gangways.

(a) Gangway safety nets shall be rigged beneath gangway (other than completely enclosed type) at all times.

(b) Gangways of not less than 20 inches in width, of adequate strength, maintained in safe repair and safely secured, shall be used.

(c) Guardrails, with a minimum height of 33 inches, shall be required on all gangways and landing platforms. Mid-rails shall be provided between the top guardrail and the surface of the gangway and/or landing platform.

(d) All gangways shall be kept clean, clear and well-lighted. Ice, snow, oil, grease and other materials affecting the safe walking surfaces of gangways shall be cleaned up at once or covered with sand, sawdust or other anti-slip materials.

(e) No materials or obstructions shall be allowed on gangways and supporting bridles shall be kept clear to permit safe passage.

(f) Gangway stanchions shall be bolted or secured at the bottom with toggle pins to prevent the stanchions from being pulled out of their sockets.

(g) Overcrowding of gangways shall not be permitted.

(h) Gangways shall be kept properly trimmed at all times.

(i) Gangways resting on or extending over bulwarks, shall be provided with substantial steps, and platforms if necessary, properly positioned and firmly secured between the end of the gangways and the deck.

(j) Unless the construction of the vessel makes it impossible, gangways shall be so located that loads do not pass over them. In any event, loads shall not be passed over gangways while personnel are on them.

(3) The following poor housekeeping conditions shall be corrected:

(a) shipyard roads, piers and drydock accesses having holes, openings, loose or broken boards, slippery surfaces, tripping obstructions, etc.;

(b) rags, boxes, debris, and other flammable materials subject to spontaneous combustion left lying about ship;

(c) gas, water and air hose stretched across ladder and passageways (tripping hazards);

(d) materials left strewn about work areas, in passageways, or at the top and bottom of ladders (tripping hazards);

(e) removal of floor plates and/or handrails without suitable guarding;

(f) oil, grease or other slippery substances on decks, ladders, gangways, or approaches;

(g) paint left in unprotected lockers, storerooms, or other compartments not designated for storage of flammables;

(h) paint mixing operations being performed in areas not designated or being performed in mixing areas with electrical appliances which is not approved explosive-proof type.

(4) The following practices during burning and welding operations shall not be allowed:

(a) burning and/or welding in an area containing flammable materials;

(b) burning and welding in an area without a firewatch;

(c) firewatch not provided with fire extinguisher.

(5) Personal Protective Equipment.

(a) Safety helmets (hard hats) shall be available aboard and warn by all ship's personnel and MSTS shore personnel in areas where overhead repair work is being performed.

(b) Safety goggles or coveralls shall be worn by all ship's personnel and MSTS shore personnel, in areas where chipping, abrasive blasting or other eye hazardous operations are being performed.

(c) Safety belts shall be worn by ship's personnel and MSTS shore personnel working aloft making certain that life line is secured.

(d) Personnel working aloft are not to be exposed to energized radar equipment or to poisonous gases and fumes from smoke stack exhaust.

2-16-22 ENGINE SPACES.

a. Ventilation. Men shall not be permitted to work in a dead fireroom unless adequate ventilation is provided. Special care shall be taken to insure an adequate supply of fresh air in a dead

fireroom if the boilers in that fireroom are connected to the same smokepipe as steaming boilers in another fireroom.

b. Temperature. Firerooms shall be kept above 40° F. when there is water in the boilers and pipe lines.

c. Watch. No one shall stand a fireroom watch unless he is thoroughly familiar with the precautions contained in this Chapter. Applicable operating and safety instructions shall be posted adjacent to machinery and built-in power tool equipment to assist watch and/or operating personnel to perform their duties safely.

d. Oxyacetylene Bottles. The use of oxyacetylene bottles below for burning and/or welding operations shall be with the Master's approval. Oxyacetylene bottles must be returned to on-deck stowage after completion of said work.

e. Guage Glass Guards. Liquid column guage glasses installed to indicate liquid levels in boilers, tanks, etc. must be adequately guarded against breakage. Wire guards are not necessary with the flat type of guage glasses now in general use but should be provided when the cylindrical type of guage glass is used.

f. Oil Level Indicators. Column type guage glasses shall not be used as oil level indicators.

g. Torches. One torch pot for each boiler shall be located strategically at boiler front and ready for immediate use. Each torch must be equipped with a flare-back guard.

h. Noise Hazardous Signs.

