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2-5-14 THREADING DIES.

- a. Free of dirt. Dies shall be kept clean and free of chips and dirt.
- b. Chipped or Burred Edges. No dies with chipped or burred edges shall be used.
- c. Clamped to Stock. The die must be firmly clamped to the stock.
- d. Cutting Operation. The cutting edges shall be oiled before and during the cutting operation. Die shall be backed off a part turn every second revolution.
- e. Hand Die Stock. When a hand die stock is being used, care shall be taken by the operator to avoid straining himself.
- f. Stowing. The die and stock shall be thoroughly cleaned and put away after use.

2-5-15 WHETSTONES AND STEELS.

- a. Free of Dirt. Whetstones and oil stones shall be kept free of dirt and cracks.
- b. Guiding Tools. One hand shall guide the tool while it is being sharpened on the stone.
- c. Guards. Stones and steels shall be equipped with guards, wherever possible.
- d. Direction of Stroke. All strokes should be made away from the body.
- e. Block or Spacer. A stone shall not be used in place of a block or spacer.
- f. Use of Steel. A steel shall never be used as a pry, chisel, or bar.

2-5-16 WRECKING BARS, CROWBARS.

- a. Sharp and Free of Burrs. Wrecking bars and crowbars shall be kept sharpened and free of burrs.
- b. Slipping. Care shall be taken that the bar does not slip and cause injury to fellow workers.

c. Pulling Nails. When nails or screws are being pulled, wrecking bars shall have a block placed under the jaws after a long nail or screw has been started; this takes some of the strain off the jaws and increases the leverage.

d. Striking Bar. Wrecking bars shall never be struck with case-hardened steel tools. Wood, plastic, or soft steel objects shall be used for striking purposes.

2-5-17 WRENCHES.

a. Selection of Wrench. Care shall be used in the selection of the right wrench for the job; an extension shall never be used on a wrench.

b. Condition. Only wrenches in good condition shall be used; a bent wrench if straightened, has been weakened and shall not be used.

c. Strain. A small wrench should not be overstrained. No wrench should be subjected to severe side strain.

d. Use as Hammer. No wrench shall be used as a hammer.

e. Machine in Motion. A wrench shall never be used on material in a machine in motion; the machine shall be stopped to permit working on the stock.

f. Wrench Faced Forward. An adjustable wrench shall be faced so that the movable jaw will be located forward in the direction in which the handle is to be turned.

g. Bite Near Middle. The bite of an adjustable wrench shall be taken near the middle of the jaws, so there will be teeth in front if the wrench slips; the teeth shall be kept sharp.

h. Working in confined Space. There shall be adequate clearance between the worker and the wrench; in tight places the worker shall take care that the grip he uses will not endanger him.

2-5-18 PORTABLE POWER TOOLS, GENERAL PRECAUTIONS.

a. Inspection. Portable power tools shall be kept cleaned, oiled, and repaired. They shall be carefully inspected before use. The switches must operate properly and the cords be clean and free of defects. The plug shall be clean and sound.

b. Grounds.

(1) The frames of portable electric tools and appliances

shall be grounded through a third wire in the cable containing the circuit conductors. Double insulated tools from sources qualified under applicable military specification are exempt from this requirement.

(2) Grounding circuits other than by means of the structure of the vessel on which the tool is being used, shall be checked to insure that the circuit between the ground and the grounded power conductor has resistance which is low enough to permit sufficient current to flow to cause the fuse or circuit breaker to interrupt the current.

c. Fire Hazard. Sparking portable electric tools shall not be used where flammable vapors, gases, liquids, or exposed explosives are present.

d. Care of Cords.

(1) Care shall be taken that cords do not come in contact with sharp objects; they should not be allowed to kink, nor left where they might be run over.

(2) Cords must not come in contact with oil or grease, hot surfaces, or chemicals.

(3) Seriously damaged cords shall be replaced. They are not to be patched with tape.

(4) Tools shall be stored in a clean, dry place where the cord can be loosely coiled.

2-5-19 POWER TWIST DRILLS.

a. General. Precautions for hand drills as given in Article 2-5-6 are also applicable to power twist drills. In addition, the following requirements shall be met.

b. Drill Firmly Grasped. A portable power drill shall be grasped firmly during the operation to prevent it from bucking or breaking loose, thereby causing injury or damage.

c. Cleaning. When the work is completed, the drills shall be removed, and drill and motor shall both be well cleaned.

2-5-20 PNEUMATIC TOOLS.

a. Protective Apparel. Operators using this type of tool shall wear and use necessary personal protective devices.

b. Authorized Personnel. Only authorized and trained personnel shall operate pneumatic tools.

c. When Not in Use. Pneumatic tools shall be laid down in such a manner that no harm can be done if switch is accidentally tripped. No idle tool shall be left in a standing position.

2-5-21 POWER HAMMERS.

a. Pointing Hammer. No employee shall point any pneumatic hammer at other personnel. Hammers shall be operated in a careful and safe manner at all times.

b. Tool Holder. All hammers shall be equipped with a device for holding the tool in the machine. These safety tool holders shall be inspected at frequent intervals.

c. Air Exhaust. Operators shall not restrict the air exhaust port in any fashion.

d. Hand-Grip Switch. All pneumatic hammers shall be equipped with a hand-grip safety switch.

e. Limit of Use. Hammers shall be used only for those purposes for which intended.

f. Gloves. Operators of pneumatic hammers should wear gloves. Body shock and jar is lessened by grasping hammer lightly.

g. Protective Apparel. All hammer operators shall wear necessary eye, face, and body protection.

2-5-22 POWER WRENCHES.

a. Correct Use. Pneumatic wrench operators shall use a wrench only for those purposes for which it is intended.

b. Hand-Grip Switches. All wrenches shall be equipped with hand-grip safety switches.

c. Inspection. All wrenches shall be inspected frequently by competent personnel.

d. Gloves or Loose Clothing. Operators of pneumatic wrenches should not wear loose fitting articles of clothing.

e. Protective Devices. Wrench operators shall use all protective devices provided.

2-5-23 PORTABLE CIRCULAR SAWS. All portable, power-driven circular saws shall be equipped with guards above and below the base plate or

shoe. The upper guard shall cover the saw to the depth of the teeth, except for the minimum arc required to permit the base to be tilted for bevel cuts. The lower guard shall cover the saw to the depth of the teeth except for the minimum arc required to allow proper retraction and contact with the work. When the tool is withdrawn from the work the lower guard shall automatically and instantly return to the covering position.

* 2-5-24 PORTABLE ELECTRIC GRINDERS.

a. Grinding Wheel Safety Guard. Each grinder shall be fitted with a suitable grinding wheel safety guard that will protect the operator from flying chips, broken wheel segments, and grindings. The guard shall be of structural steel, cast steel, or malleable iron (see table below). The strength of fastenings shall exceed the strength of the guard and be such as to minimize its displacement in case of wheel breakage.

GRINDING WHEEL SAFETY GUARD THICKNESSES

Wheel diameter	Structural Steel minimum thicknesses		Cast Steel minimum thicknesses		Malleable Iron minimum thicknesses	
	Peripheral member	Side member	Peripheral member	Side member	Peripheral member	Side member
0 to 6	1/16 in	1/16 in	1/4 in	1/4 in	1/4 in	1/4 in
7 to 12	1/8 in	1/8 in	1/4 in	1/4 in	3/8 in	5/16 in

b. Positioning Guard. The grinding wheel safety guard shall extend at least 180 degrees around the periphery and inner side of the grinding wheel. This guard shall be capable of being rotated concentrically around the spindle housing, and of being secured in any position throughout this rotation. The guard shall be so constructed that it is not necessary to detach it from the grinder when changing wheels.

PART 2
GENERAL SAFETY PRECAUTIONS

CHAPTER 6
WEIGHT HANDLING AND CONSTRUCTION EQUIPMENT

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2-6-1 DEFINITION AND SCOPE. Weight handling equipment as referred to in this Chapter, encompasses cargo gear (including heavy lift booms) ship-board cranes, elevators, dumbwaiters, and conveyors. It does not include fork lifts, straddle carriers, and pallet trucks; for safety precautions covering the operation of such equipment, see Chapter 2-1.

2-6-2 PRINCIPAL CAUSES OF ACCIDENTS. The predominant unsafe practices and hazardous conditions in the operation of cargo gear, ship-board cranes, elevators, dumbwaiters and conveyors are listed below. Operators of all such equipment should study this list carefully, noting particularly the hazards connected with their own work. They should also heed seriously the instructions and warnings of their supervisors regarding safe practices to be followed during operation, making every effort to avoid accidents from any of the following major causes.

- a. Swinging boom without looking, warning, or signalling.
- b. Riding the cargo hook in and out of the hatch.
- c. Operating equipment with defective or improperly functioning parts.
- d. Working or walking under suspended loads.
- e. Oiling, adjusting, or repairing equipment while it is in operation.
- f. Using equipment with ungarded or inadequately guarded moving parts.
- g. Failing to use personal protective devices or clothing such as goggles, safety shoes, gloves, and hard hats.
- h. Operating equipment in a thoughtless or unsafe manner.
- i. Allowing loaded cargo booms to contact stays, shourds, or other fixed objects.
- j. Failing to secure equipment, brakes, booms, and winches before repairing or leaving the equipment.
- k. Poor housekeeping either on the equipment itself or in the operating area. Accumulation of oil and grease on deck near cargo winches and other deck machinery shall be promptly removed and cleaned. If the accumulation of grease and oil is the result of defective machinery, such equipment shall be repaired as soon as practical.
- l. The safe working load of cargo booms and shipboard cranes shall not be exceeded. The certified safe working loads of the cargo gear are based on using the booms as swinging booms and not handling cargo by the burtoning method. It is, therefore, recommended that three tons be the maximum lift for burtoning loads when using a single runner. In instances where in the masters or commanding officer's opinion, the safe working load of the cargo gear would be exceeded in making assigned lifts, the master or commanding officer will obtain prior permission for such use from the area commander.

2-6-3 OPERATING.

