c. Depth of Cut. The plane blade shall be properly adjusted, as too deep a cut will cause the plane to buck and clog.

d. Firmly Grasped. The plane or draw knife shall be grasped with both hands.

e. Bracing with Knees Prohibited. No one shall use a draw knife while using the knees to brace the material.

f. Protecting Blade. To avoid possible injury to the hands when reaching for other tools, planes and draw knives shall be put away in such a manner that the blades will be protected.

2-13-16 BORING AND MORTISING MACHINES.

a. Chucks. Safety bit chucks with no projecting set-screws shall be used.

b. Boring Bits. Boring bits shall be provided with a guard that will enclose all portions of the bit and chuck above the material being worked.

c. Chain Mortiser. The top of the cutting chain and driving mechanism shall be enclosed.

d. Counterweights. If there is a counterweight, one of the following or equivalent means, shall be used to prevent its dropping.

(1) It shall be bolted to the bar by means of a bolt passing through both bar and counterweight.

(2) A bolt shall be put through the extreme end of the bar.

(3) Where the counterweight does not encircle the bar, a safety chain shall be attached to it.

(4) Other types of counterweights shall be suspended by chain or wire rope and shall travel in a pipe or other suitable enclosure wherever they might fall and cause injury.

f. Universal Joints. Universal joints on spindles of boring machines shall be completely enclosed to prevent injury to operator.

g. Guarding Operating Treadles. All operating treadles shall be covered by an inverted U-shaped metal guard, fastened to the floor, of adequate size to prevent accidental tripping.

2-13-17 SANDING MACHINES.

a. General.

(1) All sanders shall be carefully inspected before use. Sanding disks on belts shall not be used if they are frayed or cracked.

(2) Personnel Protection.

(a) Goggles and masks shall be used during the sanding operations and while cleaning up afterward.

(b) The hands or other parts of the body shall be kept from coming into contact with the abrasive surface of the sander.

(3) Sanders are to be grasped with both hands and held firmly against the work. Care shall be taken that the sander does not break away, thereby causing injury or damage.

(4) The electric plug shall be pulled before sanding belts or disks are changed or before repairs or adjustments are made to the sander.

b. Belt Sanding Machines. Each belt sanding machine shall have both pulleys enclosed in such manner as to guard the points where the sanding belt runs onto the pulleys. The unused run of the sanding belt shall be enclosed. Belt type sanders shall be adjusted to the proper tension.

2-13-18 COMBINATION OR UNIVERSAL WOOD-WORKING MACHINES.

a. Guards. For combination or universal wood-working machines, each point of operation of any tool shall be guarded as required for such tool in a separate machine. Such machines shall be provided with a separate starting and stopping device for each point of operation.

b. Feed Rolls. Feed rolls of self-feed sanding machines shall be protected with a semicylindrical guard to prevent the hands of the operator from coming in contact with the in-running rolls at any point. The guard shall be constructed of heavy material, preferably metal, and firmly secured to the frame carrying the rolls so as to remain in adjustment for any thickness of stock. The bottom of the guard shall come down to within 3/8 inch of a plane formed by the bottom or contact face of the feed roll where it touches the stock.

c. Drum Sanding Machines. Each drum sanding machine in a location where an exhaust system in required shall have an exhaust

hood. If no exhaust system is required, another guard shall be used. Guards shall be so arranged as to enclose the revolving drum. However, in cases where the use of a table makes complete enclosure impracticable, the guard should be arranged so as to enclose as much of the disk as possible and still have room for manipulation of the material to be finished.

d. Disk Sanding Machines. Each disk sanding machine shall also have an exhaust hood or other guard which shall be arranged as described above.

PART 2
GENERAL SAFETY PRECAUTIONS

CHAPTER 14
REFINISHING AND PROTECTION OF SURFACES

SECTION I - GENERAL

SECTION II - PAINTING

SECTION III - CLEANERS AND SOLVENTS

2-14-1 FIRE HAZARDS. The use of paints, varnishes, lacquers, cleaners, solvents, and other finishing materials containing flammable solvents readily ignitable at comparatively low temperatures involves a marked fire hazard. Liquids containing volatile flammable solvents exposed to evaporation from flammable vapors which, if not cared for by adequate ventilation, may form explosive or flammable mixtures with air. The National Fire Protection Association Inspection Manual, Chapters 13 and 17, shall be used as a guide in handling, storing, and using flammable liquids.

2-14-2 CONTAMINATION OF AIR. Vapors and gases from cleaners, solvents, and paints frequently have a harmful toxic effect on the human system. Every precaution should be taken to prevent excess contamination of the air by solvent vapors. This applies to tank-type cleaners, lacquer thinners, benzine, naphtha, paints, solvents, etc.

2-14-3 PAINT STORAGE. Containers holding paints, varnishes, lacquers, removers, thinners, cleaners, or any volatile solvents shall be kept tightly closed when not in actual use. They shall be stored in a separate building or in a fire-resisting room which is well ventilated and where the paint material will not be exposed to excessive heat, smoke, sparks, flame, or the direct rays of the sun. Wiping rags and other flammable waste material shall always be placed in tightly closed metal containers, and the containers must be emptied at the end of a day's work. Painters' overalls should be hung in metal lockers. Lamp, paint, and oil lockers and similar compartments aboard ship shall be constructed of steel or shall be wholly lined in metal.

2-14-4 PAINT REMOVAL WITH TORCH. Whenever a torch is used for paint removal, the operator must guard against accidental ignition of flammable materials in the vicinity.

2-14-5 TOXIC AND POISONOUS SUBSTANCES. Good habits of personal hygiene will prevent lead poisoning. Certain paints and organic solvents irritate or burn the skin and should be handled with approved gloves. ~~See 2-11-7.~~ DELETE

2-14-6 PAINTING AREA.

a. Mixing Paint. Painters should have detached shops or temporary structures where all paint should be mixed, and where paint buckets, brushes, and rags can be kept at the end of the day's work. Only the quantity of oil or paint needed for one day's work shall be taken into the building being painted. Paint mixing and storage shops other than structures of temporary nature should be protected by automatic sprinklers.

b. No Smoking. Signs reading "No Smoking Allowed IN or Around This Building" should be posted conspicuously inside and outside each paint shop or other building in which paint is used or stored. No open flame of any kind shall be allowed near paint-mixing operations.

c. Ventilation. Forced draft ventilation should be provided for personnel engaged in scaling, brush painting, spraying, and in using paint removers.

d. Aloft or Overside. Before painting, inspect scaffolding and rigging for safety. Lifelines should always be worn on this work, with the lifeline secured. When brush painting from ladders, the paint bucket should be hung from a ladder rung with a suitable hook, and the painter shall hold onto the ladder with one hand.

e. Housekeeping. Good housekeeping must be especially stressed where painting work is being done.

2-14-7 HEALTH HAZARDS AND PROTECTIVE EQUIPMENT.

a. Medical Examinations. Painters must continuously observe good habits of personal hygiene to avoid the health hazard of lead poisoning. Medical examinations of painters should be conducted periodically in the course of continued work with toxic paint materials.

b. Respirators. When torches are used to remove old coats of paint, suitable protection (adequate ventilation or the wearing of a proper type respirator) should always be provided against the possibility of lead poisoning from inhalation of the fumes.

c. Thorough Washing. Strict adherence by painters to a system of good personal hygiene in washing with the proper type of soap or detergent, eating, drinking, etc., will practically eliminate the possibility of lead poisoning. Painters should be particularly careful to keep dirty fingers out of the mouth and away from food and other substances going into the mouth. Painters should always wash hands, arms, and face with warm water and soap before eating.

d. Gloves. Rubber gloves should always be worn when handling cleaning compounds, thinners, paints, removers, or other materials that may irritate the skin.

e. Life Jackets. Each man shall wear a properly fitted life jacket when working in a precauious position near or over water, or at an elevated position with a lifeline of such length (no more than 2 feet of slack) that the jolt from a fall would not injure him. Since injuries to painters often result from the improper use of ladders and scaffolds, particular care should be exercised in this area.

f. Antifouling Paint. Care shall be taken not to get any plastic antifouling paint on the face, hands, or clothing, as it will burn the skin. Masks and gloves shall always be worn when using this kind of paint.

2-14-8 SPRAY PAINTING.

a. Dangers. The application of paints, varnishes, lacquers, enamels, wood bleaching liquids, and other flammable liquids by the spray process is more hazardous than brush applications because of the volume and concentration of the work and because spraying produces a residue of flammable character and deposits which are subject to spontaneous ignition. Health hazards due to the presence of potentially harmful substances such as lead, benzol, and silica may also be present in paint spraying operations.

b. Ventilation. To insure immediate removal of vapors and waste residues from spraying operations, complete ventilation of the compartment is essential. However, adequate ventilation may and usually does require positive means in addition to natural ventilation. A system balanced so as to provide fresh air supply as well as exhaust is therefore recommended. Ordinarily the ventilation necessary for the health and comfort of the operators is sufficient also to remove flammable vapors.

c. Protective Clothing. Operators of spray machines shall wear protective garments which fit snugly at the ankles, neck, and wrists. They shall wear gloves, and approved filter-type respirators while spraying or when mixing dry colors or using other finishing materials which create flammable vapors. They should never inhale the mist from the spray gun.

d. Showers. Where paint-spraying operations are conducted extensively, showers should be installed close by and the employees should use them after every shift.

e. No Smoking. Smoking is prohibited in rooms where spray guns are in operation. The presence of any open flame is forbidden in such locations.

f. Electrical Equipment. Electrical equipment in rooms where paint-spraying or extensive paint mixing operations are carried on, or where large quantities of paints are stored, should be installed in accordance with CG 259-111.60-40b.

g. Fire Fighting. Supervisors should insure that fire fighting equipment is readily available and that personnel are trained in its use.

h. No Loitering. Only authorized personnel shall be allowed in spray painting rooms.

i. Spray Booths. Where paint spraying operations are regularly conducted inside a building or structure, a standard metal

spray booth with an exhaust system using type D motor should be provided which complies with the requirements of the National Board of Fire Underwriters.