(1) Noise hazardous signs must be located in suitable areas in the engine spaces to caution personnel to wear ear protection.

(2) Wearing ear protection by watch personnel in those areas bearing "Noise Hazardous" signs is mandatory.

i. Housekeeping.

(1) The general rules for good housekeeping set forth in Chapter 2-1, are to be observed insofar as they are applicable in the engine spaces.

(2) Gratings and Floor Plates.

(a) Gratings and floor plates must be kept dry and free of grease and oil.

(b) Gratings and floor plates must be kept clear and are not to be used for stowage space.

(c) Gratings and floor plates shall be kept secured in place.

(d) Open floor plate or grating areas shall be guarded and adequately illuminated.

(e) Do not stow articles on engine room and fire room gratings which obstruct ventilation or which may fall below.

* (f) Gratings shall not be covered with flammable materials such as canvas. Approved electrical rubber matting shall not be used in engine room areas other than those specified, as oil vapors deteriorate matting adding to fire hazard and makes matting very slippery.

(3) The hanging of clothes or other flammable fabrics in machinery spaces for the purposes of drying is prohibited.

(4) Do not allow any obstructions to exits from engine room and water-tight doors.

(5) Handrails.

* (a) Two course handrails with top rail a minimum of 33 inches high are required on all engine room levels above the main operating platform.

(b) When handrails have been removed for machinery repairs or removal, etc., area shall be properly guarded and illuminated.

j. Sounding Tubes. Spring loaded valves on sounding tubes shall not be secured in the open position preventing closing after use. Cap or plug-type tubes shall be capped or plugged after use.

2-16-23 EMERGENCY PROCEDURE. In case of accident the situation shall be localized if at all possible.

a. Isolating Compartment. The compartment involved shall be isolated to prevent escaping steam from getting into other boilers and machinery.

b. Remaining at Stations. All men shall remain at their stations unless otherwise directed and give strict attention to the machinery in operation in accordance with proper damage control procedures until properly relieved.

2-16-24 FIRE PREVENTION IN FIREROOMS AND OTHER ENGINE ROOM SPACES.

a. Oil.

(1) Hazards.

(a) Spilled oil shall be wiped up immediately. Oil is not to be allowed to accummulate on furnace bottoms, in inner casings, bilges, pockets, etc.

(b) Spilled oil is not allowed to accummulate on engine room tank tops or on other engine area decks. Accummulations shall be wiped up and areas flushed down and pumped dry.

(c) Steam pipe insulation that becomes soaked with oil can start a fire in machinery spaces. Oil leaks must be repaired and oil soaked pipe covering removed and discarded immediately. Particular attention shall be given this matter following repairs or construction. Naked incandescent lamps must be removed from all engineering spaces.

(2) The temperature of fuel oil shall never be raised to or above the flash point in any part of the system except between the heaters and the atomizers. In no case shall oil be heated to a temperature higher than that necessary to reduce the viscosity of the oil to 135 seconds Saybolt Universal.

(3) When a fuel-oil burning system is designed for 300 pounds per square inch oil pressure, the pressure in any part of the system shall not exceed that which is necessary to produce this amount at the burner manifolds on the boiler fronts. Nor shall the pressure at the fuel-oil service-pump discharge exceed 350 pounds per square inch gage.

b. Open Flames.

(1) Allow no open lights and flames such as oil lanterns, matches, torch flames, welding arcs in or near open oil tanks or oil tank vents without the proper gas-free certificate as prescribed by applicable Coast Guard or Department of Labor Regulations.

(2) Smoking is prohibited in all storerooms, grease and paint lockers, and in areas suspected of containing explosive or flammable vapors.

c. Applying Metal Conditioning Compound.

(1) Do not smoke.

(2) Do not apply the compound while another boiler in the same fireroom is steaming or while the boiler is connected to the same

smoke pipe as another boiler which is steaming.

(3) Avoid using excessive amounts of the compound, which can collect in pockets which would be subject to high temperature when steaming.

(4) After a boiler has been sprayed with the compound, do only emergency work inside the boiler or uptakes until the compound has been removed by firing the boiler.

(5) Take particular care to detect fires which might occur when the boilers are first steamed after application of the compound.

(6) The use of compound shall be in accordance with the instructions given in NAVSHIPS Technical Manual, Chapter 51.