- a. Operators. Operators of weight handling equipment shall be thoroughly familiar with the operation of the equipment prior to operating same.

b. Physical Fitness. An operator who is not physically able or mentally alert shall not be permitted to start work with any piece of equipment.

c. Inspection. A frequent and regular inspection should be made of all equipment. A well-maintained machine is usually a safe machine. All controls such as steering mechanism, brakes, and operating clutches shall be tested by the operator before any work is begun on a new shift. If any of these do not operate properly, they should be adjusted or repaired before any load is moved. Inspection of cargo gear is contained in 2-2-4c.2.(b) of this Instruction.

d. Refueling. Refueling of gasoline or diesel-operated equipment shall never be done while it is in operation. Frequent inspection of fuel lines and tanks for leaks will prevent fires as well as loss of fuel.

e. Gasoline Safety Cans. When transporting gasoline from general supply to equipment in 5-gallon quantities, safety cans shall be used. If tank truck service is not available, gasoline in quantities in excess of 5 gallons shall be transported in steel drums. All bungs shall be tight and the drum itself checked for soundness. When dispensing gasoline from drums an approved pump should be used.

f. Leaving Machine. An operator shall never leave his machine while the engine is running.

g. Guarded Parts. All belts, gears, shafts, clutches, drums, flywheels, chains, and other reciprocating or rotating parts of equipment shall be adequately guarded.

h. Removing Guards. Guards, safety appliances, or any other safety devices shall not be removed or made ineffective except for the purpose of making adjustments or repairs, and then only after the power has been shut off. These guards and devices must be replaced immediately after completion of the needed repairs and adjustments.

i. Adjusting Machines. No one shall ever attempt to repair, clean, oil, or grease any part of the equipment while it is in motion.

j. Lighting. Adequate illumination must be provided for any night operation.

k. Designated Use of Machine. The use of a machine for any purpose other than on the work for which it was designed is prohibited.

2-6-4 SIGNALS.

a. Identification of Signalman. One person only, should be

designated as signalman, and both he and the machine operator shall be entirely familiar with the standard hand signals. Where possible, the signalman shall be given some distinguishing article of dress, such as a brightly colored helmet. He must be in a position to closely observe the load and the workmen or intermediate signalman, and still be in plain sight of the operator at all times.

b. Emergency Stop. A "STOP" signal may be given by any person and shall be obeyed by the operator.

c. Signaling Lift. The signalman is responsible for making sure that members of the crew remove their hands from slings, hooks, and loads before giving a signal. He shall also make sure that all persons are clear of bights and snatch block lines.

2-6-5 RIGGERS' RULES.

a. Riggers & Cargo Handlers Safety Apparel. All M&R riggers and cargo handlers shall wear protective hats that meet current specifications in use by the Navy. They shall also wear such hand and other protective gear as may be prescribed and authorized under current regulations.

b. Safe Methods. Riggers and cargo handlers using slings to attach lifts to hoisting equipment should use only the approved safe methods for properly fastening the slings to the load and to the hook. Only experienced men shall do this work. There must be no question about the load being secured against slipping. The load shall always be carefully calculated in advance and no attempt should ever be made to lift a load greater than the rated capacity of the crane.

c. Rigging and Hooking Load.

(1) While lifting cylindrical loads such as shafting, by strap, chain, or wire rope wrapped around the load, the wrapping must be given at least two turns around the object.

(2) A load shall never be carried on the point of a hook.

(3) Magnets or slings shall not be used in lifting compressed gas cylinders. A cradle or platform shall be used to hold the cylinders.

(4) Box hooks are prohibited except for raising loads to a height to enable placement of slings or dunnage.

(5) When "choking" a load, place the shackle so the pin will ride in the eye of the pendant, but not in the standing part so the pin will not unscrew.

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(6) Two or more separately rigged loads shall not be hoisted in a single lift even though the total load may be well within the load capacity of the crane.

(7) The cargo officer in charge is responsible for seeing that chains or wire ropes are not kinked or knotted.

(8) Never make a hitch with chain or wire rope on the hoist block.

(9) Chains or slings will not be permitted to dangle or drag under loads.

d. Hoisting Load.

(1) Before hoisting, the cargo officer in charge shall make sure the load is balanced in the sling.

(2) Before making a lift the person in charge shall see that the upper block of the gear is directly over the load to avoid swinging.

(3) The signalman shall keep his eye on the load as it is hoisted to see that nothing fouls.

(4) If a kink is noted in a chain the load must be lowered and the kink removed.

(5) When shipboard cranes are being used to make a lift, the position of the boom shall not be altered nor shall the load be raised or lowered while travel is being accomplished.

(6) Tag lines shall be used to guide lifts whenever there is a possibility of the load moving out of control. Tag lines shall be of adequate length and shall be kept free of loops and knots.

(7) Before hoisting the load, it shall be inspected and loose objects secured before hoisting.

e. Men Under Suspended Load. All personnel shall be cleared from areas under suspended loads, except that if the 1st Officer decides the only possible way to perform the job is to have a man or men under the suspended load, he may authorize such action. The 1st Officer shall personally inspect the site before giving such authorization.

f. Riding the Load. No one will be permitted to ride the load.

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g. Riding Block or Hook. No one shall be permitted to ride the hoist block or hook.

h. Hook Capacity. The 1st Officer shall know the load capacity of the hook and shall see that such capacity is not exceeded.

i. Snaking Cargo. Snaking cargo shall be done with the snaking runner led directly from the heel block, except that snaking may be done from the head of the boom when the nature of the cargo and the surface over which it is dragged are such as to avoid stalling the load, or when the winch actually does not have sufficient pulling power, with the purchase used to overlead the boom. Snatch blocks shall be used to provide a fair lead for the snaking runner to avoid unnecessary dragging against coamings and obstructions. Snatch blocks shall not be used with the point of the hook resting on the flange of a beam, but shall be hung from padeyes, straps or beam clamps. Snatch blocks or straps shall not be made fast to batten cleats, ladder rungs, side rails, or other unsecure fittings.

j. Barricades. When making lifts in areas where vehicles or personnel are likely to enter, the area will be roped off or otherwise barricaded and signs or a watch will be posted.

k. Landing Loads.

(1) Loose paper, dunnage, and debris shall be collected as the work progresses and be kept clear of the immediate work area. Dunnage shall not be placed on deck where it interferes with the free movement of the drafts. Dunnage stacked against sweat battens shall not be used when the levels of such stacks are above the safe reach of cargo handlers.

(2) Caution shall be used in landing loads such as bundled or bagged materials since they may spread.

(3) When withdrawing slings from underneath a load, cargo handlers should exercise caution to prevent the slings from flying loose and striking someone or catching and tipping the load.

l. Defective Rigging Gear. When the 1st Officer or Cargo Officer is informed or otherwise discovers that the gear is defective, he shall have it removed from service.

m. Small Materials Load. When handling bundles of small materials, extra care should be taken to see that all parts are secured. Wherever possible place small pieces in a "skip-box".

n. Sharp Corners. Slings shall be given protection (pieces of rounded wood, heavy bagging, or old rubber tires) on sharp

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corners, especially in cases where the sling might slide.

o. Keeping Clear of Crane and Hooks. Cargo Handlers, as well as all other personnel, must be continually warned to keep clear of cranes to avoid the possibility of being crushed between stationary objects and the rear end of cranes. Cargo handlers should be especially careful to keep clear of swing hooks.

p. Maximum Capacity Loads. Extra care shall be taken when handling near maximum capacity loads for a given radius. All cargo handlers shall be informed when this condition exists.

q. Dragging Gear. Rigging gear should not be dragged across the deck as this causes rapid wearing and consequent weakening of the gear.

r. Running Cable. Workmen shall never grab hold of a cable as it runs off a drum or is being pulled through a sheave.

2-6-6 FIBER ROPES.

a. Inspection. Fiber ropes used to support a human load shall be inspected when installed and thereafter as frequently as may be necessary to insure their safe condition. Visual inspection should be made for abrasion, broken fibers, cuts, fraying, and deterioration due to acids or corrosive substances. Ropes found to have defects shall be removed from such service immediately.

b. Dragging Rope. Rope shall never be dragged along the ground or over rough or dirty surfaces.

c. Storing Rope. Ropes not in use should be stored in a dry, well ventilated place supported on slats or hung in loose coils. They shall never be exposed to lime or acids, nor stored in a room containing acids.

d. Sheaves and Blocks. Sheaves and blocks built for wire rope shall never be used for fiber rope.

e. Sharp Edged Burdens. When objects with sharp edges are to be lifted with ropes, protective pads shall be placed between the edges and the rope.

2-6-7 WIRE ROPE AND SLINGS.

a. Wire Rope Reeving. Standards for wire rope reeving systems given in NAVDOCKS DM-38, Weight Handling Equipment, shall be observed as applied to weight-handling equipment or BUSHIPS Technical Manual, Chapter 27, Wire Rope.

b. Rust Prevention. Wire rope slings shall be frequently inspected and lubricated in accordance with manufacturer's recommendations, to keep them pliable and prevent rust. Rusty ropes are dangerous because corrosion can then quickly develop inside and outside.

c. Storage. Wire rope should be stored in a place protected from the weather and acid fumes. It should not be stored in places where acid has been or is kept. It should also be protected from uric acid.

d. Twisting. A wire rope should be handled carefully so that it is neither twisted nor untwisted.

e. Removing Rope from Service. Wire rope used for the purpose of raising or lowering men or material shall be removed from service immediately when:

(1) The number of broken wires in any pitch length or lay of rope total the number shown in the following table:

Wire rope	Number of broken wires
6 x 7	3
6 x 19	6
6 x 37	9
8 x 19	8

(2) The wires in the crown of the strand are worn to less than 60 percent of their diameter.

(3) Inspection indicates a dangerous amount of corrosion or distortion.

f. Damaged Equipment. Hooks, shackles, rings, pad eyes, or slings that have been deformed or damaged shall be removed from service.

g. Rope End Connection. Only qualified riggers and qualified A.B. seamen of the Deck Department shall fabricate rope end connections for use on cargo gear, as well as running and standing rigging.