(1) Compressed air or flammable liquids should not be used for cleaning these booths. If scraping tools are used they shall be made of nonferrous material.

(2) Every spray booth should be provided with automatic fire-extinguishing systems. If the sprinklers are subject to loading by paint deposits they should be cleaned frequently. The National Fire Protection Association Standards on "Spray Painting and Finishing" give detailed recommendations for safeguarding this process.

j. Cleaning Spray Guns. Spray guns, paint containers, and hose must be thoroughly cleaned after use. The adjustments at the back of the gun and the trigger action should be lubricated frequently. Consult BuShips Technical Manual 9190.63 for additional data.

2-14-9 RUST-PREVENTIVE COMPOUNDS.

a. Ventilation. When cleaning and spraying with rust-preventive compounds special care shall be taken that working spaces are always well ventilated.

b. Open Flame. Smoking, welding, oxyacetylene burning, or any other operation involving open flames or sparks, shall not be allowed in the same compartment where rust-preventive compound is being used. In the open air, burning shall not be carried on within 20 feet of spraying.

c. Preventing Electric Sparks.

(1) Only nonsparking shoes should be worn by personnel working with rust-preventive compounds.

(2) Only explosion-proof electrical equipment shall be operated in such places.

(3) A spray gun used for spraying rust-preventive compounds shall be grounded to eliminate any generated electrostatic charge.

d. Personnel Protection.

(1) Protective cream or ointment should be applied to parts of the body which are exposed to contact with these vapors.

(2) Protective gloves shall be worn when applying

cleaning liquid or when spraying, brushing, flushing, or dipping with this compound.

(3) When using rust-preventive compounds in a confined or poorly ventilated space, an air-supplied respirator, Navy Type A, shall be worn. When spraying, brushing, flushing, or dipping with this compound in the open air, the twin-chemical cartridge respirator, Navy Type B-2, shall be worn.

2-14-10 PAINTING BY DIPPING.

a. Hazards. Painting by dipping objects in tanks of paint, enamel, varnish, etc., involves the hazard of exposed surfaces of flammable liquids and the evaporation of solvents.

b. Ventilation. Complete ventilation of the area in which dipping operations are carried on is essential. Dipping should preferably be carried on in a detached building or a cut-off section; it should not be conducted in basements where ventilation in difficult to obtain.

c. Tank Covers. Small dip tanks can be protected by automatic closing covers. Such covers should be held open either by a fusible link or by some form of thermostatic device designed to close the cover and cut off the air supply in case of fire.

d. Overflow Pipes. Overflow pipes should be provided for all dip tanks to prevent spillage and designed so that the contents of the tank can in the event of an emergency be drained to an underground tank located outside the building.

e. Drain Boards. Drain boards on which the surplus finish drips from articles leaving the dip tank are a point of hazard and should be included in the protection for the tank.

f. Open Flame. No smoking or open fires shall be permitted in areas where paint dipping operations are conducted. Only standard methods of heating shall be employed in such areas. The standards of the National Fire Protection Association on dipping tanks give detailed requirements for safeguarding this process.

2-14-11 VAPORS AND GASES.

a. Ventilation. Every precaution should be taken to prevent excessive contamination of the air by solvent vapors. Most solvent vapors are heavier than air and require that fresh air be admitted at the top of the room and contaminated air be withdrawn near the deck. Personnel whose duties require them to work around vapors, gases, solvents, acids, etc., shall be instructed in the dangers and hazards of handling these substances.

b. Vapor Removal From Tanks. When working with solvents in deep or nearly closed tanks such as vapor degreasing tanks, vapors should be removed in accordance with the recommendations of the manufacturer for the particular equipment used.

c. Unsafe Concentration. Toxic vapors or gases shall not exceed the maximum allowable concentration (part per million) established by the American Conference of Industrial Hygienists.

NOTE: Up-to-date threshold values shall be forwarded to the fleet from time to time.

2-14-12 STORAGE AND HANDLING.

a. Method. Solvents will be handled and stored with regard to their particular properties concerning overheating, combustion, proximity to dangerous materials, and improper ventilation. Good housekeeping should be especially stressed in handling and storage areas.

b. Containers.

(1) Solvent containers shall be constructed of plastics when compatable with contents and be kept tightly closed when not in use. They must be stored with the bung or outlet up. When a container is found to be leaking, the contents shall be immediately transferred to another container. Keep out of the sun and away from heat.

(2) Never use pressure to empty containers. In case of spillage, flush with plenty of water. Be sure empty containers are completely drained. Keep lights, fire, and sparks away from openings. Never drop containers. Never use empty containers for another purpose.

(3) Containers used for the storage and handling of solvents in small quantities should be approved by Underwriters Laboratories for the particular type of solvent.

(4) All containers in which solvents are stored or used shall be plainly marked and instructions thereon shall be carefully read and complied with.

2-14-13 ACIDS.

a. List of Acids. The following acids are most frequently used in the Navy:

(1) Chromic, cresylic (cresol), hydrochloric, hydrofluoric,

oxalic, phosphoric, and sulfuric.

(2) Hydrocyanic, poison gas; mixed acid (sulfuric and nitric), may cause nitrous gas poisoning; nitric, may cause nitrous gas poisoning; perchloric acid solution, strong oxidant, corrosive fluid; and fuming sulfuric, highly concentrated.

b. Working Precautions. When working with or near acids, operators must prevent splashing, spilling, spraying, or inhalation of acid fumes or gases. In metal pickling, where open tanks are used, acid burns are a particular hazard. Personal protective equipment i.e., acid type goggles, rubber gloves and rubber aprons shall be worn while handling acids.

c. Odors. Some acids, hydrogen sulphide for example, provide a warning by odor. However, odor cannot always be relied on for warning, inasmuch as the nose becomes readily fatigued in a short period of time, thus failing to warn.

d. Reflex Respiratory Action. Many acids warn by setting up a reflex respiratory action as in the case of sulfur dioxide which is practically irrespirable. Other gases such as nitrous oxide have little warning effect and set up no respiratory reflexes.

e. Warning.

(1) Avoid contact with eyes, skin, or clothing.

(2) Do not take internally; do not breathe vapors.

(3) Store in cool protected spaces and away from direct heat. For additional information regarding storage, see BuShips Technical Manual, Chapter 9300.

(4) Do not add water to acids. In diluting acids, the acid must be added to water slowly and with constant mixing.

(5) Spillage of some acids may cause fire or liberate dangerous gases.

(6) Care should be taken to avoid mixing any organic material (such as alcohol) with chromic acid, since an explosive mixture will result.

f. Treatment. In case of contact with acids, flush the affected part with plenty of water and get medical attention.

2-14-14 ALCOHOLS.

a. List of Alcohols. The following alcohols are most frequently used in the Navy:

(1) Allyl, butyl, and isopropyl.

(2) Ethyl (denatured), and Methyl. These alcohols cannot be made nonpoisonous and may be fatal if swallowed. If swallowed, give a tablespoonful of salt in a glass of water or give two teaspoonfuls of baking soda in a glass of water, and get medical attention.

b. Warning.

(1) Keep alcohols away from heat and open flames.

(2) Do not take internally; do not breathe vapors.

(3) Avoid contact with eyes, skin, or clothing.

(4) Use with adequate ventilation.

c. Treatment. In case of contact with alcohols, flush the affected part with plenty of water, apply a 5 percent solution of bicarbonate of soda, and get medical attention.

2-14-15 AMINES.

a. List. The following amines are most frequently used in the Navy: n-butylamine, diethylamine, diethylenetriamine, ethyleneamine, morpholine, monoethanolamine, and triethanolamine.

b. Warning.

(1) Keep away from heat and open flames.

(2) Avoid contact with eyes and skin.

(3) Do not breath vapors.

(4) Use with adequate ventilation.

c. Treatment. In case of contact with amines, flush the affected part with plenty of water and get medical attention.

2-14-16 GLYCOLS AND ETHERS.

a. List. The following glycols are most frequently used in the Navy: ethylene glycol, and diethylene glycol. Ethers used are n-butylether and dichloroethyl ether.

b. Warning for Glycols.

(1) Avoid prolonged or repeated contact with skin.

(2) Avoid prolonged breathing of vapor and do not take internally.

(3) Use only with adequate ventilation.

c. Warning for Ethers.

(1) Keep ethers away from heat or open flames.

(2) Do not take internally.

(3) Do not allow to evaporate to near dryness. Addition of water or appropriate reducing agents will lessen peroxide formation.

2-14-17 ESTERS.

a. List. The following esters are most frequently used in the Navy: iso-amyl acetate, n-butyl acetate, ethyl acetate, methyl acetate, and isopropyl acetate.

b. Warning.

(1) Keep esters away from heat and open flames.

(2) Avoid contact with eyes and skin.

(3) Do not breathe vapors.

(4) Use with adequate ventilation.

2-14-18 KETONES.

a. List. The following ketones are most frequently used in the Navy: acetone, methyl ethylketone, and isopropyl ketone.

b. Warning.

(1) Keep ketones away from heat, sparks, and open flames.

(2) Avoid prolonged or repeated contact with skin.

(3) Use with adequate ventilation.

(4) Do not take internally or breathe the vapors.

2-14-19 CHLORINATED COMPOUNDS.

a. List. The following chlorinated compounds are most frequently used in the Navy: chlorinated naphthalene, chlorobenzene, chloroform, dichloroethylene, ethyl chloride, ethylene dichloride, methylene chloride, perchloroetylene, and trichloroethylene. Carbon tetracnloride is prohibited from use without the written approval of COMSTS. Methyl chloroform (1,1,1 trichloroethane) is a suitable substitute for carbon tetrachloride for most purposes.

b. Warning.

(1) Keep away from heat and open flames.

(2) Do not take internally or breathe the vapors.

(3) Avoid contact with the skin.