2-16-25 FIRE FIGHTING.

a. Fire Extinguishers. Fire extinguishers are to be kept in proper working condition.

b. Fire in the Bilges. In case of fire in the bilges, the master valve shall be closed and the oil pump stopped.

c. Fire in the Casing. In case of fire in the casing of an air-encased boiler, the steam-smothering system in the casing shall be used immediately.

d. Fire in a Bulkhead-Enclosed Boiler Room. The steam-smothering or other fixed system shall also be used immediately in case of fire in a bulkhead-enclosed boiler room. It must be determined prior to using the steam-smothering system that personnel are out of the boiler room.

e. Oil Fires. When an oil fire occurs, the blowers shall be shut down unless they will aid personnel to escape by keeping the flames away from possible exits.
NOTE: General procedures to be followed in fire fighting and damage control will be found in the MSTS Damage Control Manual.

2-16-26 AIR RECEIVERS AND COMPRESSORS (UNFIRED PRESSURE VESSELS).

a. Design and Construction. Unfired pressure vessles shall be designed in accordance with applicable codes of the American Society of Mechanical Engineers, the National Bureau of Standards, or Bureau of Yards and Docks Inst. 11012.62, High Pressure Air Systems; Design Criteria No. 35, and Marine Engineering Regulations and Material Specifications C.G. 115.

b. Inspection and Testing.

(1) Inspection and testing of unfired pressure vessels shall be accomplished in accordance with applicable C.G. Inspection Regulations.

(2) Cylinders used for shipment of compressed or liquefied gases shall be inspected in accordance with regulations of the Interstate Commerce Commission. (See Article 2-9-52)

c. Torpedo Airflasks. Torpedo airflasks, although not designed in accordance with accepted standards (see 2-16-26a.), are in use in fixed and portable systems throughout the Navy. The risks accepted in using these airflasks for combat purposes are not acceptable when they are used for other purposes. When they are used in fixed and portable systems in the shore establishment, working pressures and installation shall be modified in conformance with ASME standards, and inspection and testing shall be in accordance with instructions contained in Ordnance Pamphlet 1806, High Pressure Air Systems Ashore--Design and Operation.

2-16-27 AIR RECEIVERS (COMPRESSED AIR TANKS).

a. Operating Pressure. Do not operate an air receiver at a pressure higher than the maximum allowable working pressure unless such operation has been specifically authorized.

b. Unauthorized Use of Compressed Air. Do not use compressed air to accelerate the flow from containers of oil, gasoline, or other fluids. This practice is dangerous to the operator and fellow workers and is prohibited.

c. Cleaning and Repairing.

(1) Never attempt to make repairs of any nature while the air receiver is under pressure.

(2) Carefully observe precautions for cleaning air receivers. When air receivers are of sufficient size to admit a man through a manhole opening, the manhole covers should be completely removed. Adequate Ventilation must be provided, and there must be no oxygen deficiency, no volatile gases, and no carbon monoxide present in dangerous quantities.

2-16-28 AIR COMPRESSORS.

a. General Care.

(1) Be sure the air at intake is cool and free from flammable gases, vapors, or dusts.

(2) Do not permit wood or other flammable materials to remain in contact with the air discharge pipe.

(3) Immediately secure a compressor if the temperature of the air discharged from any stage rises unduly or exceeds 400° F.

(4) Do not install a stop valve or check between the compressor and receiver unless a relief valve is also fitted between the compressor and the stop or check valve. (If the compressor is started against a closed valve or a defective check valve the air cannot escape and an explosion will result.)

(5) Pressure gages shall never be rendered inoperative except when they are to be removed for some valid reason.

(6) Never kink a hose to stop the air flow. Keep the clamps on the hose tight.

b. Starting and Running.

(1) When starting an air compressor check the safety valves, pressure valves, and regulators to determine that they are working properly.

(2) Do not leave the compressor station after starting the compressor unless it has been made certain that the control, unloading, and governing devices are working properly.

(3) Refer to Chapter 49, "Compressed Air Plants," NAVSHIPS Technical Manual, for starting and testing procedures for air compressors on shipboard.

(4) Do not run an air compressor faster than the speed recommended by the manufacturer.

c. Lubricating.

(1) Lubricate air compressors regularly. Use only the proper grade oil as recommended by the manufacturer, and avoid the application of too much oil.