(1) Forged-steel speltered sockets are required to be used for wire rope end connections on all portal, tower, floating, hammer-head, overhead traveling, wall and gantry cranes. Speltered sockets should also be used on all other cranes with certain exceptions where forged-steel wedge or swaged sockets may be used. Spelter means zinc and zinc only. Speltering shall be performed as specified in NAVDOCKS P-300, Management of Transportation Equipment or BUSHIPS Technical Manual, Chapter 27, Wire Rope.

(2) Clamps, clips, and screw wedges rope end connections are prohibited on any weight-handling equipment.

h. Rope Clips. Where wire rope clips are used to assemble a connection, the U-bolt shall be over the bitter end of the rope and the minimum number and spacing of clips shall be in accordance with the following table:

<u>Diameter of wire rope (inches)</u>	<u>Size of clip</u>	<u>Number of clips</u>
5/16	3/8	3
3/8	3/8	3
7/16	1/2	4
1/2	1/2	4
5/8	5/8	4
3/4	3/4	4
7/8	1	5
1	1	5
1 1/4	1 1/4	5
1 3/8	1 1/2	6
1 1/2	1 1/2	6
1 3/4	1 3/4	6

Spacing between clips shall be approximately six rope diameters.

i. Inspecting and Tightening Clips. All end fittings such as sockets Fiege connectors, and wire rope clips should be examined before the equipment is put in use to determine if there is an area of break adjacent to the fitting. Clips should be tightened after the first hour of running time and also at all regular inspections. After comparatively long use, clips should be removed and the rope examined for broken wires. If any are found, the damaged part should be removed and a new attachment made.

j. Adjustment to Guy Wires. No adjustment shall be made to guys while any workman is aloft on a guyed pole or mast.

2-6-8 SHEAVES AND DRUMS.

a. Worn Equipment. Sheaves, drums, or pulleys which have become worn, chipped, or the grooves corrugated shall not be used because they will injure the rope.

b. Use Proper Rope. Sheaves and blocks designed for use with fiber ropes shall not be used for wire rope, since they are not strong enough for that service and the wire rope does not fit the sheave grooves.

c. Gate Block Hooked. A gate block, commonly known as a snatch block, shall always be closed and hooked before being used.

2-6-9 CHAINS.

a. Dangers. All hoisting chains shall be inspected at frequent intervals for such defects as stretch, wear, gouge marks, open welds or fractures as indicated by very fine surface cracks, and shall be removed from hoisting service when such defects are found. Chains are less reliable than manila or wire rope as they break without any warning.

b. Stretched Chains. Chains which have stretched more than 5 percent in any five link section shall be discarded. Chains, which in any individual link show wear greater than 25 percent of the thickness of the metal, shall be removed from service.

c. Storing Chains. Chains shall not be stored where they will be run over by tractors, trucks, or other equipment.

d. Makeshift Repairs Prohibited. Makeshift repairs such as splicing with bolts shall not be used in hoisting chain or chain slings.

e. Kinks. Chains should not be subjected to sudden shock while in use. Loads shall not be lifted with a kinked or knotted chain.

f. Fittings. Attachments or fittings for chains should be of the type, grade, and size suitable for service with the size of chain used.

2-6-10 HOOKS.

a. Strength. Hooks and rings used with chain should have at least as great a strength as the chain. Hooks should be given a visual inspection at the beginning of each work day and prior to lifting the full rated load.

b. Bent Hook. When a hook has been bent by overloading, it will not be straightened and put back into service. A new hook shall be used in such cases.

c. Safety Latch. Safety latch hooks in good condition will be used in operations where there is danger of catching the load on an obstruction and where heavy, stiff slings are used; also where ammunition and explosives are being handled. This applies particularly to hoisting materials from narrow vertical trunks. In instances where safety latch hooks are not available, shackles and hooks used in lieu thereof shall be moused.

* d. Painting Prohibited. Cargo and crane hooks shall not be painted as paint hides defects.

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2-6-11 ELEVATORS, DUMBWAITERS, AND CONVEYORS - GENERAL. Due to defective equipment and/or improper operation of elevators and dumbwaiters, a number of serious personnel casualties have occurred on MSTS ships. Many of these casualties could have been prevented if the subject equipment had been properly maintained and proper operating procedures observed. MSTS administrative commanders are directed to carry out the following procedures:

a. Service Contract. Enter into a service contract for maintenance, service, inspection and certification of elevator and dumbwaiter equipment on a periodic and annual basis.

b. American Standard Safety Code. Comply with applicable protective measures required by American Standard Safety Code for elevators, dumbwaiters, and escalators.

(1) Equipment shall be tested at least annually to assure full compliance with b. above. This test shall normally take place during regular overhaul.

(2) Certification that equipment meets the requirements of b. above shall be filed with the ship's records.

c. Safety Control Devices. Insure that all dumbwaiter safety control devices shall be so located as to prevent tampering and manipulation of the control devices while any dumbwaiter door is open.

d. Operating Instructions. Insure that operating instructions for all elevators and dumbwaiters are posted at the control stations. These instructions shall include all necessary safety precautions load limitations of equipment, and shall prohibit the transportation of passengers on elevators designated for light service only.

e. Placing Out of Service. Insure that elevators and dumbwaiters are placed out of service, when safety devices are inoperative until repairs have been made.

f. Communication. Insure that suitable means of communication is provided between all dumbwaiter stations.

2-6-12 CONVEYORS. When conveyors are used to transport supplies from the dock to the vessel through side ports, a warning sign shall be posted in close proximity to the conveyor aboard ship that said conveyor shall not be used as a gangway.

2-6-13 SHIP FITTING - OBJECTIVE AND SCOPE.

a. Hazards. Erecting steel is one of the most hazardous jobs in the construction field. Much depends on the skill and good judgment

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of the workmen, but many injuries will be prevented if the men realize fully the extent of the danger accompanying this work and learn to observe these precautions daily as one of the basic requirements of their job.

b. References. The erection of steel requires the extensive use of cranes, derricks, hoists, slings, and ropes. Precautions covering such equipment will be found in Section II of this Chapter.

2-6-14 SHIP FITTING - GENERAL

a. Protective Apparel. Workmen employed on steel erection operations shall wear protective hats at all times. They should wear stout shoes (safety shoes are preferable), gloves and overalls without cuffs. They shall wear safety belts when working 12 feet or more above the deck, and at all times when working over water or doing repair work on a ship's sides.

b. Goggles. Goggles of approved type shall be worn by personnel employed in cutting out rivets, caulking, burning, grinding, chipping, or similar operations.

c. Welding. Welding operations shall be shielded or screened when necessary for the safety of the workmen or others in the vicinity.

d. Fresh Paint. Workmen shall not work on steel members which have been freshly painted.

e. Hoisting Material. Material shall not be hoisted to a structure until it is ready to be put into position and fastened.

f. Load Falls. There shall be at least two parts in the load falls used in steel erection.

g. Steel Cables. Steel cables shall be used on all loads in steel erection. When hoisting steel a guide rope should be attached to guide the load until it reaches the level where it is to be erected.

h. Bolting Steel. In setting steel, each piece shall be securely bolted or welded before the line is taken off.

i. Temporary Wiring. Particular care shall be taken in the stringing of any temporary electric wiring coming in contact with steel. Wire with defective insulation shall not be used.

j. Keep Tools in Boxes. All bolts, nuts, dollies, wrenches, other tools, and other articles shall be kept in kegs or boxes so that vibration will not cause them to creep and fall through or over the edge of planking. All boards, planks, kegs, and other loose material shall be secured before leaving the job.

PART 2
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CHAPTER 7
STAGES AND BOATSWAIN'S CHAIRS

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2-7-1 BOATSWAIN'S CHAIR.

a. Definition. The term "BoatSwain's chair", shall mean a seat to support a person in a sitting position at an elevation.

b. Dimensions of Chair. The chair shall be a seat not less than two feet long and one foot wide by one and one half inches thick.

c. Cleats. Where practicable, cleats should be screwed to the underside of each end of the chair and project at least 9 inches in front of the seat.

d. Suspension Rope. The chair shall be supported by means of a sling attached to a suspension rope. This rope shall either be securely fastened to a fixed object overhead or pass through a securely fastened overhead block. The free end shall be fastened to a fixed and easily accessible object.

e. Strength of Sling. The sling shall be of at least 5/8-inch diameter manila rope, or its equivalent in strength.

f. Stirrups. When the suspension rope is attached to a pole by means of a hitch, the workman shall be provided with stirrups supported independent of the chair, upon which he can rest his weight while he is shifting the pole hitch.

g. Safety Belt. Every workman using a chair shall be provided with a safety belt. The safety belt shall be attached to a hanging life-line, a rolling hitch should be used to make such connection.

h. Open Flame. Burning and welding, blowtorch operations, or the presence of any open flame shall not be permitted on or near the chair unless suspension ropes and slings are of steel. In such cases, the sling shall be of at least 3/8-inch diameter wire rope.

2-7-2 SUSPENDED STAGE PLATFORMS. A "suspended stage platform" shall mean a platform suspended from the hook of a crane or derrick or other approved mechanical weight lifting device. Staging used aboard ship shall be made up of a 12 inch plank 2 inches thick, and approximately 12 feet long. It should be straight-grained yellow pine or spruce and free of knots. Horns of 1 1/2 inch by 3 inch hardwood bolted to the underside about 18 inches from each end, and extending 12 to 15 inches on either side. Secure stage lines around the plank at the horns with a marlinspike hitch and then bend a bowline in the standing parts to form a bridle.

* 2-7-3 LADDERS.

a. Specifications.

(1) Ladders should be inspected at frequent regular intervals. Ladders with weakened, broken, or missing treads, rungs, or cleats, or broken or "splintered" side rails shall not be used.

(2) Ladders should be kept coated with a clear shellac or other transparent material, or treated with linseed oil. Painting with opaque paint is forbidden.

b. Position.

(1) Ladders shall be placed and secured or lashed to prevent toppling, so that the rails have a secure footing and a substantial support at or near the top.

(2) A ladder shall never be placed in front of a door opening toward the ladder unless the door is locked, or otherwise blocked, barricaded or guarded.