(4) Use only with adequate ventilation.

c. Stowage. The Chief Engineer shall have custody of and be responsible for the proper stowage of approved solvents carried aboard ship. Solvents shall not be stored with flammable liquids, and shall be kept under lock and key. The amount of approved solvent carried aboard ship shall be limited to quantities required for a single round trip voyage. *

2-14-20 NITROPARAFFINS.

a. List. The following nitroparaffins are most frequently used in the Navy: nitromethane, mitroethane, and nitropropane.

b. Warning.

(1) Keep away from heat and open flames.

(2) Do not breathe vapors or take internally.

(3) Avoid contact with skin.

(4) Use with adequate ventilation.

2-14-21 HYDROCARBONS.

a. List. The following hydrocarbons are most frequently used in the Navy: benzene, toluene, xylene, naphthalene, gasoline, and Stoddard solvent.

b. Warning.

(1) Keep away from heat, sparks, and open flames.

(2) Do not breathe vapors.

(3) Avoid contact with skin.

(4) Use only with adequate ventilation.

2-14-22 MISCELLANEOUS.

a. Ethyl Methacrylate Monomer and Methyl Methacrylate Monomer.

(1) Keep away from heat and open flames.

(2) Do not breathe vapor.

(3) Avoid contact with eyes, skin, and clothing.

(4) Use with adequate ventilation.

b. Sodium Hydroxide (caustic soda).

(1) Do not take internally.

(2) Avoid contact with eyes, skin, and clothing.

(3) Wear goggles or face shield while handling.

(4) To avoid violent spattering while making solutions add sodium hydroxide slowly to the surface of the solution.

c. Turpentine.

(1) Keep away from heat, sparks, and open flames.

(2) Do not breathe vapors.

(3) Avoid contact with the skin, eyes, and clothing.

(4) Use only with adequate ventilation.

2-14-23 DISPOSAL OF MATERIALS.

a. Organic Solvents. These materials should be reclaimed or disposed of for reclamation or burned.

b. Acids. In general, spent acids should be disposed of for reclamation or flushed down the drain with a large excess of water. Care should be taken in the disposition of hydrofluoric acid, since this material is very hazardous to personnel. This acid and cresylic acid should be neutralized with a base (alkali) before flushing down the drain with a large excess of water.

c. Alcohols. These materials should be reclaimed or disposed of for reclamation or flushed down the drain with an excess of water.

d. Amines. These materials, which are sometimes present in cleaning compounds, should be flushed down the drain with an excess of water.

e. Glycols and Ethers. These materials should be disposed of for reclamation or flushed down the drain with an excess of water.

f. Esters. These materials should be disposed of for reclamation or flushed down the drain with an excess of water.

g. Ketones. These materials should be disposed of for reclamation. Do not flush down drain.

h. Chlorinated Compounds. These materials should be reclaimed or disposed of for reclamation.

i. Nitroparaffins. Dispose of for reclamation or burn in open with careful and controlled combustion.

j. Hydrocarbons. These materials should be reclaimed or disposed of for reclamation or burned.

k. Ethyl and Methyl Metacrylate Monomers. These materials are used in cementing plexiglas, and any unsatisfactory materials should be burned.

l. Sodium Hydroxide (caustic soda). This material should be neutralized with an acid and flushed down the drain with an excess of water.

m. Turpentine. This material should be disposed of for reclamation or burned.

PART 2
GENERAL SAFETY PRECAUTIONS

CHAPTER 15
ELECTRICITY AND ELECTRONICS

SECTION I - GENERAL

SECTION II - WORKING WITH ELECTRICITY

SECTION III - ELECTRONIC SAFETY

2-15-1 PERSONAL PROTECTION.

a. Safety Instructions. Personnel engaged in electrical work are to be fully informed of the hazards involved. They shall receive proper instruction in accident prevention and first aid procedures. Chapters 60 thru 69 of BuShips Technical Manual and Coast Guard 259 "Electrical Engineering Regulations" should be

consulted for specific details covering electricity and electronics not covered in this Chapter.

b. Clothing.

(1) General Safety Measures.

(a) Do not work on electrical apparatus with wet hands or while wearing any wet clothing.

(b) When performing work or within four feet of electrical equipment, do not wear any clothing with exposed zippers, buttons, or other metal fasteners.

(c) Personnel shall wear no loose or flapping clothing.

(d) No flammable articles, such as celluloid cap visors shall be worn.

(e) Personnel shall remove rings, wrist watches, bracelets, and other similar metal items before performing work on or within four feet of electrical equipment with exposed current-carrying parts.

(f) Personnel shall wear high-cut shoes with sewed soles for work on live electrical circuits where the voltage is above 50 volts. Thin-soled shoes and shoes with metal plates or hobnails are prohibited. Safety shoes with nonconductive soles shall be worn if available.

(2) Special Protective Clothing.

(a) Rubber gloves should be worn by personnel likely to come in contact with live conductors or current-carrying parts of equipment in the course of their work where the system voltage is 30 volts. Since circuits below 30 volts are also dangerous, no work should ever be done on live conductors of any voltage except in case of emergency. If the work requires that one hand be free of covering a rubber glove should be worn on the other. The following safety rules shall apply in the use of rubber gloves.

1 Personnel intending to work on live circuits, or on equipment containing exposed current-carrying parts where the voltage exceeds 30 volts, shall put on rubber gloves before coming within reach of the live parts and shall not remove them until entirely clear of such equipment.

2 Leather protectors shall be worn over rubber gloves when conditions warrant.

3 Rubber sleeves or rubber gloves shall never be rolled down or worn inside out.

4 Personnel shall wear rubber gloves when cutting a supposedly dead cable or testing supposedly burned-out transformers.

5 Rubber gloves shall be checked by the user for punctures, tears, or abrasions. Cuffs should be rolled up and air forced into the fingers and palms of the gloves. If there is any leakage or thin spots evident, the gloves should not be used. *

(b) Never wear protective equipment which you believe may be defective. Such equipment is to be tagged and turned in for repair or replacement.

*

c. Other Protective Equipment.

(1) Danger signs and suitable guards, adequately illuminated, shall be provided to warn all personnel wherever live parts of electrical circuits or equipment are permanently exposed when the circuit voltage exceeds 30 volts. See 2-15-14 for warning signs specified for shipboard and shore electronics installations.

(2) On all circuits where the voltage is in excess of 30 volts, and where the deck or walls are of metallic construction, the worker should be insulated from accidental ground by use of approved insulating material. The insulating material shall have the following qualities:

(a) It shall be dry, without holes, and shall not contain conducting materials.

(b) The voltage rating for which it is made shall be clearly marked on the material, and the proper material shall be use so that adequate protection from the voltage can be supplied.

(c) On voltage below 600 volts, dry wood may be used or, as an alternative, at least two layers of dry canvas, sheets of phenolic material, or rubber mats. Where other than approved rubber mats are used, the marking provision of paragraph (b) above shall not apply; however, care shall be taken to insure that substitute material is capable of providing the required insulation value.

(d) Care shall be exercised to insure that moisture, dust, metal chips, etc. which may collect on insulating materials is removed at once. Small deposits of such materials can become very great electrical hazards.

(e) All insulating materials on machinery and in the area shall be kept free of oil, grease, carbon dust, etc., since such deposits destroy insulation.

(3) Any area in and around high-voltage equipment shall be provided with insulated deck and work bench surfaces and clearly marked with high-voltage warning signs. Use of non-conductive rubber matting in these areas shall be in accordance with military specifications Mil-M-15562. All rubber matting shall be cemented down except on gratings and removable floor plates where oily, wet surfaces may be encountered, wood gratings covered with rubber matting shall be used.

(4) Where static electricity is generated by movement of workmen in work areas such as hospital operating rooms, anesthetic

areas, ordnance plants, etc. containing explosive mixtures of flammable vapors, dusts or gases, a suitable protective conductive covering for floors, decks, work benches, furniture etc. is required so that these charges may be quickly conducted to ground. (See National Fire Protection Association Bulletin No. 56, "Flammable Anesthetics", dated 1959 or subsequent revisions.)

(5) Whenever it is necessary to perform work on electrical circuits or equipment in wet or damp locations, dry wooden stools or platforms shall be provided so that there will be no possibility of contact between the wet or damp floor and workmen's shoes.

(6) Metal tool handles shall be covered with rubber insulating tape. Use of plastic or cambric sleeving or friction tape alone is prohibited for this purpose.

(7) The covers for fuse boxes, junction boxes, switch boxes, and other types of wiring equipment and accessories shall, except when work is being done on them, be kept securely closed, and kept locked.

(8) Protective metal enclosures shall be provided for electrical and electronic equipment i.e., switchboards, control panels, antenna transmitting equipment, resistor panels etc. These enclosures shall be provided with locking doors or accesses. The metal bases, frames etc. are to be effectively grounded. Grounding is to be checked at regular intervals and after repair work has been performed, the grounding conductor used to connect the enclosure to ground shall have a cross sectional area of the line conductors which carry power to the equipment. The grounding conductor shall make positive metal-to-metal, low resistance contact with the enclosure at one end and at the other end with the metal object used as a ground, the hull of the ship in shipboard installations, and the ground rods, water pipes or installed grounding object in shore installations. In shore installations the resistance between the earth and the metal object used as ground shall not exceed 3 ohms.

(9) Safety devices such as interlocks, overload relays, and fuses shall not be altered or disconnected except for replacement, nor shall safeguard circuits be modified without specific authority.

(10) Unserviceable tools shall be condemned and repaired or, if possible, replaced. Tool handles, either wooden or plastic, which are cracked, chipped, splintered, or broken must be replaced.

d. Identification of Electrical Outlets. Shipboard electrical outlets shall be plainly identified as to voltage and type of current when the following conditions exist.

(1) When outlet current is in excess of 110 volts, the voltage and type of current must be specified.

(2) Electrical outlets which are at variance with the primary power source, i.e., A.C. current on a D.C. powered ship.