(2) Use only oils which have high flashpoints to lubricate the air cylinders of air compressors.

d. Cleaning.

(1) Keep compressor, tanks, and accompanying piping clean to guard against oil-vapor explosion. Clean intake air filters periodically.

(2) Use only soapy water or suitable non-toxic, non-flammable solution for cleaning compressor intake filters, cylinders or air passages. Never use benzene, kerosene, or other light oils to clean

these portions of a system. These oils vaporize easily and will form a highly explosive mixture under compression.

e. Adjustment and Repair.

(1) Turn off the motor before making adjustments and repairs on an air compressor.

(2) Before working on or removing any part of a compressor make certain that the compressor is secured and cannot be started automatically or by accident, that air pressure in the compressor is completely relieved, and that all valves between the compressor and receivers are closed.

(a) Spilled oil shall be wiped up immediately. Oil is not to be allowed to accummulate on furnace bottoms, in inner casings, bilges, pockets, etc.

(b) Spilled oil is not allowed to accummulate on engine room tank tops or on other engine area decks. Accummulations shall be wiped up and areas flushed down and pumped dry.

(c) Steam pipe insulation that becomes soaked with oil can start a fire in machinery spaces. Oil leaks must be repaired and oil soaked pipe covering removed and discarded immediately. Particular attention shall be given this matter following repairs or construction. Naked incandescent lamps must be removed from all engineering spaces.

(2) The temperature of fuel oil shall never be raised to or above the flash point in any part of the system except between the heaters and the atomizers. In no case shall oil be heated to a temperature higher than that necessary to reduce the viscosity of the oil to 135 seconds Saybolt Universal.

(3) When a fuel-oil burning system is designed for 300 pounds per square inch oil pressure, the pressure in any part of the system shall not exceed that which is necessary to produce this amount at the burner manifolds on the boiler fronts. Nor shall the pressure at the fuel-oil service-pump discharge exceed 350 pounds per square inch gage.

b. Open Flames.

(1) Allow no open lights and flames such as oil lanterns, matches, torch flames, welding arcs in or near open oil tanks or oil tank vents without the proper gas-free certificate as prescribed by applicable Coast Guard or Department of Labor Regulations.

(2) Smoking is prohibited in all storerooms, grease and paint lockers, and in areas suspected of containing explosive or flammable vapors.

c. Applying Metal Conditioning Compound.

(1) Do not smoke.

(2) Do not apply the compound while another boiler in the same fireroom is steaming or while the boiler is connected to the same smoke pipe as another boiler which is steaming.

(3) Avoid using excessive amounts of the compound, which can collect in pockets which would be subject to high temperature when steaming.

(4) After a boiler has been sprayed with the compound, do only emergency work inside the boiler or uptakes until the compound has been removed by firing the boiler.

(5) Take particular care to detect fires which might occur when the boilers are first steamed after application of the compound.

(6) The use of compound shall be in accordance with the instructions given in Chapter 51, BuShips Technical Manual.

2-16-25 FIRE FIGHTING.

a. Fire Extinguishers. Fire extinguishers are to be kept in proper working condition.

b. Fire in the Bilges. In case of fire in the bilges, the master valve shall be closed and the oil pump stopped.

c. Fire in the Casing. In case of fire in the casing of an air-encased boiler, the steam-smothering system in the casing shall be used immediately.

d. Fire in a Bulkhead-Enclosed Boiler Room. The steam-smothering or other fixed system shall also be used immediately in case of fire in a bulkhead-enclosed boiler room. It must be determined prior to using the steam-smothering system that personnel are out of the boiler room.

e. Oil Fires. When an oil fire occurs, the blowers shall be shut down unless they will aid personnel to escape by keeping the flames away from possible exits.

NOTE: General procedures to be followed in fire fighting and damage control will be found in the MSTS Damage Control Manual.

2-16-26 AIR RECEIVERS AND COMPRESSORS (UNFIRED PRESSURE VESSELS).

a. Design and Construction. Unfired pressure vessels shall be designed in accordance with applicable codes of the American Society of Mechanical Engineers, the National Bureau of Standards, or Bureau of Yards and Docks Instruction 11012.62, High Pressure Air Systems; Design Criteria No. 35, and Marine Engineering Regulations and Material Specifications Coast Guard 115.

b. Inspection and Testing.