(3) Ladders used near live electric circuits shall not have metal rungs, braces, trusses, or struts, because of the danger of short circuits or accidental contact with live wires.

(4) Until such time as satisfactory specification for portable metal ladders approved by the Navy Department is issued, the use of such ladders is not recommended. These ladders shall not be used within four feet of any electrical wiring or equipment. All portable metal ladders shall be marked with signs or decals reading "CAUTION - DO NOT USE NEAR ELECTRICAL EQUIPMENT". Such signs shall be placed on the inside of side rails between the third and fourth rungs from the bottom of the ladder.

c. Use.

(1) The use of ladders where scaffolds, platforms, or other substantial working levels should have been provided, has resulted in many serious accidents. Work performed from ladders should be kept to a minimum.

(2) When ascending or descending a ladder, the user shall always face the ladder.

(3) No one should go up or down a ladder without the free use of both hands. If handling material, a rope should be used.

(4) No one shall run up or down a ladder, or slide down a ladder at any time.

(5) Before attempting to climb a ladder, workmen should remove oil or grease from the soles of their shoes.

d. Step Ladders.

(1) Step ladders shall be fully opened before anyone steps on them.

(2) A step ladder shall not be used as a working platform.

(3) Tools shall not be left on top of step ladders unless tool holders are provided.

(4) Step ladders shall not be used when strenuous action on the part of the workman is required. Under those circumstances there is danger of overturning the ladder.

e. Extension Ladders. All sectional ladders must be approved for use by the safety division. Ladders longer than 30 feet are prohibited.

2-7-4 GENERAL PRECAUTIONS.

a. Use of Scaffolds. Scaffolds constructed in accordance with Navy requirements should be provided for personnel engaged in work that cannot be done safely from the ground or from other solid construction, except such short-period work as can be done safely from securely placed ladders.

b. Maintenance. All scaffolds and scaffold equipment mentioned or described herein shall be maintained in a safe condition and shall not be altered or disturbed while in use. Personnel shall not be allowed to use damaged or weakened scaffolds.

c. Weather Restrictions.

(1) Employees shall not be permitted to work on a scaffold during a storm or high wind.

(2) Employees shall not be permitted on scaffolds which are covered with ice or snow. Clinging ice shall be removed from all guardrails, and the planking sanded or otherwise protected against slipping. Platform planking should not be turned over if it is covered with sleet, snow or ice.

d. Painting. Scaffolds shall not be painted since painting conceals defects which otherwise would be apparent.

e. Protection. When not in use, scaffold planks should be carefully stored and protected from the weather.

f. Rope and Cable Quality. Ropes and cables used in suspension and swinging scaffolds shall be of the best quality steel, manila, or sisal. (See Navy Department Specifications 22Re, 2 April 1945; 21R7, 16 July 1945, and Federal Specification T-R-631, 17 June 1942.)

g. Lifelines and Safety Belts. Lifelines and safety belts shall be used when working on a boatswain's chair, and on unguarded scaffolds or ladders at heights of 10 feet and above. Manila or sisal rope used as lifelines shall be 5/8 inch in diameter.

h. Safety Belts. Workmen shall be required to wear Navy approved safety belts which have been securely attached to a safety line by a mechanical safety device.

i. Open Flame. Burning or welding, blowtorch operations, or the presence of any open flame shall not be permitted on a scaffold supported by a fibre suspension rope or sling. Should such operation be necessary, the sling or suspension cable shall be of wire or steel.

* j. Inspecting Stages and Boatswain's Chair. Boatswain's chairs and stagings that have been rigged shall be inspected by the Boatswain or his designated Able Bodied Seaman prior to use.

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scaffolds at heights of 10 feet and above. Manila or sisal rope used as lifelines shall be 5/8 inch in diameter.

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PART 2
GENERAL SAFETY PRECAUTIONS

CHAPTER 8
WELDING AND CUTTING

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2-8-1 SCOPE. This Section shall be used as the safety code for MSTS activities ashore and afloat in the operation of equipment used in welding, cutting, and allied processes. Bureau of Ships Technical Manual, applicable Coast Guard Regulations, U.S. Department of Labor Safety & Health Regulations for Ship Repairing and the American Standards Association "Safety In Electric and Gas Welding and Cutting Operations" Z.49.1 or later, shall be used as a supplementary safety code for MSTS personnel.

2-8-2 TERMS USED.

a. Approved or Approval. When referring to appliances or equipment, these terms mean tested by a Naval test laboratory and found suitable for installation and use in Naval establishments or aboard Naval vessels.

b. Welder, Welding Operator, or Operator. As used herein these terms are intended to designate any operator of electric or gas welding and cutting equipment (including operators of the equipment when used for heating operations.)

c. Hot Work. Hot work is work involving welding, flame cutting, the use of open-flame equipment, or any work involving heating metal to or above a red heat. Riveting and any cold work involving the probability of striking sparks shall be considered as hot work, except when, in the opinion of the supervisor in charge, circumstances do not necessitate such a classification.

2-8-3 LOCATION.

a. Where Performed. The convenience of arc and gas welding and cutting lies largely in the fact that the equipment can be taken to the job and the work done in place. This convenience, however, makes possible construction and repair jobs in confined or remote locations that have not been laid out in the expectation that so much or such concentrated heat or mixture of gases would be introduced into that space. therefore the preparation described in the following paragraphs are essential.

* b. Preparation of Location. Welding and cutting operations should be conducted in locations that have been freed of fire hazards by removal or protection of combustible or explosive materials, liquids or vapors, and if suitable precautions have been taken against the reaccumulation of such materials. When welding or cutting is to be done in any location other than one specifically designated for such purposes, approval of the job and of precautions to be taken shall be obtained from the Chief Engineer or his designated representative and logged before operations are started.

c. Welding Aloft. If it is necessary for a welding operator to work on platforms, scaffolds, or runways at an elevation of more than 5 feet, provision shall be made to prevent falling. This can be accomplished by the use of railings, safety belts, lifelines, or other safeguards as specified elsewhere herein. Operations below shall be terminated; flammables removed or adequately protected; and area placed off limits until completion of work aloft.

d. Prohibited Areas. Welding or cutting operations shall not be performed in or on the outer surfaces of rooms, compartments, or tanks; nor in areas adjacent to rooms, compartments, or tanks; nor on or in closed drums, tanks, or other containers which hold or have held flammable or explosive materials, liquids, or vapors unless and until all fire and explosive hazards have been eliminated (see 2-8-28 thru 2-8-49).

e. Fire Watch. When flammable or explosive materials will be exposed to welding or cutting operations, a fire watch shall be posted in that vicinity. Fire watchers shall be posted on both sides of a deck, bulkhead, wall, or ceiling being worked on if fire hazards exist on both sides. The fire watch shall remain at their stations for a reasonable time (at least 30 minutes) after the job is completed to ensure that there are no smoldering fires. Fire fighting equipment or a suitable portable fire extinguisher must be available for use by fire watch.

2-8-4 DANGERS.

a. Fire and Explosion. Personnel performing welding, cutting,

or heating operations (hot work) in small spaces must take the recommended precautions against the ever-present hazard of suffocation of fires and explosion.

b. Lethal Vapors. Welding operators must guard against breathing the noxious and sometimes lethal gases which may be formed under certain conditions. Inadequate ventilation while welding may cause illnesses such as metal fume fever or metal poisoning.

c. Electric Shock. In electric arc welding, even low voltages may be a potential source of serious shock when certain unfavorable conditions exist. (See Chapter 2-15.)

d. Eye Injury. Eye injuries from the brilliant light of the arc or from heavy gas welding may be very serious.

e. Body Burns. Body burns from the arc or from molten metal are a constant danger as well as burns from handling hot objects such as wires, tools, rod, etc.

f. Combination of Circumstances. Moreover, personnel should exercise judgment and attempt to prevent other hazards which might be created by a peculiar combination of circumstances not specifically mentioned.

2-8-5 WELDING APPARATUS.

a. Approved Apparatus. Use only approved apparatus, such as torches, regulators, hose, valves, electric welding machines and accessories, or specialized apparatus that have been examined and tested and found to be safeguarded insofar as is practicable. Helmets, and hand shields, goggles, and clothing shall be approved types made of a material which is an insulator for heat and electricity, is not flammable, and is capable of withstanding sterilization.

b. Instruction of Operators. Workmen designated to operate welding or cutting equipment shall have been properly instructed and qualified to operate such equipment.

c. Installation of Electric Welding Equipment. It is important that electric welding equipment be installed only by competent and experienced personnel in accordance with approved plans. This requirement is especially applicable to the installation of specialized equipment such as acetylene generators, flame hardening outfits, etc. and of primary power lines and outlets intended to supply electric welding machines. All precautions outlined by the manufacturer shall be followed in addition to all procedures set forth in this Chapter under gas welding, arc welding, protection of personnel, ventilation of confined spaces, and hot work in way of flammable or explosive materials, and entry into closed compartments.

d. Inspection of Apparatus in Confined Spaces. While equipment is in use especially while operating in confined spaces, it shall be frequently inspected for evidence of leaks in the hose, couplings, valve stems, or other points of the system. If leaks are not properly detected, an explosive or lethal mixture of gas and air may accumulate with serious results.

e. Blocking Portable Equipment. Before operations are started, heavy portable equipment mounted on wheels shall be securely blocked to prevent accidental movement.

f. Suspending of Work. When work in a confined space (except in shop spaces authorized for active stowage of welding equipment) is to be suspended for any substantial period of time, such as during lunch or overnight, the following special precautions must be taken:

(1) Arc-Welding Equipment.

(a) All electrodes shall be removed from the holders.

(b) All arc welding equipment shall be disconnected from the source of power.

(c) All such equipment, including the electrodes holder, shall be positively insulated so that no accidental contacts can be made if the equipment is moved during this period.

(2) Gas-Welding Equipment.

(a) In order to eliminate the possibility of gas escaping through leaks or improperly closed valves during gas welding or cutting, the torch valves shall be closed and the gas supply to the torch positively shut off at some point outside the confined area.