(3) All electrical outlets in living spaces where both A.C. and D.C. current are provided.

e. Special Precautions Against Electrical Shock. Strict adherence to the rules on the use of proper clothing and equipment, outlined above, is essential in an area where electrical work is being done and serves as an aid to the prevention of electric shock. Other safety measures to be taken are as follows:

(1) It is essential that personnel also keep in mind the fact that various pieces of equipment not ordinarily thought of as conductive can be dangerous. Miscellaneous tools and equipment containing metal parts, such as metal tapes, cloth tapes with embedded metallic threads, wooden scales with metal trimmings, cleaning brushes, dusters, or brooms having exposed metal parts, etc. shall not be used in any area within four feet of electrical equipment or wiring having exposed current-carrying parts.

(2) It is the responsibility of the supervisor to ensure that sufficient illumination is provided for safe and expeditious performance of work involving electrical wiring and equipment. See article 2-1-10 for minimum lighting necessary for specified types of work.

(3) Personnel working on electrical circuits shall exercise extreme care to ensure that their attention does not wander and that attention is not diverted from the work at hand.

(4) Continual inspection with awareness of the danger of accidental grounds and short circuits is necessary for the safety of personnel. Any dangerous conditions shall be reported and should be corrected if possible before any further work is done in the area.

(5) Do not trust insulation when electrical work is to be performed. Insulation may appear to be in perfect condition but if defective, may result in serious injury from electric shock.

(6) Fundamentally, current, rather than voltage, is the criterion of shock intensity. The passage of even a very small current through a vital part of the human body will cause DEATH. The voltage necessary to produce the fatal current is dependent upon the resistance of the body, contact conditions, the path through the body, etc. When a 60 cycle alternating current, for example, is

passed through a man from hand to hand or from hand to foot and the current is gradually increased from zero it will cause the following effects: at about 1 milliampere (0.001 ampere) the shock is perceptible; at about 10 milliampers (0.01 ampere) the shock is of sufficient intensity to prevent voluntary control of the muscles and a man may be unable to let go and free himself; at about 100 milliampers (0.1 ampere) the shock is fatal if it lasts for one second or more. The above figures are the results of numerous investigations and are approximate because men differ in their resistance to electrical shock. It is imperative to recognize that the resistance of the human body cannot be relied upon to prevent a fatal shock from 115 or lower voltages -- FATALITIES FROM AS LOW AS 30 VOLTS HAVE BEEN RECORDED. Tests have shown that body resistance under unfavorable conditions may be as low as 300 ohms and possibly as low as 100 ohms from temple to temple if the skin is broken. Volt for volt, D.C. potentials are normally not as dangerous as A.C. as evidenced from the fact that reasonably safe "let-go current" for 60 cycle alternating is 9.0 milliamperes for men and 6.0 milliamperes for women while the corresponding values for direct current are 62.0 milliamperes for men and 41.0 milliamperes for women.

(a) When working on live circuits exercise as much care to avoid contact with low voltages as with high voltages. Work on live circuits should not be undertaken alone and should be accomplished only in accordance with the procedures stated in Article 2-15-9. Circuits of 30 volts or less usually are considered safe from shock hazard but danger from the fire hazard, where high currents are possible, must be guarded against.

(b) Never take a shock intentionally from any voltage. This is dangerous practice and is strictly forbidden. Whenever it becomes necessary to check a circuit to see that it is alive, an appropriate voltage tester, voltmeter or other indicating device shall be used. Circuits carrying voltages in excess of 600 volts shall not be measured by probing or holding the test probes in the hands. Whenever measurements of voltages in excess of 600 volts are necessary, the procedures prescribed in Article 2-15-9, paragraph c, shall be followed.

(c) Do not approach closer than one foot to any electrical circuit or any electrical equipment where the circuit voltage is below 7,500 volts and which has exposed live metal parts, except to accomplish a particular mission with respect to the circuit or equipment. Where the circuit voltage exceeds 7,500 volts, maintain clearances as tabulated in Article 2-15-9d(3)(c).

(7) Where work is being performed within four feet from the exposed parts of electrical or electronic equipment by painters, carpenters, or other trades, regardless of the voltage an insulating

barrier shall be provided between the work area and any live electrical parts -- or the circuits shall be deenergized. In all such cases the supervisors of the nonelectrical workers shall report the location of the work to the electrician in charge. The electrician shall instruct the supervisors of the nonelectrical workers regarding proper insulating barriers as may be applicable or provide for deenergizing and locking out of circuits where possible. The supervisor of the nonelectrical workers is responsible for carrying out precautionary instructions given by the electrician in charge.

* f. First Aid. Electrical workers are to know the procedures of the mouth-to-mouth or nose-to-mouth methods and (Holger-Nielson) back pressure methods of resuscitation which is to be used when artificial respiration is necessary. (See NAVSHIPS Technical Manual, Chapter 60, Article 23 for specific details. Employees not familiar with these methods shall arrange with the safety officer to obtain the necessary instructions without delay. The engineering officer or other cognizant official shall require personnel engaged in electrical work to demonstrate their practical knowledge of the application of artificial respiration. He is to arrange for additional training, if necessary, so that workers may attain proficiency. A copy of artificial respiration poster shall be posted in close proximity to main auxiliary and emergency switchboards and other areas where personnel may be exposed to electric shock.

2-15-2 SAFETY FROM FIRE.

a. Preventing Fires. General cleanliness in the entire area is essential for the prevention of fires. In addition, the following requirements are particularly applicable in an area where work with electricity is being carried on:

(1) Avoiding Use of Flammable Cleaning Fluids.

(a) Gasoline, benzene, ether, and similar flammable cleaning fluids shall never be used on either energized or deenergized electrical apparatus.

(b) Alcohol shall never be used for cleaning near electrical equipment from which a spark might be received.

(2) Oil, grease, carbon dust, etc. can become ignited by electrical arcing. Machinery is to be kept absolutely clean and free of all such deposits.

(3) Lighted matches or other open flames shall never be used in confined spaces because of the danger of explosions and fires.

b. Fire Fighting. In the event of a fire, the following precautions are to be carried out:

(1) Rules Applying to All Fires.

(a) Immediately deenergize the circuit or equipment affected.

(b) In a few cases the means of calling the fire department may be much closer at hand than the electric power controls. In such cases the fire department should be called first, but circuits should be deenergized before fire fighting begins.

(c) Control the fire insofar as possible with the correct type of firefighting equipment until firefighting personnel arrive. Firefighting equipment must be kept readily available at all times.

(2) Rules Applying to Specific Situations.

(a) If an electrical fire occurs at a location where standpipes are available, the standpipes should be manned only by experienced firefighting personnel who are familiar with that equipment.

(b) In case of cable fires which the inner layers of insulation, or insulation covered by armor, support combustion, the only positive method of preventing the fire from running the length of the cable is to cut the cable and separate the two ends.

(3) Extreme care shall be taken to select the proper type of equipment to combat electrical fires. The preferred extinguisher for electrical fires is the Class C extinguisher. The stream from this extinguisher is nonconductive and can be directed against energized circuits without danger of shock. Fire extinguishers ordinarily used for electrical fires are the carbon dioxide and dry chemical types.

c. Inspection before Current is Restored. If the electrical wiring or apparatus has been affected by fire a careful inspection must be made before the current is turned on in the building.

d. Explosion-proof light Fixtures, Switches, Motors, Etc. Electric lighting shall be the only means used for illumination in areas where flammable liquids vapors, fumes, dusts, or gases are present. All electric equipment and installations shall be in accordance with provisions of the National Electrical Code for Class 1 locations. Lighting fixtures of the explosion-proof type shall not be disassembled or lamps replaced until it is certain that the circuit

is dead. Vapor globes on these fixtures shall be securely replaced and periodically inspected to make certain they are securely in place.

2-15-3 INSPECTION AND MAINTENANCE.

a. Personnel Responsible. Inspection and maintenance work on electrical equipment shall be performed only by qualified and authorized personnel.

b. Inspections. Electrical appliances and equipment must be periodically inspected for adequacy and functioning of safety features (the exact periods of time to be determined by the safety officer or other qualified person) for damaged insulation and loose connections. Appliances and equipment found to be defective shall be removed from service.

c. Overhauling Machinery. Unauthorized modifications to electrical wiring and equipment shall not be made, nor shall suthorized modifications be made by other than qualified personnel.

d. Cleaning. Electrical and electronic equipment must be kept clean at all times to ensure proper performance. The following precautions are to be observed when cleaning:

(1) Safety in Use of Cleaning Equipment.

(a) Brushes, dusters, brooms, or other such articles which may be used within four feet of or on electrical equipment having exposed or current-carrying parts shall not themselves contain any exposed metal parts.

(b) If a vacuum cleaner is necessary, use only one with a nonmetallic hose and an adequate dust receiver.

(c) Use sandpaper and files only upon competent advice.

(d) Do not use solvents unless absolutely necessary. When solvents are necessary, use only the smallest possible quantity of approved solvent. (See COMSTSINST 5100.9A or subsequent revision)

(2) Use only rubber or insulating hose in airlines for blowing out equipment. Use no more than 50 pounds of pressure to avoid damage to the insulation. Be sure the air is free from water. Never turn compressed air on yourself or others, since it can cause serious injury.

2-15-4 ELECTRICAL ENCLOSURES. All electrical equipment, such as transmitting antennas in permanent outside locations and having exposed carrying parts less than 8 feet above the ground or deck shall be

enclosed by a metallic fence or barrier and made accessible to authorized personnel only. Such barriers or fences shall be high enough to discourage climbing and shall have interior clearances, electrical grounding and warning signs.

2-15-5 SPECIAL WARNINGS TO PERSONNEL. Care shall be taken in handling all tools, loose metal parts, liquids, etc. which it is necessary to use in an area where there is electrical equipment or electrical work being done. The following general rules shall apply:

a. Danger From Metal Objects.