(1) Inspection and testing of unfired pressure vessels shall be accomplished in accordance with applicable Coast Guard Inspection Regulations.

(2) Cylinders used for shipment of compressed or liquefied gases shall be inspected in accordance with regulations of the Interstate Commerce Commission. (See Article 2-9-52.)

c. Torpedo Airflasks. Torpedo airflasks, although not designed in accordance with accepted standards (see 2-16-26a), are in use in fixed and portable systems throughout the Navy. The risks accepted in using these airflasks for combat purposes are not acceptable when they are used for other purposes. When they are used in fixed and portable systems in the shore establishment, working pressures and installation shall be modified in conformance with ASME standards, and inspection and testing shall be in accordance with instructions contained in Ordnance Pamphlet 1806, High Pressure Air Systems Ashore--Design and Operation.

2-16-27 AIR RECEIVERS (COMPRESSED AIR TANKS).

a. Operating Pressure. Do not operate an air receiver at a pressure higher than the maximum allowable working pressure unless such operation has been specifically authorized.

b. Unauthorized Use of Compressed Air. Do not use compressed air to accelerate the flow from containers of oil, gasoline, or other fluids. This practice is dangerous to the operator and fellow workers and is prohibited.

c. Cleaning and Repairing.

(1) Never attempt to make repairs of any nature while the air receiver is under pressure.

(2) Carefully observe precautions for cleaning air receivers. When air receivers are of sufficient size to admit a man through a manhole opening, the manhole covers should be completely removed. Adequate ventilation must be provided, and there must be no oxygen deficiency, no volatile gases, and no carbon monoxide present in dangerous quantities.

2-16-28 AIR COMPRESSORS.

a. General Care.

(1) Be sure the air at intake is cool and free from flammable gases, vapors, or dusts.

(2) Do not permit wood or other flammable materials to remain in contact with the air discharge pipe.

(3) Immediately secure a compressor if the temperature

of the air discharged from any stage rises unduly or exceeds 400° F.

(4) Do not install a stop valve or check between the compressor and receiver unless a relief valve is also fitted between the compressor and the stop or check valve. (If the compressor is started against a closed valve or a defective check valve the air cannot escape and an explosion will result.)

(5) Pressure gages shall never be rendered inoperative except when they are to be removed for some valid reason.

(6) Never kink a hose to stop the air flow. Keep the clamps on the hose tight.

b. Starting and Running.

(1) When starting an air compressor check the safety valves, pressure valves, and regulators to determine that they are working properly.

(2) Do not leave the compressor station after starting the compressor unless it has been made certain that the control, unloading, and governing devices are working properly.

(3) Refer to Chapter 49, "Compressed Air Plants," Bureau of Ships Technical Manual, for starting and testing procedures for air compressors on shipboard.

(4) Do not run an air compressor faster than the speed recommended by the manufacturer.

c. Lubricating.

(1) Lubricate air compressors regularly. Use only the proper grade oil as recommended by the manufacturer, and avoid the application of too much oil.

(2) Use only oils which have high flashpoints to lubricate the air cylinders of air compressors.

d. Cleaning.

(1) Keep compressor, tanks, and accompanying piping clean to guard against oil-vapor explosion. Clean intake air filters periodically.

(2) Use only soapy water or suitable non-toxic, non-flammable solution for cleaning compressor intake filters, cylinders, or air passages. Never use benzene, kerosene, or other light oils

to clean these portions of a system. These oils vaporize easily and will form a highly explosive mixture under compression.

e. Adjustment and Repair.

(1) Turn off the motor before making adjustments and repairs on an air compressor.

(2) Before working on or removing any part of a compressor make certain that the compressor is secured and cannot be started automatically or by accident, that air pressure in the compressor is completely relieved, and that all valves between the compressor and receivers are closed.

PART 2
GENERAL SAFETY PRECAUTIONS

CHAPTER 17
RADIOLOGICAL SAFETY

2-17-1 APPLICABLE PRECAUTIONS. MSTS Commands possessing, transporting, or utilizing sources of ionizing radiation shall follow the regulations in NAVMED P-5055, Radiation Health Protection Manual.