(b) Where practical, the torch and hose shall also be removed from the gas supply during such time. For securing equipment when not in use, see 2-8-20g.

g. Protection of Equipment. Welding equipment used in the open should be protected from inclement weather. When not in use, the equipment should be stored in a clean, dry place.

2-8-6 FIRE-EXTINGUISHING EQUIPMENT.

a. Use of CO₂ Water Lines, and Water Tanks. Suitable fire-extinguishing equipment of approved types shall be maintained near all welding and cutting operations. The suitability of the equipment shall be judged by an analysis of the conditions at the scene of operations. If, for instance, the only combustible material within range of the

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welding or cutting operations or sparks therefrom is bitumastic water-proofing, a CO₂ extinguisher may be adequate. However, in a small space with a very small access opening, the operator may not be able to get out in case of fire and the use of CO₂ might be injurious to him. Under such conditions the use of water from a 1½-inch water line or water pump tank would be preferable.

b. Combatting Electrical Fires. Again, if the insulation of some electrical equipment that cannot be removed or adequately protected is the only combustible material present then a water spray may be more perilous than the fire itself. For combatting electrical fires CO₂ should be provided.

c. Carbon Tetrachloride. Carbon tetrachloride extinguishers shall not be used. "Carbon-tet," on hot metal decomposes to form phosgene, a very deadly gas, and may be more dangerous than the fire itself if used inside a closed compartment.

d. Care of Equipment. All installed fire-fighting equipment including sprinkler systems within the compartment where work is to be conducted and in adjacent compartments shall be maintained in working order at all times when welding or cutting operations are in progress.

2-8-7 PROTECTIVE CLOTHING.

a. Clothing Required. The officer in charge or safety engineer shall determine the appropriate protective clothing required for any welding operation, depending upon the size, nature, and locations of the work.

b. Gloves. Welding operators should at all times wear flame-proof gauntlet gloves complying with applicable specifications.

c. Protection from Radiated Heat and Sparks. Flameproof aprons, jackets, sleeves, or leggins made of leather, asbestos, or other suitable materials should be worn as protection against radiated heat and sparks, particularly during overhead welding. Coveralls, etc., shall not have steel buttons, steel belt buckles, etc., which may scrape on metal and strike a spark.

d. Alternate Clothing. If leather is unavailable, woolen clothing is preferable to cotton because it is not so readily ignited and helps protect the operator from changes in temperature. Cotton clothing, if used, should be chemically treated to reduce its flammability. All outer clothing such as jumpers or overalls should be reasonably free from oil or grease. Oilskins shall not be worn by any operator while using welding or cutting equipment.

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e. Plastic Clothing. Certain waterproof plastic clothing appears to store up large amounts of static electricity after very light friction and should not be worn by members of cleaning parties or others working around tanks likely to contain explosive vapors.

f. Rolled Up Sleeves and Pockets. Sparks may lodge in rolled up sleeves or pockets of clothing or cuffs of overalls of trousers. Sleeves and collars shall be kept buttoned and pockets not protected with flaps shall be eliminated from the front of overalls and aprons. Trousers shall not be turned up on the outside.

g. Protection of Legs and Feet. For very heavy work, fire resistant leggins, high boots, or their equivalent means should be used. The use of low-cut shoes with unprotected tops is not recommended. Safety shoes or boots should be worn which do not have exposed nail heads or rivets.

h. Head Protectors. Where there is exposure to sharp or heavy falling objects, hard hats should be used. Leather skull caps may be worn under helmets to prevent head burns.

i. Protection From Electric Shock. Where electric arc welding under wet conditions is unavoidable, electrician's rubber gloves should be worn instead of leather gloves. Leather protector gloves should be worn over the rubber gloves to protect them from damage by snagging or welding sparks.

2-8-8 EYE PROTECTION.

a. Goggles. Not only welding and cutting operators, but also other personnel such as helpers, chippers, inspectors, etc., who must remain in the vicinity, shall use suitable helmets, handshields, or goggles during all welding operations, in order to protect their eyes from stray flashes, reflected glare, and flying particles. All lenses in goggles and helmets shall meet the tests for transmission of radiant energy prescribed in the applicable Naval department specifications and shall have the shade of lens specified under f. below.

b. Types of Goggles. There are two general types of goggles.

(1) Spectacle type goggles are made both with and without metal side shields. They may have either a rigid nonadjustable or adjustable metallic bridge.

(2) Eyecup or cover type goggles have flexibly connected lens containers shaped to conform to the configuration of the face. The cover type is designed to be worn over correcting spectacles whereas eyecup goggles are worn alone.

c. Overhead Welding. Only the eyecup or cover type goggles should be used when welding or cutting near or above eye level.

d. Goggles for Gas Welding. Spectacle type (side shielded) or eyecup or cover type goggles shall be used during all gas welding or cutting operations. Spectacle type goggles without side shields and with suitable filter lenses are permitted for use with gas welding operations on light work and for inspection.

e. Protections for Electric Arc Welding. Helmets or hand shields shall be used during all arc welding or cutting operations. Spectacle type (side shielded) goggles should also be worn on these operations to provide protection from injurious rays from adjacent work and from flying objects. The goggles may have either clear glass or colored glass. When colored glass is provided in the goggles, the shade numbers for the glasses in the goggles and the helmet shall be determined as indicated in the following paragraph.

f. Shade of Lens. The lens to use in any instance may well be determined by the individual operator who is wearing or using the helmet, hand shield, or goggles; but should not vary more than two shades from those recommended in the following table. The object is not only to diminish the intensity of the visible light to a point where there will be no glare, so that the welding area can be distinctly seen, but also to protect the welder from the harmful infrared and ultraviolet radiations from the arc or flame. Protective cover lens shall be immediately replaced when it is found to be badly pitted, cracked or otherwise splattered to prevent distorted vision during welding or cutting operations. The following list should be used for guidance in selecting goggles:

<u>Shade of Lens</u>	<u>Kind of Work</u>
Clear glass in spectacle type (side shielded) or up to shade 4 in any type.	Light electric spot welding or for protection from stray light from nearby welding.
No. 5 filter	Light gas cutting and welding.
No. 6 filter	Gas cutting, medium gas welding, and arc welding up to 30 amperes.
No. 8 filter	Heavy gas welding and arc cutting and welding, 30-75 amperes.
No. 10 filter	Arc cutting and welding 76-200 amperes.
No. 12 filter	Arc cutting and welding 201-400 amperes.
No. 14 filter	Arc cutting/welding over 400 amperes.

g. Transferring Equipment. Helmets and goggles should not be transferred from one person to another without antiseptic cleaning.

h. Welding Bays painted Black. Where welding with the electric arc is regularly carried on, the walls of the welding bay shall be painted flat black or other nonreflecting color to prevent flickering reflections or the work should be enclosed in a booth.

i. Portable Booths. Where the work permits, workers or other persons adjacent to the welding areas shall be protected from the rays by means of enclosing the work area with flame-proof screens or individual booths which have been painted with a nonreflecting color, such as zinc oxide and lamp black.

j. Treatment of Arc Burned Eyes. In case of temporary eye burns the eye will not be permanently injured, but the pain may be intense for as long as 24 to 48 hours. Obtain medical treatment promptly if arc burn is felt or suspected.

2-8-9 RESPIRATORS AND AIR-LINE MASKS.

a. Lead and Cadmium Paints and Alloys. When an operator is engaged in welding or cutting lead-bearing steels, lead or cadmium-bearing paint or low melting point lead alloys, whether indoors or out, an air-line mask or local exhaust ventilation at the point of origin shall be used. Where conditions do not permit their use, a filter-type respirator, approved for protection from lead fumes, may be used but only where the work is carried on intermittently and for short periods.

b. Welding Inside Closed Containers. Where welding operations are carried on inside tanks or other closed containers, air-line respirators or hose masks should be furnished the men so employed; and when used, a workman shall be stationed on the outside to service the power and ventilation lines to insure the safety of those working within. The attendant should observe the welding operator at all times, and in case of emergency shall immediately shut off the gas or electric current and render such other help as the occasion warrants. A filter type respirator may be used for short periods of time.

2-8-10 SAFETY BELTS AND LIFELINES. Where a welding operator must enter a confined space through a manhole or other small opening, means shall be provided for quickly removing him in case of emergency. Safety belts and lifelines used for this purpose shall be so attached to the operator's body that the body cannot be jammed in a small exit opening.

2-8-11 COMMUNICATION. When men are in tanks and other such spaces, even after such spaces have been cleaned and found "SAFE", a reliable

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man shall stand outside at the manhole and keep count of the men in the space and communicate with them every few minutes to be sure that no one has been overcome by lethal gases.

2-8-12 WARNING ABOUT HOT METAL. After welding operations are completed, the welder shall mark the hot metal or provide some other means of warning other workers.

2-8-13 CYLINDERS - GENERAL. General directions for the safe handling and stowage of compressed fuel gas and oxygen cylinders are given in Chapter 2-9, (Fuels and Compressed Gases), and in BuShips Technical Manual. Following are a few special precautions concerning cylinders when in actual use in welding or cutting, or in "active stowage" (ready service.)

a. Specifications for Cylinders. All portable cylinders that are used for the storage or shipment of compressed fuel gases or oxygen shall have been furnished in accordance with the applicable Naval specifications and such regulations as are prescribed by the Interstate Commerce Commission. Cylinders shall be marked in accordance with the requirements set forth in Chapter 23 of the Bureau of Ships Technical Manual, as well as in accordance with the applicable requirements of the above specifications and I.C.C. regulations.

b. Markings. No one shall alter or tamper with numbers or markings stamped into or painted on cylinders except at Bureau of Ships authorized activities.

c. Call by Proper Names.

(1) Fuel gases should be called acetylene, hydrogen, etc., and not by the word "gas", which is a general term including oxygen.