(1) Personnel shall exercise care when it is necessary to walk above open electrical equipment or exposed wires to insure against dropping or loss of metallic objects attached to clothing.

(2) Tools of magnetic material can be pulled into contact with dangerous circuits when these tools are used in the vicinity of magnets associated with magnetrons in radars. Care must be taken to avoid this hazard.

b. Danger From Foreign Objects. Storage or insertion of foreign articles in or near switch-gear, control appliances, panels, etc., is forbidden.

c. Danger From Energized Equipment. Personnel required to work on energized equipment shall be familiar with the precautions in Article 2-15-9.

2-15-6 SECURING SWITCHES PRELIMINARY TO WORK.

a. Deenergizing Circuit. In general, all utilization circuits shall be deenergized before any work is performed on them. When it is necessary, due to existence of emergency conditions, to work on such circuits, precautions cited in Article 2-15-1 herein shall be observed. When electrical equipment is to be worked on, it shall be disconnected from the source of supply by opening main or branch supply switches, circuit breakers, or cutouts so as to completely eliminate the possibility of current flowing to the equipment. Switches, circuit breakers, or cutouts opened for this purpose shall be secured in the open position, shall have tags attached, and only the individual placing the tag shall remove it and reenergize the circuit.

b. Tagging. After securing, the switches shall be tagged with a "Hold" card bearing the following words: "This circuit was ordered open for repairs and shall not be closed except on direct orders of the Undersigned." The "Hold" card is to be signed and dated, usually by the person directly in charge of the work. If the

card cannot be seen clearly a red light is to be used to illuminate it.

c. Testing and Discharging. After switch and circuit breakers have been opened, and before work has been started, the circuits which it is intended to deenergize shall be tested (see article 2-15-9c) and discharged to ground (see article 2-15-7e).

d. Removing Tag or Lock. When the work has been completed, the tag is to be removed by the same person. Nobody should remove another person's tag. If the switch has been locked it shall be unlocked and the circuit restored by the person retaining the key.

e. Tagging by More Than One Party. When more than one repair party is engaged in the work, a signed and dated tag for each party shall be placed on the supply switch. The individual who tagged this switch for his party is to remove only his own party's tag when the work has been completed and it has been determined that all persons are in the clear.

2-15-7 GROUNDING OF METAL PARTS.

a. Where Necessary. Metal cases, bases, frames, and other metal parts of electrical equipment, appliances, machines, and fixtures powered from supply circuits in excess of 50 volts A.C. or D.C. shall be grounded. Where inherent grounding is not provided by the mounting arrangements, ground connections shall be provided to ground the frame, enclosure, or support of permanently installed electrical equipment. Semiportable equipment which is normally used at a fixed location shall also be grounded. Portable electrical equipment in conductine housings shall have adequate grounding. The grounding wire and ground shall be in accordance with paragraph 2-15-1c(8).

b. Grounded-Type Plugs and Receptacles.

(1) All portable and semi-portable electrical equipment, including running lights, floodlights, and incandescent bulb searchlights shall be provided with three-conductor cords. One conductor shall be securely connected to the metal frame of the electrical device or equipment; the other end of this particular conductor shall terminate at the grounding prong of a polarized three-prong plug which, in turn, is to fit a non-water tight or water tight polarized receptacle, depending upon the location or, if permanently wired to a junction box, the third conductor shall be grounded to the junction box. Metal shells on connector plugs (if so equipped) shall be riveted to ground prong.

(2) Water tight polarized receptacles, with ground connections, shall be provided on outside decks and in areas exposed to the weather or excessive moisture. Non-water tight polarized receptacles

shall be installed in inside spaces and areas not exposed to excessive moisture. Polarized receptacles shall be installed in passageways for cleaning and polishing equipment; in galleys, pantries, etc. for commissary equipment; in shops, machinery spaces, storerooms, resistor rooms, etc. for portable tools and portable lights; at hatch coamings for cargo cluster lights and portable tools, where carried; in passengers' and crews' laundries for washers and irons (on D.C. electric irons using third wire as a rheostat, a fourth wire shall be provided for ground) for vending machines, water coolers, computing machines, surgical apparatus.

(3) Receptacles, other than polarized type, shall not be provided for offices, public spaces, and hospital areas. In the immediate vicinity of the stateroom lavatory or mirror, and in troop compartments single ordinary two-conductor receptacles shall be permitted; otherwise all other stateroom receptacles shall be of the polarized type.

(4) Bracket fans will not be required to have three-conductor cords, but the fan brackets or bases shall be grounded to the ship's structure through fastenings bolts, or pigtails shall be fitted with screw fastenings to hull structure. Where existing bracket fans have three-conductor cords, the ground leads shall be secured at the receptacles in an approved manner.

(5) Receptacle outlets of the type providing a grounding pole shall be of a distinctive design that will not permit the dead metal parts of portable apparatus to be connected to a live conductor. *

(6) Where receptacle outlets on a ship are connected to different types of potentials, receptacle outlet types shall be selected so that a portable device cannot be plugged into a receptacle outlet of an unsuitable potential. *

c. Grounding Masts. Mast stays shall be grounded at the deck to prevent accummulation of static charges. In order to avoid the formation of loops by the grounded mast stays and in order to reduce the magnitude of deviation of the radio direction finder, a rigging insulator is inserted in each mast stay near the top. The foregoing does not apply to vessels fitted with high-frequency direction finding equipment. Rigging on these vessels shall be broken by insulators in such a manner that no ungrounded portion is over 15 feet in length and no grounded portion over 8 feet in length.

(1) In order to prevent charring of wood masts, spars, etc., all metal fittings on them shall be grounded by means of a copper strip at least 1 by 1/32 inch.

(2) All electrical grounds on metallic standing rigging and jacob's ladders shall be inspected periodically for excessive

deterioration at the points of contact between dissimilar metals. The connections shall be thoroughly cleaned and new parceling and serving applied in accordance with NAVSHIPS Tech. Manual Article 9180.1.3 as necessary.

d. Wooden Buildings. In wooden buildings, care should be exercised to run all electric wiring at least four feet from all down-leads of any lighting protective system. All steel masts, metallic gutters and down spouts, steel beams, columns, and other metallic members of appreciable mass should be grounded.

e. Discharging Machines to Ground. The charge retained by electrical equipment when it is secured is, in certain cases, sufficient to cause a severe shock. Before the terminals of an apparently dead piece of equipment are touched, the equipment should be discharged to the ground. Capacitors, reactors, lighting arresters, transformers, and similar equipment with high values of capacity or inductance are particularly dangerous and should be discharged twice at intervals of not less than 15 seconds if the highest possible level of personal safety is to be attained.

* 2-15-8 PORTABLE ELECTRICAL EQUIPMENT. Electrically powered portable tools such as drills, grinders, scaling hammers, and sanders may become sufficiently damaged during normal use to cause electrical shock to the user. Cases are recorded in which shock has been fatal. Shipboard conditions are especially conductive to increasing the severity of a shock because the person affected is usually in contact with the ship's metal structure and because the dampness often present in the user's clothing lowers electrical resistance. All personnel who use portable electric tools are cautioned to make certain that a proper ground connection is provided. (See Article 2-15-7 for grounding precautions.) A monthly test for ground continuity shall be conducted by cognizant engine department personnel, logged, and recorded in ship's Safety Council Minutes.

a. Portable Cables. Portable electrical cables shall be carefully selected and maintained. Spliced portable cables are extremely dangerous and shall never be used unless an emergency warrants the great risk involved. Portable cables should be of sufficient length that they will not be subjected to longitudinal stresses or need to be pulled taut to make connections. Current-carrying capacity should be ample for the expected power demanded. Portable cables should be checked frequently while in service to ascertain degree of heating. Any cable which feels more than comfortably warm to the bare hand placed outside the insulation should be checked immediately for overloading. Interconnections between lengths of portable cable shall be made only on approved connection block or by other approved fittings which shall be suitably insulated and enclosed to eliminate all possible hazards from fire or shock to personnel.

b. Personal Equipment. No personal electrical equipment, such as radios, television sets, record players, wire or tape recorders, etc. shall be used aboard ship without the engineering officer's tag of approval and authorization by ship's master and/or captain. Periodic inspection shall be made to enforce this vital safety regulation. See NAVSHIPS Technical Manual 60-28 for specific details.

c. Blown Fuse. A blown fuse shall be replaced by a fuse of the same ampere capacity. Insertion of metal discs, coins, etc. in back of plug fuses, or the shorting out of cartridge type fuses, is strictly prohibited.

d. Removable Fuse Links. "Removable Fuse" link type cartridges are prohibited.

e. Secondary of a Current Transformer. Special precautions shall be taken to insure that the secondary of a current transformer is not opened or disconnected until it has been positively determined that the primary circuit has been deenergized. This precaution shall be observed regardless of the operating voltage of the circuit in which the current transformer primary is placed.

2-15-9 WORKING ON ENERGIZED CIRCUITS.

a. When Permissible. Repairs are not to be made on energized circuits except in an emergency. The commanding officer afloat or similar competent authority ashore shall determine whether an emergency exists. A circuit must be considered energized until it has been checked and the switch opened and tagged. (See Article 2-15-6 and Paragraph c., below.)

b. Personnel Involved.

(1) Repair work on an energized circuit shall be performed only by personnel fully aware of the dangers involved, including those dangers encountered on the so-called lower potential circuits (below 600 volts), as well as those on higher voltages (above 600 volts).

(2) All work shall be supervised by qualified technicians or experienced communications or electronics material officers.

(3) Men should be stationed by circuit breakers or switches, and telephones should be manned, if necessary, so that circuits or switchboards can be immediately deenergized in case of emergency. A man qualified in first aid for electric shock shall stand by during the entire period the work is being performed.

(4) Persons performing the work shall be insulated from ground and shall avoid possibility of contact with grounded hand rails and exposed metal deck or equipment frames.

c. Checking the Circuit. When a circuit below 600 volts is to be checked, the voltmeter or voltage tester should first be tested on a circuit known to be operating in order to determine if the testing device is in good condition. When voltages of 600 volts or more are to be measured, the following precautions are to be followed:

(1) Preparing the Equipment.