PART 2
GENERAL SAFETY PRECAUTIONS

CHAPTER 18
ORDNANCE

SECTION I - GENERAL ORDNANCE SAFETY

SECTION II - ORDNANCE IN CONNECTION WITH SPECIAL PROJECTS

2-18-1 GENERAL.

a. Scope. To avoid danger of casualties, the observance of the following safety precautions is mandatory. COMSTS shall be informed via chain of command of any circumstances which conflict with these safety precautions or which for any other reason require changes in or additions to them. Until the conflict has been resolved interim measures which will achieve optimum safety shall be at the discretion of the Commanding Officer/Master.

b. Interpretation. When in doubt as to the exact meaning of a safety precaution, an interpretation shall be requested from COMSTS via chain of command. Conditions not covered by these safety precautions may arise which, in the opinion of the Commanding Officer/Master, may render further operation of the equipment unsafe. Under these conditions, nothing in these safety precautions shall be construed as authorizing further operation of such equipment.

c. Safety Devices. Safety devices provided shall always be used as designated to prevent possibility of accident, and shall be kept in good condition and operative at all times. All instructions promulgated by competent authority to insure safe operation or handling of equipment shall be strictly observed.

d. Changes in Material. Changes, modifications in, or additions to ordnance material, or other material used in connection therewith, shall not be made without explicit authority from the bureaus concerned.

2-18-2 AMMUNITION HANDLING AND STOWAGE.

a. Supervision. As familiarity with any work, no matter how dangerous, is apt to lead to carelessness, all persons who may supervise or perform work in connection with the inspection, care, preparation, use, or handling of ammunition or explosives have the following responsibility:

(1) They shall exercise the utmost care that all regulations and instructions are rigidly observed.

(2) They shall carefully supervise those under them and frequently warn them of the necessity of using the utmost precaution in the performance of their work. No relaxation of vigilance shall ever be permitted.

b. Fueling Operations. Except in case of emergency, ammunition shall not be transferred during fueling operations.

c. High Temperature. All ammunition, explosives, and powder shall be protected from abnormally high temperature. If so exposed, they shall be handled in accordance with current instructions of the Bureau of Naval Weapons. Permissible maximum storage temperatures shall be prescribed by the Bureau of Naval Weapons.

d. Smokeless Powder.

(1) Smokeless powder which has been wet from any cause whatever must be regarded as dangerous for dry storage. Such powder shall be handled in accordance with current instructions of the Bureau of Naval Weapons.

(2) Smokeless powder which shows unmistakable signs of advanced decomposition shall be disposed of in accordance with current instructions of the Bureau of Naval Weapons.

e. Handling. To minimize the risk of fire, explosion, and damage to ammunition and its containers from accidental causes, ammunition shall be handled as little as practicable. As the action of denting thin-cased high-explosive ammunition is known to have caused detonation of the explosive in some instances, special care shall be exercised to insure that such ammunition is never struck, dropped, or bumped.

f. Switches. The covers of switches, circuit breakers, etc., shall be kept securely closed while powder is exposed in the vicinity.

g. Magazines.

(1) Magazines shall be kept scrupulously clean and dry at all times. Nothing shall be stored in magazines except explosives, containers, and authorized magazine equipment. Particular attention shall be paid that no oily rags, waste, or other foreign materials susceptible to spontaneous ignition are stored in them.

(2) Naked lights, matches, or other flame-producing apparatus shall never be taken into magazines or other spaces used as magazines.

(3) Before performing any work which may cause either an abnormally high temperature or an intense local heat in a magazine or other compartment used primarily as a magazine, all explosives shall be removed to safe storage until normal conditions have been restored.

2-18-3 MISCELLANEOUS ORDNANCE SAFETY PRECAUTIONS.

a. Small Arms. Safety precautions in (Army) FM23-5, FM23-35, and TM9-2117 safety regulations for firing rifles, revolvers, and shotguns shall apply to MSTS personnel firing or handling small arms.

b. Responsibility for Custody and Security of Small Arms. Masters of MSTS civil-service manned ships (USNS) are responsible for small arms aboard ship and should exercise such responsibility and care as per COMSTSINST 3120.2C and current local directives.