(2) Oxygen should be called by its proper name -- not, for example, by the word "air".

d. Refilling Cylinders. Refilling of cylinders and transfer of gas from one cylinder to another within the Naval establishment shall be done only by competent personnel at Naval activities authorized by the Bureau of Ships to do so, and shall be done according to approved procedures.

e. Mixing Fuel Gases and Air or Oxygen. Mixtures of combustible gases and air are very explosive and shall be carefully guarded against. No device or attachment facilitating or permitting mixture of air or oxygen with combustible gases prior to consumption, except at the burner or in a standard torch or blow pipe, shall be allowed unless approved for the purpose.

f. Mixing Gases. No one shall mix or attempt to mix different fuel gases in one cylinder nor mix any fuel gas with oxygen in one cylinder.

g. Use for Other Purposes. No one shall use a container for any purpose other than that for which it was intended.

h. Safety Devices. No one shall tamper with safety devices in cylinders or valves.

i. Assigned Locations. Keep all cylinders in definitely assigned locations (see 2-9-55), that are:

(1) well ventilated and away from corrosive chemicals and fumes;

(2) away from radiator or other sources of heat or fire; in summer, away from direct rays of the sun;

(3) away from elevators, stairs, or gangways;

(4) free from danger of being knocked over or damaged by heavy objects passing or falling;

(5) where they cannot form part of an electric circuit;

(7) far enough away from the actual welding or cutting operations so that sparks, hot slag, or flame will not reach them;

(8) on or above the weather deck.

j. Securely Fastened. Cylinders in use or in stores or cargo shall be securely fastened to prevent shifting or falling under any weather conditions.

k. Confined Spaces. When welding or cutting is being performed in any confined space with difficult means of exit, the gas cylinders and heavy welding or cutting equipment shall be left on the outside.

l. Protection From Ice. Cylinders in the open should have valves and safety devices protected against accumulations of ice and snow. Warm (not hot) water shall be used to thaw ice in cylinders' valve outlets.

m. Excessive Heat. In summer, cylinders in the open shall be screened from the direct rays of the sun to protect against excessive temperature rises. (The maximum temperature to which cylinders should be subjected is 130° F. Higher temperatures may cause dangerous pressure increases.)

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2-8-14 HANDLING OF CYLINDERS.

a. Use of Cradles, Racks, Platforms. When loading or transferring cylinders, especially when using a crane or derrick, the cylinders shall be secured in a cradle, boat, suitable platform, rack, or special container (such as sand bag). Cargo nets, rope, or chain slings should not, and electromagnets must not be used for this purpose. Valve protecting caps shall be in place during such operations.

b. Do Not Drag or Slide Cylinders. Cylinders moved by hand should be tilted and rolled on their bottom edges without dragging or sliding. Cylinders shall not be dropped or struck, and they shall not be permitted to strike each other violently.

c. Do Not Use as Roller or Support. Cylinders shall not be used as rollers or supports especially for welding or cutting operations, even if they are thought to be empty.

d. Remove Regulators Before Moving. Unless cylinders are secured in a special rack, regulators shall be removed and valve-protection caps should be put in place before cylinders are removed.

e. Rough Handling. All cylinders shall be handled carefully. Rough handling knocks or falls are likely to damage the cylinder, valve, or safety devices and cause leakage. Dropping or careless handling can break off a cylinder valve, and a sudden release of oxygen from a full cylinder can cause it to take off like a rocket.

f. Use of Hand Truck. Wheeled hand trucks for transporting and holding cylinders while welding or cutting are not recommended for shipboard use unless the commanding officer considers that their use will expedite operations. If used, the truck shall be of substantial design as follows:

(1) The truck shall be securely and firmly fastened to a bulkhead or stanchion to prevent shifting or falling under any weather conditions.

(2) The frame shall be rigid enough to permit handling with tackle.

(3) Grips on handles shall end in a line vertical with the aft side of the wheels to facilitate fastening to a bulkhead.

(4) Platforms shall be fitted with sides to prevent cylinders from sliding off.

2-8-15 CYLINDER VALVES.

a. Protection Cap. Valve protection caps are designed to protect valves from damage. Before raising cylinders from a horizontal to a vertical position, the cap should be properly in place, the cap should be turned clockwise to see that it is hand-tight, then the cylinder should be raised by grasping the cap. Hooks or line through valve protection caps shall not be used for lifting cylinders from one vertical position to another. Bars shall not be used under cylinders and particularly not under valves or valve-protection caps to pry cylinders loose when frozen to the ground or deck or otherwise fixed; the use of warm (not boiling) water is recommended. Valve-protection caps should always be in place except when cylinders are in use or connected for use.

b. Open Valves Slowly. Cylinder valves shall always be opened slowly.

c. Never Repair Valves. Never tamper with nor attempt to repair cylinder valves. If trouble is experienced, indicate on a "defective" tag the nature of the trouble and return the cylinder to the supplier.

d. Do Not Force Valves. Do not use a hammer or a wrench to open cylinder valves. If valves cannot be opened by hand, tag them as defective and in need of repairs before recharging.

e. When the Oxygen Cylinder Is In Use. The valve should be opened at least one full turn, preferably all the way, to prevent leakage around the vent stem. Avoid complete removal of stem from a diaphragm type valve (it might be lost or dirt might enter the mechanism).

f. Closing Valves. Valves shall be closed under the following conditions:

before moving cylinders;
when work is finished;
when cylinders are "empty".

2-8-16 FUEL-GAS CYLINDERS.

a. Vertical Position. Acetylene and liquefied fuel-gas cylinders shall be placed with valve-end up whenever they are used. They should also be stowed in this position and not allowed to lie on their sides. If horizontal stowage is necessary, cylinders must be in vertical position 2 hours before using. Otherwise acetone in which the acetylene is dissolved will be drawn out with the gas.

b. Leaking Cylinders. If a leak develops at a fuse plug or elsewhere on a cylinder, it shall be removed to the weather well away from the source of ignition. Such a cylinder shall be plainly tagged as defective and in need of repair before refilling.

c. Leaking Around Valve Stem. If, when the valve on a fuel gas cylinder is opened, there is found to be a leak around the valve stem, the valve should be closed and the gland nut tightened. If this does not stop the leak, the use of the cylinder should be discontinued. The cylinder shall be plainly tagged as defective and in need of repairs before using or recharging. If the need to use the cylinder is very urgent, the leak can probably be stopped by opening the valve all the way; but this should be done only when emergency conditions requiring quick closing of the cylinder valve are not likely to occur.

d. Leaks in Piping. Tests for leaks of any piping system or apparatus shall be made with soapy water. Use grease-free soap. NEVER EMPLOY FLAMES TO DETECT LEAKS.

e. Opening of Valve. An acetylene cylinder valve open $\frac{1}{4}$ to $\frac{1}{2}$ turn will permit an adequate flow of gas; and in order that the valve may be turned off quickly in case of emergency, it should not be opened more than one and one half turns.

f. Keeping Wrench Available. Where a special wrench is required it shall be left in position on the stem of the valve while the cylinder is in use so that fuel gas can be quickly turned off in case of emergency. In the case of manifolded or coupled cylinders, at least one such wrench shall always be available for immediate use.

g. Protection of Safety Plug. When cylinders are in use, nothing shall be placed on top of an acetylene cylinder which may damage the safety plug or interfere with the quick closing of the valve.

h. Pressure of Acetylene. Under no conditions shall acetylene be generated or used at a pressure in excess of 15 pounds p.s.i. gage pressure. This requirement is not intended to apply to the storage of acetylene dissolved in a suitable solvent (such as acetone) in cylinders manufactured according to Interstate Commerce Commission requirements and to applicable Naval specifications.

i. Liquid Acetylene. The use of liquid acetylene in welding is prohibited.

2-8-17 OXYGEN CYLINDERS.

a. Keep Away From Oil and Grease. Keep oxygen cylinders and fittings away from oil and grease, which in the presence of oxygen

under pressure, may burst into flame. A jet of oxygen shall never be permitted to strike an oily surface or greasy clothes, or to enter a fuel oil tank or other compartment that has contained a flammable substance. Every possible precaution shall be taken to prevent oily and greasy substances from coming in contact with cylinders and cylinder valves. Do not handle oxygen cylinders, valves, regulators, hose (oil or grease deteriorates rubber), and other apparatus or fittings with oily hands, gloves, or greasy materials. Cylinders shall never be stowed or used where oil or grease from ship's machinery or overhead cranes or belts can splash or fall upon them. Oxygen will not burn, but it supports and accelerates combustion and will cause oil and other flammable materials to burn more easily and with greater intensity.

b. Keep away From Combustibles. Do not store oxygen cylinders near highly combustible material, especially oil and grease; or near reserve stocks of acetylene or other fuel gas cylinders; or near any other substance likely to cause or accelerate fire.

c. Not a Substitute for Compressed Air. A serious accident may easily result if oxygen is used as a substitute for compressed air. Never use oxygen in pneumatic tools, in oil preheating burners, to start internal combustion engines, to blow out pipe lines, to "dust" clothing or work, to create pressure, or for ventilation.