(a) Deenergize the equipment to be tested.

(b) High voltage capacitors and the terminals to which the test equipment is to be connected shall be discharged at least twice, with a minimum fifteen-second interval, by the use of a suitably insulated shorting or grounding bar.

(c) Attach a temporary but secure ground to the circuit.

(d) Ascertain that the test equipment controls are set correctly for testing of the high voltages.

(e) Connect to the desired test points, the test leads capable of safely carrying the high voltages.

(f) Remove the temporary ground from the circuit.

(g) Withdraw from the equipment under test, making sure that you are free from the leads and in a proper position for taking meter readings correctly.

(2) Taking the Measurements.

(a) Do not take the measurements directly, as by means of flexible leads or probes.

(b) Assign the responsibility of energizing the equipment to an assistant standing by the switch.

(c) Do not touch the test instruments while the power is on.

(d) After taking the reading, deenergize the equipment.

(e) Before removing the test leads, discharge high voltage capacitors and the terminals to which the test equipment is connected at least twice, with a minimum fifteen second interval, by the use of a suitably insulated shorting or grounding bar.

(f) Attach temporary ground to the terminals to which the test instrument is connected.

(g) Remove the test leads.

(h) Remove the temporary ground.

(i) Repeat the above precautions for each measurement as applicable.

d. Precautions for Specific Voltages. Although many of the precautions listed for work with specific voltages relate to line work, the over-all safety measures relate to all work on live circuits and for that reason are included here with other general working rules.

(1) Conductors and equipment operating at 600 volts or less may be worked upon alive if the following requirements are met:

(a) Adjacent live or grounded conductors and equipment shall be covered with insulating material or approved rubber protective equipment.

(b) Two men should work together, particularly when work is done on energized parts carrying more than 150 volts, in wet weather, or at night. When working on energized lines a man should not change his position on a pole without first informing others working nearby.

(c) Bare or exposed places on one conductor must be taped or covered before another conductor is exposed.

(2) Intermediate Voltage Work, 600 to 3,000 Volts.

(a) All conductors and equipment must be considered as carrying current and as being alive until it has been determined beyond doubt that they are dead. When positive proof as to whether a conductor or a piece of equipment is energized cannot be established by a visual check, an approved voltage detector is to be used. Before being used, the detector must be checked on a conductor that is known to be alive and a positive indication noted. This check on a known live conductor must be repeated after the test on a dead conductor has been made. When it is not possible to recheck the voltage detector on a live conductor, two voltage detectors should be used, one as a check against the other.

(b) When work is to be done on or within reach of conductors or equipment operating between 600 and 3,000 volts, energized and grounded conductors or equipment within reach must be isolated with suitable barriers or covered with rubber hose line, insulator hoods, line protectors (pigs), or blankets. If it becomes necessary for the workman to change his working position he must cover or barricade any energized or grounded conductors or equipment that will be within his reach in the new position.

(c) When conditions permit, the section of the line being worked on shall be deenergized by opening the sectionalizing switches, and grounding.

(3) Lines and equipment operating at 5,000 volts or over must be deenergized and grounded, (see article 2-15-6) before work is started, except for emergency repairs on overhead lines, which may be worked on alive with approved live-line tools.

(a) Work on deenergized circuits must be done between two sets of grounds, one set to be placed on the first pole or structure toward the source of energy and the other on the first pole toward the load. When grounds are to be attached, the ground connection must be made first. When grounds are to be removed the ground connections must be broken last.

(b) The following precautions must be taken when live-line tools are used:

1 Work with live-line tools shall not be performed when rain or snow is imminent or falling, or when heavy dew, fog, or any form of excessive moisture is present.

2 When working on lines energized at more than 5,000 volts, use approved hot-line tools without rubber gloves. Handle series street lighting circuits supported on arms with other lines energized at more than 5,000 volts, the same as the power supply conductors.

3 No more than one conductor may be worked on at a time with live-line tools.

4 Live-line tools must be kept dry and free from dirt. Tools which have been subjected to damp weather must be thoroughly dried and tested before being used again.

5 Live-line tools being transported on line trucks shall be stored so as to prevent damage to them. Waterproof canvas bags may be used for this purpose. A compartment equipped with padded hooks or binds may be built into the truck for this purpose.

(c) A minimum body clearance from energized lines and equipment shall be maintained by men working on or around electrical equipment of high voltage, as shown in the following table:

OPERATING VOLTAGE (Kilovolts)	MINIMUM DISTANCE (Feet)
5 to 7.5	1
7.5 to 12	2
12 to 33	3
33 to 66	4
66 to 132	5
132 to 220	8

2-15-10 WET AND DRY CELL BATTERIES.

a. General Precautions. The following general safety precautions are to be observed in connection with storage batteries and dry batteries:

(1) Keep flames and sparks away from the vicinity of batteries.

(2) When using tools around batteries exercise care not to short circuit battery terminals.

(3) Never open batteries except in well-ventilated spaces and only in extreme emergencies if the room temperature is above 125° F.

(4) Keep the temperature of the battery compartment below 95° F. if possible.

(5) Post appropriate warning signs outside entrance doors and in battery rooms, "Danger-Explosive Vapors--No Smoking--No Open Lights."

(6) Personal Protective equipment (approved goggles, gloves, apron and respirator) shall be available in battery locker and worn when handling electrolyetes and exposed to vapors.

b. Ventilation of Storage Batteries. The following precautions are to be observed in connection with the ventilation of storage batteries:

(1) Be sure to ventilate a battery compartment which has been sealed before turning on the lights, making or breaking electrical connections, or performing any type of work in the compartment.

(2) Make certain the ventilating apparatus of a battery compartment is operating properly before starting a charge.

(3) Stop the charge if ventilation is interrupted, except in an emergency. Do not resume the charge until the ventilation has been restored.

(4) Avoid sparks when removing or replacing batteries in compartments which may contain fumes.

(5) Use only tools with insulated handles for removing and replacing batteries.

(6) When using batteries with one terminal grounded, disconnect the grounded terminal before removing the battery and do not reconnect it until the battery has been replaced.

c. Charging Storage Batteries. The following precautions are to be observed when batteries are to be charged:

(1) Do not make repairs to the battery connections while its circuit is energized.

(2) Turn off the charging current before batteries are connected or disconnected on the charging line.

(3) Be extremely careful to keep open flames and sparks away from batteries while they are being charged. The hydrogen given off during this operation is highly flammable and may cause flash fires and explosions.

d. Handling Battery Acid. When handling battery acid, personnel are to observe the following precautions:

(1) Never pour the water into the acid; the acid must always be poured slowly into the water.

(2) Guard the eyes and skin from splashing acid.

(3) Do not store sulfuric acid in places where freezing temperatures are possible.

(4) Keep the electrolyte at a level above the tops of the seperators.

e. Using Type 19026 Dry Batteries.

(1) The 300-volt B. Section of the Navy Type 19026 pack battery is capable of giving a very serious, and even fatal, shock upon contact. Extreme care must be taken not to come into contact with the terminals of this battery or of any high voltage battery. Post "Danger-High Voltage" signs in immediate vicinity and insulate deck areas.

(2) When this type battery is to be disconnected from the operating apparatus, the current flow shall be stopped before disconnecting the plug. It is possible for sufficient hydrogen gas to accumulate in this battery to produce a serious explosion if ignited, and a spark produced by pulling the plug from the socket while the current is flowing is liable to ignite accumulated gas.

2-15-11 SWITCHES AND CIRCUIT BREAKERS. Switches and circuit breakers perform the same function, and the precautions to be taken with them overlap in many details. The following precautions shall be taken as they are applicable to the particular circuit:

a. Installation of Switches. Switches shall be installed so as to minimize the danger of accidental operation. Where practicable, they shall be installed so that gravity cannot operate them. When this is not practicable, they shall be equipped with suitable latches to prevent accidental closing. Except where absolutely necessary, switches are not to be installed in locations where explosives and/or flammable vapors exist. When they are installed in these locations, they should be of the special explosion-proof type. Only safety-type switches shall be permitted at machines.

b. Operating Switches. A workman shall not operate any system switch, circuit breaker, or other disconnecting device until he is instructed to do so by proper authority and is thoroughly familiar with the equipment involved. When operation has been authorized, the following precautions shall be taken:

(1) Preliminary Precautions.

(a) When maintenance or repairs involve switching operations which may affect the serving utility's system (shipyard or contractor) the Chief Engineer must notify the system operator of the utility, so that prearranged emergency measures may be followed if utility's circuit breakers trip out.

(b) When local branch circuits which feed moving or rotating parts are to be energized, men near moving parts must be notified that the circuit is to be energized. Where the men are not visible from the control station, a safety watch shall be maintained with adequate means of communication between the station and the watch.

(2) Safety During Work.

(a) During the time the electrical foreman is switching, the men on the job shall not follow him or congregate where the switching is being performed.

(b) Switch handles should always be moved to definite positions.

(c) Before doing any switching on a regulated feeder, workmen should be sure that regulators are off the automatic position and set in the neutral position.

(3) Safety With Special Type of Switches.

(a) Outdoor disconnecting switches shall not be operated without the disconnect pole provided for that purpose.

(b) Each time an air-break switch is opened, a check shall be made to make certain that all contacts are actually open and safe clearance is obtained on all three phases. The position of the operating handle is not to be depended upon as evidence that the switch is open.

c. Safety With Circuit Breakers.

(1) Before any work is done on a circuit breaker the following precautions shall be taken:

(a) All control circuits to which it is connected shall be deenergized.

(b) Draw-out circuit breakers shall be switches to the open position and removed before any work is done on them.

(c) Disconnecting switches ahead of circuit breakers shall not be opened until after circuit breaker is tripped to open position. No work shall be done on the opened circuit breaker until all isolating switches protecting it also have been opened.