2-18-4 EXPLOSIVE SAFETY PROCEDURES FOR SHIPBOARD RESEARCH PROJECTS.

a. Applicability. The following instructions shall govern the handling, stowage, assembly, and firing aboard ship of explosives used in research projects. These explosives shall include, but are not limited to, in-service underwater sound signals, special underwater sound signals, demolition block type explosives, and all other type explosives used in conjunction with research projects.

b. Objective. The objective of this section is to establish explosive safety procedures that will reduce the safety hazards to a minimum and acquaint personnel with the hazards of explosives and materials used in research projects and to provide a uniform handling and firing method that shall be followed by all personnel involved.

c. Master's Responsibility. In accordance with U.S. Navy Regulations, Article 0771, the Master is responsible for the safety of the ship and all persons on board and has the authority and responsibility to suspend any operation aboard his ship which he feels may endanger the lives of the personnel aboard.

d. Emergency Procedures. Personnel aboard ship involved in any way with the firing of explosives shall read and be familiar with the material in this section prior to participation. Practice firing runs shall be performed until the explosive shooter in charge is satisfied that the firing operations are satisfactory and safe. Emergency procedures shall be developed and practiced as applied to the specific ship assigned so that the firing team will know what action each shall take in the event of an emergency. The emergency procedures shall be reviewed by the Master of the ship with the chief scientist and a mutually agreed method of operation adopted. The availability and location of medical assistance shall be clearly defined.

2-18-5 GENERAL PRECAUTIONS.

a. Handling All Explosives. All explosive materials must be handled with extreme care and protected against shock, friction, fire and extremes of heat, cold, moisture and direct sun rays.

* (1) Compliance with NAVWEPS OD 30579, Explosive Safety Precautions for Research Vessels, is required.

(2) Compliance with OP 4, Ammunition Afloat, is required and the additional specific precautions contained herein as applicable to research projects.

(3) Compliance with Code of Federal Regulations, Title 46, Part 146, governing the transportation or storage of explosives or other dangerous articles or substances, and combustible liquids on board vessels is required.

(4) The location, positioning, stowage and movement of explosives prior to and during firing shall be such as to prevent premature or accidental detonation of explosives. Explosives shall be placed so that they will not be ignited by the fire burst or detonated spontaneously from the accidental detonation of the charge at the firing location.

(5) All on-deck explosives shall be in closed ammunition or shipping containers or inside a steel deck structure with the door closed except for explosives placed on deck for immediate firing.

CAUTION: THE ARMING SAFETY PIN SHALL NOT BE REMOVED UNTIL THE SIGNAL IS BEING LAUNCHED.

(6) The quantity of explosives at the firing point shall be kept to a minimum. The components (arming and firing mechanisms, fuze and explosive sections) shall be kept in their containers (ammo case) at least 35 feet from the firing point until assembled. The quantity of assembled signals shall be held to the minimum required for an orderly firing sequence.

CAUTION: ANY ARMING AND FIRING MECHANISM (fuze) WITHOUT AN ARMING SAFETY PIN IN PLACE WHEN REMOVED FROM ITS SHIPPING CONTAINER SHALL NOT BE MATED WITH AN EXPLOSIVE SECTION (Signal Body) BUT SHALL BE JETTISONED AT SEA.

NOTE: When explosives other than signals listed in OP 2982 or MARK 22 are used at the firing point, these signals shall be considered as other explosives and handled accordingly.

WARNING

NO EXPLOSIVE MATERIAL (OTHER THAN SAFETY FUZE OR PRIMACORD) SHALL BE CUT ABOARD SHIP.

b. Electrical Storm. No explosives shall be handled during or immediately preceding or after an electrical storm. Return all units to magazines at such times.

c. Transporting Detonators and High Explosives. Detonators and high explosives shall not be carried by the same man or otherwise transported or left close together.

d. Handling Initiating Explosives. Handle detonators, leads, squibs, caps and all initiating explosives with extreme care.

e. Keep Detonators From Other Explosives. Keep detonators and all other initiators away from other explosives until the last possible moment of use.

f. Storing Detonators. Detonators shall be kept in a cushioned box until the moment of use. The box lid must be kept in place except when actually removing or putting in a unit. Keep box in a safe place away from the firing location.

g. Keep Shunts on Electrical Detonators. Never carry detonators in pockets. Keep shunts on electrical detonators until moment of use.