2-8-18 REGULATORS.

a. Pressure-Reducing Regulator. Cylinders shall not be used without first attaching an approved pressure-reducing regulator to the cylinder valve or to a manifold.

b. Cracking Cylinder. Before connecting the regulator to the cylinder valve, the valve shall be opened one quarter of a turn and closed immediately. This action is generally termed "cracking" and will clear the valve of dust or dirt that otherwise might enter the regulator. Always stand to one side of the outlet when opening the valve. Never "crack" a fuel gas cylinder near other welding work or near sparks, flame, or other possible sources of ignition. Be sure the regulator is closed (the adjusting screw backed out until loose) before opening the cylinder valve.

c. Connecting Regulator. When a regulator is attached, open the cylinder valve slightly at first so that the regulator cylinder-pressure gage hand moves up slowly; then open the valve all the way. If the pressure is suddenly released, it is likely to damage the regulator and pressure gages.

d. Right- and Left-Handed Threads. Threads on oxygen regulator outlets, hose couplings, and torch valve inlets are

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right-handed. Threads on acetylene cylinder valve outlets are right-handed, but of different pitch from oxygen cylinder valve outlets. If threads do not match, the connections are mixed. Do not attempt to force unmatched or crossed threads.

e. Personnel in Front of Pressure Gage. When valves are opened no one should be allowed to stand in front of the pressure gages.

f. Acetylene Valve Outlet. When setting up cylinders for use, the acetylene valve outlet should be pointed away from the oxygen cylinder.

g. Metal Tools. Metal tools (even the so-called sparkless type) for making repairs shall be used with caution to avoid striking a spark. Such a spark may cause ignition if a mixture of gas and air is present.

h. Modification of Regulators Prohibited. Regulators or automatic pressure-reducing valves shall be used only at the pressures and for the gas for which they are intended. Do not experiment with regulators or modify them in any way.

i. Testing Gages on Regulators. Working or low pressure gages attached to regulators should be periodically tested to ensure their accuracy. Do not test oxygen gages with oil.

j. Faulty Threads or Nuts. Union nuts and connections on regulators should be inspected before use to detect faulty or dirty threads or seats which may cause leakage of gas when the regulators are attached to the cylinder valves. When damaged nuts or connections are found, they shall be removed from service. Dirty threads or seats shall be cleaned.

k. Clear Working Space. Keep a clear space between the cylinders and the work so that the cylinder valves can be reached easily and quickly if necessary.

l. Low Pressure Within Cylinder. The use of any cylinder shall be discontinued before the pressure falls to zero. Oxygen cylinders, particularly, shall not be used in welding or cutting operations, except in an emergency, after the gage pressure falls below approximately 25 p.s.i. Cylinder valves shall then be securely closed and valve protecting caps replaced. These practices prevent moisture, other gases, etc., from contaminating the cylinder before it is refilled. Such cylinders shall be tagged or marked "Empty" or "MT". Empty cylinders shall be segregated from full cylinders, but shall be stowed in the same compartments (or on deck) and otherwise handled with the same precautions as specified for full cylinders.

m. Removal. Before a regulator is removed from a cylinder valve, the cylinder valve shall always be closed and the gas released from the regulator.

2-8-19 PORTABLE MANIFOLDS. When it is necessary to discharge fuel gas or oxygen simultaneously from several cylinders in order to provide sufficient volume for heavy work on several concurrent jobs, a portable manifold (sometimes called a coupler block) may be used to connect the cylinders to a single regulator or to a single header having several outlets with individual regulators. Portable manifolds shall be of substantial design and capable of safely withstanding any pressure to which they may be subjected in operation.

2-8-20 THE TORCH.

a. General. The following precautions, including procedure for lighting, adjusting, and extinguishing torch flames, shall be carefully followed. Closed and poorly ventilated compartments shall be inspected and approved by an authorized person prior to conducting any hot work (see 2-8-37). Special precautions indicated by the manufacturer of any apparatus shall also be carefully carried out.

b. Tip or Nozzle Pressure. Always use the proper tip or nozzle, and operate it at the correct pressure for the particular work involved. This information should be taken from tables or work sheets supplied with the equipment.

c. Suitable Source of Ignition. Do not use matches for lighting torches or serious hand burn may result. Use friction (spark) lighters, stationary pilot flames, or some other suitable source of ignition.

d. Lighting Torch. When lighting the torch, open the acetylene valve first and ignite the gas while the oxygen valve is still closed. Do not allow the unburned acetylene to escape into small or closed compartments.

e. Lighting Torch in Confined Space. Do not attempt to light torches from hot metal, especially in a confined space. An explosive mixture of acetylene and oxygen can accumulate quickly and may cause damage or personnel injury if ignited. Do not allow such a mixture to accumulate. Particularly, do not be slow to light a torch, especially a large one for heavy work. A stationary pilot flame, such as a candle, shall be used in lieu of a spark lighter in a confined place.

f. Extinguishing Torch. When extinguishing the torch, close the acetylene valve first, then close the oxygen valve.

g. Securing Equipment When Not in Use. When welding or cutting is stopped and will not be resumed within 15 minutes, or when the

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operator leaves the scene for any period of time, the equipment shall be secured as follows:

- (1) Extinguish the torch as in f. above.
- (2) Close both acetylene and oxygen cylinder valves.
(leave regulators open momentarily.)
- (3) Open acetylene valve on torch and allow gas in hose to escape (5 to 15 seconds) to outside atmosphere, NOT into small or closed compartment. Close valve.
- (4) Open oxygen valve on torch and allow gas in hose to escape (5 to 15 seconds). Close valve.
- (5) Close both regulators. (Note -- oxygen and acetylene regulators are closed when adjusting screws are backed out until loose.)

h. Regulators and Valves Clear of Hose. Do not hang a torch with its hose on regulators or cylinder valves. Make certain that the torch is not burning when not in use and that the valves are closed tightly.

i. Valves Tightly Closed. If, after equipment has been in use, it is to be stowed for a considerable period before being used again, it shall be inspected carefully to determine that cylinder and torch valves are firmly closed, regulators are closed (adjusting screws released); and all hose connections are tight. If stowed thus, it is not likely to create any explosion hazards in the compartment in which stowed, and it can be put back into use at any moment.

j. To Prevent Backfiring. If equipment has been stowed with torch valves open or loosely closed or with hose connections loose, or if hoses and torch are being newly connected prior to use, or if either of the cylinders has just been changed, there is danger of backfiring unless all connections are made tight and the system "purged" of air as follows before the torch is lighted.

k. Purging System of Air. Be sure torch valves are firmly closed; then open cylinder valves slowly, open regulators slightly, open torch acetylene valve and allow unlighted gas to escape to the outside atmosphere, Not into a small or confined space. Allow gas to flow for 5 to 15 seconds, depending on length of hose, until all air, or mixture of gas and air, has been forced out of the system. Then close the torch acetylene valve. Repeat the procedure on the oxygen side of the system. Then proceed with lighting the torch as above.

l. Uncapped Openings. When combustible gas lines or other parts of equipment are being purged of air or gas, lights or other

sources of ignition shall not be permitted near uncapped openings.

2-8-21 HOSE.

a. Color. Red is the generally recognized color for acetylene hose and green or black for oxygen hose.

b. Twin Hose Lines. A single hose with two or more gas passages, in which a wall failure might permit the flow of gas from one passage into the other, or permit the mixing of gases in the hose, is not permitted. Twin hose lines made especially for oxyacetylene operations are permissible when they are substantially two hoses, held together by webbing or other means, and so constructed that gas from one hose line cannot conceivably leak into the other. When parallel lengths of oxygen and acetylene hose are taped together for convenience and to prevent tangling, not more than 4 inches out of each 8 should be covered with tape, otherwise it is difficult to locate leaks and identify hose.

c. Metal Clad Hose. Metal clad or armored hose is not recommended.

d. Worn Spots. Hose shall be frequently inspected for worn spots or defective connections and defective hose shall be repaired or removed from service.

2-8-22 WELDING ON SHIPBOARD.

a. Responsibility of Commanding Officer. When oxygen and acetylene or other fuel gases are to be used aboard ship, the cylinders would normally be placed as close as possible to the work. However, in construction, repair, overhaul, or conversion jobs conducted in shipyards, bases, or alongside repair ships, it becomes necessary to decide whether to allow the cylinders and outlet headers inside the ship or to keep them outside. Decision shall rest with the Commanding Officer and shall be based on an analysis of which set of hazards -- that is, leaving equipment inside or taking it outside the ship -- can be more readily safeguarded. In either event, before hot work is done in way of flammable or explosive materials and before there is any entry into closed or poorly ventilated spaces, the Commanding Officer shall see that careful preparations are made as described in 2-8-37 through 2-8-49.

b. Cylinders Inside the Ship.

(1) If cylinders are located inside the ship in many compartments from which they cannot be removed quickly, they may become involved in a fire. There is little danger of the cylinders themselves exploding, but the heat and pressure may open the cylinder safety

devices and release the gases. Escaping fuel gases may become ignited and the flaming cylinder will add to the fire; or unburned fuel gas escaping into a confined space may form an explosive mixture before it is ignited; or escaping oxygen may cause a small fire to burn more fiercely.

(2) When cylinders are manhandled through doors and hatches and up and down ladders, special care must be taken to prevent injury to personnel or damage to the cylinders, which in turn may cause an accident. On ships under construction, however, when decks are not in place, rapid and safe handling of cylinders by cranes is practical.

c. Cylinders Outside the Ship. On the other hand, keeping the cylinders, outlet headers, etc., outside of the ship on the weather deck, the ways, or the dock, exchanges one set of hazards for another such as:

(1) Higher gas pressures and additional couplings required for longer hose lines increase the danger of gas leaks into the ship.

(2) Hoses strung out along decks and through doors and hatches are more in danger of being damaged or cut and thus flammable or toxic gases or oxygen-gas mixtures may be released into the ship.

(3) When men are working deep inside the ship and the cylinders are topside or on the dock, the special procedures relative to stringing hoses through the ship (2-8-23) shall be carefully followed.

2-8-23 STRINGING HOSE THROUGH SHIP. Whenever cylinders, portable outlet headers, or service piping outlets are left in a shop aboard ship, or on the weather deck, the dock, or some other point remote from the scene of work, and hose lines are strung out for long distances to the work, the procedure below shall be followed.

a. Connecting Apparatus. Connect regulators, hose, and torch as outlined in 2-8-18 through 2-8-21.

b. Trial Lighting of Torch. Light torch and adjust regulators for proper pressures. Extinguish torch, leaving supply valves and regulators open temporarily.

c. Inspection for Leaks. Inspect all connections for leaks, especially torch valve and hose connections that will go inside the ship.

d. Close Supply Valves. If no evidence of leaks is found, close the cylinder or other supply valves just behind the regulators. Leave the regulators open at proper adjustments.

e. Protecting Hose. String the hose, with torch attached, to

the location of the work. If several hoses are strung through the ship, or if the work will take several hours or days, provision should be made to suspend the hoses off the deck to minimize the danger of damage to the hose. Take all practical precautions to ensure that doors and hatch covers are securely held open to preclude cutting of the hose by an accidentally closed door or hatch cover, and to guard the hose from damage by traffic in its vicinity.

f. Opening and Closing Supply Valves. An assistant should be assigned to maintain contact with the operator. He should be stationed where he can close the valves quickly in case of an emergency, and reopen the supply valves when directed by the operator. The work may then proceed.