(d) Where disconnecting switches are not provided to isolate circuit breakers, the supply bus to the circuit breaker shall be deenergized on all circuits where the voltage is in excess of 150 volts. On circuits where the voltage is below 150 volts, work may be done under emergency conditions with the circuit breaker energized by strict adherence to the provisions of regulations for working on energized circuits contained in Article 2-15-9 herein.

(e) Before working on an oil circuit breaker, workmen must be sure that the breaker cannot be opened or closed automatically. When possible, it should be in the open position or have the operating mechanism blocked.

(2) When operating circuit breakers follow these precautions:

(a) Use only one hand.

(b) Keep the hands clear of parts other than operating handles.

(c) Touch only one breaker handle at a time.

(d) Close isolating or back-up switches before closing circuit breaker to restore service or to energize circuits.

(e) Trip circuit breakers before opening switches.

(f) Keep the face turned away while closing circuit breakers.

(g) A circuit breaker shall not be prevented from performing its normal function by short circuiting or blocking out interlocking, overload, or other protective devices, except for purposes of authorized test work.

(h) Never stand over a circuit breaker while the power is on.

(3) Before a branch or equipment circuit breaker or switch is closed, it should be determined that:

(a) the circuit is ready, equipment connected to it is in condition to be energized, and all clearance has been given up and all tags removed;

(b) men working on the circuit have been notified that the circuit is to be energized and they are in the clear;

(c) circuit protective devices are in good working condition.

d. Labeling. Switches and circuit breakers shall be labeled to show the equipment serviced. Care shall be taken to insure that these labels are kept up to date and not obliterated.

2-15-12 WORKING ON TRANSFORMERS. Precautions of this section are limited to the equipment used in the ordinary electric circuit. For further details concerning capacitors and condensers, personnel are referred to the precautions in 2-15-15.

a. Protection of Personnel at Work.

(1) When removing transformer fuses, the workman must wear rubber gloves with leather over-gloves. This applies also to fuses which are being replaced by means of switch sticks equipped with fuse tongs or by means of regular fuse tongs, where the circuit voltage exceeds 150 volts.

(2) Workmen must not stand on top of energized transformers, regardless of voltages, except in extreme emergencies, and then only with the full knowledge and consent of the man in charge of the

work crew. When such procedure is followed, the transformer cover shall be first covered with a rubber blanket, protected in turn with a rubber bag. Standing on top of a transformer when wearing climbers is strictly prohibited under any circumstances whatsoever.

(3) Workmen must not stand beneath transformers which are being raised to, or lowered from, any overhead structure. While transformers are being raised or supported with blocks, men on the pole or structure must take a position above, or well in the clear of the transformer.

(4) Large transformer case interiors are not normally ventilated and very frequently contain poisonous or explosive fumes. No work should be done inside any transformer case until provision has been made to continually exhaust such fumes while the work is progressing. Men working in transformers should be instructed to report any feeling of ill effects from fumes or gases immediately, and shall be ordered out of the immediate area until they have recovered.

b. Care of the Transformer.

(1) The case of all transformers shall be grounded to a positive ground. On systems operating with one conductor grounded, the case shall be connected to the ground conductor at the transformer.

(2) When a paralleled transformer is taken out of service the secondary phase lead or leads must be disconnected before the primary cutouts are opened. The secondary neutral or ground connection should not be disconnected until the primary cutouts have been opened.

2-15-13 SCOPE OF ELECTRONIC SAFETY

a. Electrical vs. Electronic Safety. Although certain areas of electrical and electronic safety are generally similar and safety factors of one usually apply to the other, the present-day use of electronics in radar, sonar, communications, television, guidance control and other electronic systems makes it necessary that the safety requirements for electronics be expanded and treated as a separate field in itself.

b. Special Attention Aboard Ship. On board ship, particularly, personnel should be made aware of the need for special precautions relating to electronic devices. Therefore personnel shall have a thorough knowledge of the following safety rules in addition to those in Sections I and II.

2-15-14 SAFETY GUARDS AND WARNING SIGNS.

a. Explosive Vapors. Warning signs shall be displayed wherever explosive vapors are present. No electronic equipment or auxiliary control unit shall be energized within the area while these signs are up.

b. Rotating Antennas. Where personnel are sent aloft in the area of rotating antennas, switches or motor controllers actuating the antenna movement shall be disabled and warning tags attached to prevent accidental energizing.

c. Open Circuits. Warning tags requiring open-circuit condition shall be placed on all necessary power supply switches to prevent accidental application of power to units of an electronic system that are under repair or overhaul.

d. Radio Frequency. R.F. Hazard signs shall be displayed in areas where the power of radio frequency radiation is sufficient to introduce a hazard to equipment or operating personnel. (See 2-15-16)

e. Permanent Signs. Danger or warning signs shall be permanently posted in conspicuous places and adjustable guards shall be installed in appropriate areas to prevent personnel from making accidental contact with antennas, antenna leads, power supply leads or terminals, fuses, or any uncovered contacts that have sufficient voltage and current characteristics to constitute a hazard to personnel.

f. Electrical Heating Lamps. Lamps shall be equipped with guards (periphery) (other than face) to minimize accidental contact with lamps. *

2-15-15 ELECTRONICS - GENERAL.

a. Precautions With Radio Frequency Circuits. Detailed safety in the operation of electrical circuits is prescribed in Articles 2-15-9 thru 2-15-12. Due to the general use of radio throughout the Navy, however, the following precautions are emphasized:

(1) Energized high voltage circuits should not be broken except when absolutely necessary and then only when authorized by a qualified officer or other responsible official.

(2) When other transmitting equipment is in use at the same installation or close by, workers should take precautions to prevent shock, burns, or other injury due to energy picked up from adjacent antennas or equipment. Circuits should be grounded to protect against such shock or burns. If the location of the protecting ground is not in the immediate area of the working party, suitable warning tags shall be employed to prevent unauthorized removal of the protective ground.

(3) Contact with the insulation on wires carrying R.F. current shall be avoided. This insulation can act as the dielectric of a condenser when contacted, thus causing shock or burn injuries to personnel.

b. Preventing Shock From Capacitors and Pulse Forming Networks. Extreme caution shall be taken prior to working on or near deenergized circuits which employ large capacitors or pulse forming networks. A suitable grounding or shorting bar shall be used to short circuit all terminals and contacts to ground. This precaution shall be taken regardless of the length of time the equipment has been deenergized. Some pulse forming networks are capable of retaining their charge several hours after the equipment is secured and all power disconnected.

c. Hazards of Ungrounded Units. The chasis and frames of all power supplies and high voltage units removed for servicing shall be grounded prior to applying power to the unit. Personnel must remember that the removal of a unit or part from the normal location with an assembly and the energizing of the unit or part, while it is outside of the normal enclosure, removes the protection given by built-in protective features such as interlocks, grounds, and enclosures. Since these safety features then no longer exist, special precautions and safety measures must be taken.

d. Interlocks and Safety Devices. Safety devices on electronic equipment such as interlocks, overload relays, and fuses, shall not be altered, disconnected, or modified without specific authority.

e. Servicing and Adjusting. No person shall reach within or enter energized electronic equipment enclosures for the purpose of servicing or adjusting except when prescribed by official applicable instruction books and then not without the immediate presence and assistance of another person capable of rendering aid in an emergency. Caution shall be exercised when reaching into the enclosure of equipment having high voltage points. The metal shields or shells of some capacitors, klystrons, cathoderay tubes, and other components are at high potential above ground. Maintenance personnel shall be cautioned prior to servicing equipment which contains such components.

f. Precautions During Overhaul and Repair. Although local safety officials of a shipyard or repair facility will normally notify the Commanding Officer when electronic safety measures are required, ship's transmitting equipment shall be secured when:

(1) overhead cranes are operating in the close proximity of the transmitting antennas;

(2) personnel are removing rigging or structures aloft;

(3) Transporting, loading or unloading aircraft, ammunition, volatile liquids or explosive gases on the adjacent dock or on other ships' barges in the near vicinity.

g. Energizing When Ship Is In Drydock. The electronic equipment of a ship may be energized only with the express permission of the docking officer. The hull must be adequately grounded. Excitation is not to be applied to sonar transducers unless properly immersed. Sonar hoist mechanisms are to be operated only after it has been definitely ascertained that adequate clearance exists for the moving elements within their full limit of travel and that no mechanical damage will be incurred by such operation. This determination is to be made as soon as practicable after the dock is emptied. If sufficient clearance does not exist, positive steps shall be taken to prevent lowering of the transducer by gravity, manual, or power operation.

2-15-16 RADIO FREQUENCY RADIATION HAZARDS.

a. Hazards--General. Radio frequency electromagnetic radiation from antennas of electronic equipment can produce hazardous conditions in several different ways. One way is by inducing voltages in any of a variety of metallic objects which can result in shock to personnel and the production of electrical arcs which can ignite combustible materials. Another similar way of creating hazards is the inducing of voltages and currents into the operational or test wiring of electro-explosive ordnance devices which can cause the accidental firing of these devices. Another hazard is the heating of objects that are in a highly concentrated electro-magnetic beam (mainly from radars), which can cause biological damage when the object is a human body or can cause ignition of combustible materials if the object is a small piece of metal. These hazards are broken down into three categories in the following discussion:

Hazards to Combustible Materials,
Hazards to Electrically Actuated Ordnance, and
Hazards to Personnel.

b. Hazards to Combustible Materials. Radio frequency electromagnetic radiation can cause the ignition of combustible materials in two different ways; one is by producing electrical arcs and the other is by heating small metallic objects to the kindling temperature of the combustible material. The electrical arcs occur due to voltages induced in standing rigging, cables, deck loads, tools, metal containers, and other metallic objects which approach resonance to a transmitted frequency from some electronic device. The proximity and relative attitude of the transmitting antenna and the metallic object as well as the frequency determine the magnitude of the induced voltage. The induced voltage produces electric arcs

when contact with the metallic object is made or broken by personnel or any conductive media such as another metallic object or conductive liquids. Heating of small metallic objects to the kindling temperature of combustible materials can occur when the metallic object is exposed in the concentrated electromagnetic beam of a high power electronic device, such as from search, missile guidance, or fire control radar. The transmitting antennas involved in producing arcs or heating may be those on a given ship, an adjacent ship, or those associated with land based equipment. Examples of operations where danger of igniting combustible materials is involved are such handling gun powder or ammunition, handling volative liquids (especially fueling operations involving the delivery of gasoline or JP-4 from hoses, spouts or cans and the mixing of gasoline and napalm) or any operation that involves explosive vapors. The following is a list of precautionary measures that should be taken during these operations involving the handling of combustible materials.