2-18-6 FIRING PROCEDURES.

a. Unnecessary Personnel Excluded. Be sure firing area is definitely known to all hands and that unnecessary personnel are excluded from the area at all times.

b. No Smoking. The NO SMOKING rule shall be observed on deck when explosives are present, except such areas as approved by the ship's Master.

c. Warning System. A uniform system of warning shall be used when beginning operations and area shall be placarded. The bridge shall be notified prior to shooting operations.

d. Testing Safety Fuze. Safety fuze shall be tested after first cutting off and throwing away initial 6 inches of roll. Test 12 inches of fuze for burning rate to establish same. (Fuze will burn faster under water. Normal 40 sec/ft. fuze will burn in about 30 to 34 seconds when used to a depth of 50 feet of water).

e. Examining for Damage. The safety fuze shall be thoroughly examined for abrasions, sharp bends, frayed areas or any other damage. Safety fuze has been known to fire through damaged areas, instantaneously, for 5 to 6 inches.

f. Radio and Radar. Radio and radar of all ships in the area shall be secured until electrically initiated charge is safely under water. The chief scientist will keep bridge and Master informed. This shall not be necessary on non-electric fuzing or initiating explosives.

2-18-7 GENERAL NOTES.

a. Assemble One Cap and Fuze. One cap and fuze only shall be assembled ahead of actual shot. Cap and charge shall not be assembled until firing ship is underway and ready to fire so that charges may be jettisoned immediately if required.

b. Assemble One Cap and Charge. Only one charge and cap shall be assembled ahead of "over the side" and shall be hand held until used. If event is held up or called off, jettison immediately.

c. Minimum Fuze Length. The minimum fuze length is 36 inches. Where shallower depths than any attainable with this limitation are required, a BuWeps approved arrangement of floatation with soluble link for dud disposal can be employed.

d. Cutting Fuze. Cut fuze no more than five lengths ahead at any time, since fuze takes on moisture. The safety fuze shall be cut in lengths before detonators are crimped in place. Crimping shall be performed in an area separated from the other explosives.

e. Fuze Lighter. Fuze lighter shall not be placed on fuze prior to 1 minute ahead of "over the side" (an optimum time of 10 seconds should be adhered to when possible). Close watch on these procedures shall be made to insure no premature ignition. Place fingers on fuze below lighter as a safety check of accidental burning of fuze. If heat is felt, get rid of charge over the side immediately. YOUR LIFE DEPENDS ON THIS. Visually, if fuze gets dark or black, it is ignited and burning and must be jettisoned immediately.

f. Dropping Charge. The charge shall be dropped immediately when the pull wire igniter is "pulled".

WARNING

SINGLE FUZING ONLY SHALL BE USED.
DOUBLE DETONATOR WITH SAFETY FUZE
AND IGNITER IS PROHIBITED.

g. Electrical Firing. Electrical firing presents more problems since more individuals are involved. The following safeguards shall be observed.

(1) The charge and cap shall be assembled at the rail and placed in the water immediately after fastening together.

(2) Radio and radar shall be inoperative until charge is in the water.

(3) Firing cable shall be painted red or of a red material.

(4) Hook-up to firing device shall only be made after charge is in the water. Until this time, firing cable shall be shorted out.

(5) Cap cable shall be long enough so that charge is in the water before hook-up is made to shot cable.

(6) Firing device shall be so constructed that "shooter" replaces a portable circuit closure device before charge can be fired i.e., a short piece of cable with special plug on each end or short "shunted" or "shorted out".

(7) A "dud" electrical charge shall never be taken aboard ship.

h. Stowing Explosives on Deck. All explosives on deck shall be stowed securely so as not to be affected by the ship's motion.

i. Firing Point. The firing point shall be located at the stern of the ship or at such other position approved by the Master of the ship.

j. Shooter. The explosive shooter in charge shall be authorized to jettison any charge at his discretion or personal impulse, or completely call off an event.

k. Firing Crew. The firing crew shall consist of no less than 2 men, one of which will be the Safety Officer.* When operation requires the use of two men to handle charges up to and including shooter, then 3 men shall be employed.

* Safety Officer (a qualified shooter) will be designated by Chief Scientist. Safety Officer should be directed to observe the initial firing of a series and substantiate that correct and safe procedures were observed through use of a check-off list. Check-off lists for each type shooting operation shall be provided by the sponsor of the project, using applicable precautions. The Master should be fully cognizant of each type of check-off list and its use by the Safety Officer.

l. No Horseplay. No horseplay, shouts, or loud talking shall be done in the shooting area.

m. Fire Hoses. Fire hoses in the immediate firing area shall be laid out and pressure maintained in fire main for emergency use during all firing operations.

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