(1) When combustible materials as described in the previous paragraph are being handled on shore or on shipborrd, all transmitters having antennas within a certain minimum distance of the handling or fueling area shall be deenergized. Due to greater transmitter powers and more available space, the safe distances for shore based installations are doubled for a greater safety factor.

(a) Transmitters with 250W radiated output or under shall be deenergized if their antennas are 25 feet or less from shipboard handling or fueling areas, or if their antennas are 50 feet or less from shore based handling or fueling areas.

(b) Transmitters with over 250W radiated output shall be deenergized if their antennas are within 100 feet of shipboard handling or fueling areas, or if their antennas are within 200 feet of shore based handling or fueling areas.

(c) Radar transmitters having antennas within 200 feet of the handling area regardless of their output power, shall be deenergized if it is possible for the center of the main beam of radiated electromagnetic energy from their antennas to fall directly on any part of the handling or fueling area.

(d) Nearby transmitters on adjacent ships or shore installations shall be subject to the same limitations as above, and shall be deenergized as well as those on a given ship or at a given site where combustible material handling operations are under way.

(2) Hazardous voltages may be induced in cranes or booms and their rigging by the operation of transmitters at distances more remote than those specified in the previous paragraph. Therefore, when cranes or booms are used in areas where combustible materials are

geing handled within 1000 feet of any transmitter, the following precautions shall be taken.

(a) Advise the work force of the hazards involved and call their attention to these precautionary measures.

(b) Use an insulated steering hook for guidance of boom cables by use of manila rope or strain insulators, when feasible from safe loading standpoint.

(c) Observe all safety precautions with respect to ventilation, dangers from arcing, insulation of rigging, etc. as listed in Chapters 9150 and 9180 of BuShips Technical Manual.

(3) A hazard exists when photographic flashbulbs are handled, improperly stored, or used in the vicinity of high density radio frequency electromagnetic fields, especially concentrated radar beams. Therefore photographic personnel and any others handling or storing flashbulbs should be cautioned that fire, cuts, and burns may occur when the flashbulbs are exploded by being exposed to high density radiation such as in radar beams. This hazard may extend a considerable distance from the antenna for narrow beam high power radars. Flashbulbs may be safely stored in coppersheet lined boxes which will shield them from R.F. radiation. When using flashbulbs in the vicinity of radars they should be left in their cartons until used and should be handled with gloves. Also, flashbulb contacts should not be touched to the tongue.

(4) The precautions listed previously apply to both ship and shore installations; however, certain hazards to combustible materials that are peculiar to shore installations necessitate additional precautions, especially where high power radio transmitters are involved. Although the antennas and down-leads from such high power shore transmitters are generally remote from most working areas, in some instances space limitations may occasion the erecting of fueling stations, parking ramps or other structures near the antenna site. When such facilities are located adjacent to the antenna sites the following precautions shall be observed.

(a) All metal used in building wooden structures, within 200 feet of fixed antennas radiating 250 watts or more, shall be bonded together where feasible and grounded to reduce interference and fire hazard.

(b) During gasoline or JP-4 fueling operations within the vicinity of shore based transmitting antennas, especially high power transmitting antennas, particular care should be taken to adequately ground all automobiles, aircraft, and other gasoline, JP-4 or LPG powered machines while they are being fueled. In addition,

refueling trucks, pumps, filling nozzles, and tanks will also be grounded prior to any delivery of fuel.

(c) All future planning for shore based communications, transmitters, radars, or other such installations transmitting high energy radio frequency electromagnetic fields shall be gased on locating such transmitting installations not closer than 1000 feet from any ammunition magazine, ammunition operating building, road used for transporting ammunition, or any area where ammunition or explosives are regularly handled.

c. Hazards to Electrically Actuated Ordnance. Radio frequency electromagnetic radiation can cause accidental firing of electrically or electronically detonated ordnance devices such as missiles, rockets, VT fuses, destructors, and others. The electric current that accidentally fires these types of devices can be produced in several ways by R.F. radiation. One way is by inducing the current directly into the internal wiring of the device, thus the internal wiring acts as a receiving antenna. Similarly the accidental firing current may be induced in test equipment wiring or leads that are connected to the ordnance device for testing purposes. Contact of fingers or tools with wiring or connectors of an ordnance device might also provide an accidental firing current. The initial connection of control and firing cables may produce an accidental firing current especially when connecting missiles, rockets, or other such ordnance onto an aircraft whose fuselage or wiring may have an R.F. voltage induced into it by R.F. radiation. Most ordnance items of the type under consideration here are relatively safe when not being connected into a circuit or being tested because in general their internal firing circuitry is fairly well shielded by the metal skin or frame of this device. Also, very effective shielding is provided if the ordnance device is enclosed in a metal shipping and storage container, especially if the cover of the container is electrically in contact at all points with the remainder of the container. A gasketed cover using gaskets of insulating material will not provide as effective an R.F. shield for the contained ordnance device. Following is a list of precautionary measures to be observed when electro-explosive devices are being handled in the presence of R.F. radiation. (See also, ~~2-15-31.~~) (2-18-6F)

(1) Electrically actuated ordnance devices that are effectively shielded by being completely enclosed in all-metal shipping or storage containers shall not be stored or located in the same compartment with nor within 5 feet of any exposed radio frequency transmitting apparatus, antenna lead, or transmitting antenna. The only exception to this precautionary measure shall be when the ordnance device and transmitting apparatus or antenna are part of an integrated system and designed to work together, in which case special instructions applicable thereto shall apply.

(2) Unshielded electrically actuated ordnance devices are those that have been removed from their all-metal shipping containers, those that are contained in non-metallic containers, and includes aircraft that have been armed with electrically or electronically actuated ammunition, rockets, missiles or other ordnance devices. Precautions to be taken when working with such unshielded devices are as follows:

(a) Transmitters having power outputs of 250W or less shall be deenergized when their transmitting antenna is less than 25 feet from an area where unshielded electrically actuated ordnance devices are being stored, handled, or tested on shipboard; and ashore this distance shall be increased to 50 feet.

(b) Transmitters having power outputs exceeding 250W shall be deenergized when their transmitting antenna is less than 100 feet from an area where unshielded electrically actuated ordnance devices are being stored, handled, or tested on shipboard; and ashore this distance shall be increased to 200 feet.

(c) Radar transmitters shall be deenergized if their antennas are within 200 feet of unshielded electrically actuated ordnance devices and if it is possible to direct the antenna so that the center of the main beam falls directly on the unshielded devices.

(d) Regardless of transmitted power it shall be standard procedure to locate unshielded electrically actuated ordnance devices including aircraft, as far as is practical from the antennas and sources of R.F. radiation. This will not only increase the safety factor but will also reduce the number of transmitters that must be shut down.

(e) Nearby antennas located on adjacent ships or shore installations shall be considered in the above distance requirements as well as those on the particular ship or at the particular shore installation where the unshielded electrically actuated devices are located.

(f) Testing of unshielded electrically actuated ordnance devices shall be subject to the above distance limitations and will be carried out with the minimum possible number of devices located at the test site. Therefore, unless absolutely essential, testing shall not be carried out in storage areas where large quantities of ordnance devices are located.

(g) Future planning for shore based communications transmitters, radars, or other such installations transmitting high R.F. power shall be based on locating such transmitters not closer than 1000 feet from any ammunition magazine, ammunition operating

building, road used for transporting ammunition, or where explosives, including electrically actuated devices, are regularly handled.

d. Hazards to Personnel (Biological and Electrical Shock). Radio frequency electromagnetic radiation can be hazardous to personnel in two different ways. One way is by direct exposure to high density radiation (mainly radar beams) where the body tissue may be damaged due to heating of the tissue. A second way of creating a hazard is by exposing personnel to electric shock caused by R.F. potentials induced in various metal objects that may be contacted by personnel. Although usually insufficient to electrocute personnel directly the shock may cause the person involved to react violently and thereby cause a fall from an elevated position, an injury due to striking some object, or electrocution or severe injury by falling or leaping into nearby electrical circuits. Examples of metallic objects that may have sufficient R.F. voltage induced into them to constitute an electrical shock hazard are as follows:

smokestack guys,
davit head spans,
railings,
metal parts of wooden masts not effectively grounded,
aircraft,
lengths of wire cable or hawser, especially when the lengths approach resonance to an R.F. frequency as the cables or hawsers are reeled in or out,
antennas, both transmitting and receiving.

(1) Personnel should be alert at all times to the possibility of electrical shock from the above mentioned examples of metallic objects and from other similar items not specifically mentioned, and consider the undesirable effects that might result from such an accidental shock. The following specific precautions should also be taken:

(a) Ground all equipment, including aircraft, as instructed.

(b) Ground objects as logic or experience has indicated to be advisable, noting however that a single ground or even several grounds do not necessarily provide an R.F. ground for all surfaces of a large metallic object, such as an aircraft.

(2) If the power density of R.F. electromagnetic fields is sufficiently high, human body tissue can be damaged, primarily due to heating of the tissue. Sensitive organs such as the eyes are especially susceptible to this sort of damage. Many factors influence the determination of a biologically hazardous level of power density. At present, a level of 10 milliwatts per square centimeter (mw/cm^2)

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