(1) If assignment of a helper is not practical, and it is necessary to adjust supply valves, the operator shall secure the torch where it is not likely to be disturbed -- asking a shipmate or fellow worker to watch it. The operator shall be sure that torch valves are firmly closed before leaving equipment to reopen the supply valves. He shall return immediately to the torch.

(2) On each trip the operator shall follow the hoses and inspect them for damage.

(3) If, on his return, the operator detects no odor of acetylene or other indication of danger in the compartment, he may then light the torch and proceed with work.

g. Leaving Equipment Unattended. When leaving equipment unattended for even a relatively short period such as meal time, directions (2-8-20g.) for securing welding equipment shall be carefully followed.

h. Care of Equipment After Using. Upon completion of work, extinguish the torch and direct the helper to close the supply valves; or the operator shall immediately do it himself. The torch and hose shall immediately be removed from the compartment to the outside or stowed with the cylinders in their assigned locations.

2-8-24 PROTECTION FROM SHOCK.

a. Working Alone Inadvisable. Whenever it can be avoided, a welding operator should not work alone in a compartment. Immediate care of an operator who has received an electric shock may prevent serious consequences.

b. Care of Equipment. Welding equipment should be maintained in good mechanical and electrical condition to avoid unnecessary hazards. Commutators should be kept clean to prevent excessive flashing.

c. Voltage. All personnel must keep constantly in mind that any electric power circuit, whether AC or DC, high or low voltage, is a potential source of danger. It is important to observe every precaution to prevent shock. Although the voltages required for arc welding are low and normally will not cause injury or severe shock, they are enough to be a potential source of serious shock under unfavorable conditions.

d. Dangers From Low Voltage. One of the principal dangers from low voltage welding circuits is the totally unfounded assumption that they can be handled with impunity. The only way to be safe is to handle any electric circuit with extreme caution. The reference to "any electric circuit" is particularly emphasized because the welding operator not only handles the welding circuit, but he also may handle portable lights, portable motor-driven tools, and in many instances he may handle switches or portable cable on the side of the arc welding machine connected to the ship's power system.

e. Keeping Body Insulated. The danger of shock is particularly marked when the operator is sweaty or wet. The operator should develop the habit of always keeping his body insulated from both the work and the metal electrode and holder. It should never be assumed that because contact at one time is not harmful, similar contacts at other times will be similarly harmless. Changes that are not noticeable can take place which could change the effects of contact.

f. Wooden Mats Used for Insulation. Whenever it is practicable, the operator should stand on dry wooden mats or similar insulating material rather than on grounded metal structure.

g. Reference. For additional information on electrical safety during welding, see Chapter 2-15 of this Instruction.

2-8-25 ELECTRODE HOLDERS.

a. Safe Capacity. Only electrode holders which are fully insulated and in good condition shall be used. They shall have been specifically designed for arc welding and of a capacity capable of safely handling the maximum rated current required by the electrodes with which the holder is intended to be used.

b. Insulation. Any current-carrying parts passing through the portion of the holder which the operator grips in his hand shall be fully insulated with nonconducting material capable of safely insulating against the maximum voltage encountered to ground. Electrode holders with all metallic or current-carrying parts fully insulated (including the jaws gripping the electrodes) are recognized as affording superior protection to the operator. Such holders are available in stock and shall be used wherever service conditions permit.

c. Gloves. Always wear gloves when handling energized holders, cables, or machines and when removing or replacing electrodes. The gloves should be dry and in good condition.

d. Dipping in Water. Do not dip hot electrode holders in water because this would expose the operator to the chance of receiving an electric shock.

e. Energized Holder. Do not put an energized electrode holder under the arm at any time. When the energized electrode holder is not in use, the operator should place it where it will not be contacted by other personnel. If an insulated surface or insulated holding peg is not available, remove the electrode and lay the insulated holder on the deck or other adjacent object.

f. Damp Clothing; Bare Skin. Never permit the metal part of an electrode holder to touch either the bare skin or any damp clothing which the operator may be wearing.

2-8-26 CABLE AND COUPLINGS.

a. Type. Only approved welding cables of the completely insulated flexible type conforming to the applicable requirements of N. D. BuShips Spec. 15C1 shall be used. They shall be capable of handling the maximum current requirements of the work in progress, taking into account the duty cycle under which the welding operator is working.

b. Connectors and Couplings. When it becomes necessary to connect lengths of cable, substantial insulated connectors of a capacity at least equivalent to that of the cable shall be used. Fully insulated "rapid couplings" are carried in standard stock and should be used whenever possible. If connections are effected by means of cable lugs, the lugs shall be soldered to the cable and securely fastened together to give good electrical contact. The exposed metal parts of the lugs, and the means used to fasten them together, shall be completely covered with rubber tape and protected with friction tape or equivalent protective covering. If any part of the connection is left bare, accidental contact with a metallic structure may cause sparks, arcs, and fires.

c. Inspection. Cables should be inspected once a month to see that they are in good condition.

d. Bare Conductors. When a cable (either work lead or electrode lead) becomes worn, exposing bare conductors, the exposed portion shall be protected by means of rubber and friction tapes or equivalent protection.

e. Keep Cables Dry and Free of Oil. Welding cables should be kept dry where practicable, and free from grease and oil, to prevent premature breakdown of the insulation.

f. Transporting Cables. When it becomes necessary to carry cables some distance from the machines, they should be substantially supported overhead, if practicable. If this cannot be done, and cables are laid on floor or ground, they should be protected in such a manner that they will not incur damage or interfere with safe passage of personnel. Special care should be taken to see that welding supply cables are not in proximity to power supply cables or high-tension wires.

g. Looping Cable Over Shoulder. Do not loop the welding cable over the shoulder (particularly over the shoulder opposite the hand holding the electrode holder). There is no shock hazard in this practice, but operators have been dragged off staging or scaffolds when the cables were fouled by cranes, etc.

h. Separation of Cables. When using portable machines, care should be taken to see that the primary supply cables are separately laid and do not become entangled with welding supply cable.

2-8-27 GROUND RETURNS.

a. Frame Grounded. Before starting operations, the operator shall make certain that the welding machine frame is grounded, that neither terminal of the welding generator is bonded to the frame of the welding machines, and that all electrical connections are securely made. The ground connection should be attached firmly to the work, not merely laid loosely upon it.

b. Use of Structure or Pipe Line. Ground returns from the work to the machine should be made with a cable wherever practicable. However, under some operating conditions it may be necessary to utilize a structure or pipe line for the ground return. When such a structure is employed precautions against the creation of unsafe conditions must be taken.

c. Flammable Liquid Pipe Lines. Pipe lines carrying gases or flammable liquids shall not be used for a ground return circuit.

d. Contact at Joints. When a structure or pipe line is used as a ground return circuit, it shall be checked to ascertain whether proper electrical contact exists at all joints. A condition of sparking or heating at any point should cause the rejection of the structure as a ground circuit, particularly if flammable vapors or gases may be present.

e. Avoid Current Through Bearings. Ground connections must be made in front of any bearings or similar joints in a structure or machine. Welding current going to ground through a bearing will almost invariably cause sparking and heating which will pit and ruin ball and roller bearings or other polished surfaces.

f. Joints Bonded and Inspected. Where a structure or pipe line is continuously employed as a ground return circuit, all joints shall be bonded and appropriate periodic inspection shall be conducted to ascertain that no condition of electrolysis or fire hazard exists as a result of such use.

g. Inspection. All ground connections shall be checked to determine that they are mechanically strong and electrically adequate for the required current.

2-8-28 HAZARDS OF INADEQUATE VENTILATION. Under conditions of improper ventilation, welding operations may cause health hazards. These hazards are almost entirely due to: the presence of gases, dusts, and fumes containing lead, zinc, cadmium, florine, or compounds thereof; the possible formation of oxides of nitrogen; and extreme heat.

2-8-29 VENTILATION REQUIRED. When any of the above hazards are present, either adequate forced ventilation shall be provided or an individual air respirator shall be worn by the operator.

2-8-30 VARIABLES AFFECTING VENTILATION. The attention of commanding officers is invited to the variables listed below which must be evaluated for their effect on calculations of minimum forces general ventilation requirements for spaces regularly used for welding operations.

- a. Dimensions of space, with special regard to height of ceiling.
- b. Number of operators (gas or electric).
- c. Composition and coatings of metals to be welded.
- d. Type and size of electrodes, and amperage used.
- e. Rate of welding.
- f. Variations in "natural" ventilation due to weather conditions.
- g. Whether welding fumes tend to rise quickly and blow away from operator due to convection currents, or tend to rise slowly and concentrate around operator's head before dissipation.
- h. Tendency of fumes to stratify above the working level.
- i. Tendency of fumes to form flocculent dust.
- j. Accident hazards involved in reduced visibility.

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k. Excessive deposits of fume-dust on other shop equipment.

l. Excessive heat generated by gas and electric arc welding

2-8-31 SPACE CLASSIFICATION. Three space classifications have been adopted for convenience in setting ventilation standards, as follows:

Class I: Spaces of 50,000 cubic feet and over

Class II: Spaces of 5,000 to 50,000 cubic feet

Class III: Spaces under 5,000 cubic feet.

2-8-32 WHERE POSITIVE VENTILATION NOT REQUIRED.

a. Outdoor welding Operations. For welding operations on uncoated ferrous metals conducted in the open air, positive ventilating devices or respiratory protective equipment are not required. However, where an operator is engaged in welding or cutting lead-bearing steels, lead or cadmium-bearing paint, whether indoors or out, an air-line make or local exhaust ventilation shall be used. Where conditions do not permit their use, a filter-type respirator, approved for protection from lead fumes may be used, but only for short intermittent periods of work.

b. Class I Spaces. Where welding of uncoated ferrous metals is the largest proportion of the work carried on in spaces over 50,000 cu. feet, positive ventilation is not required for the protection of welders provided:

(1) Welding bays are not structurally blocked, thereby obstructing cross ventilation.

(2) No welding operations are on the inside of tanks, boilers, or other closed iron or steel containers.

(3) A space allowance of 10,000 cubic feet is assured each operator.

2-8-33 INDIVIDUAL VENTILATION DEVICES.

a. Exhaust Ducts. Where welding of uncoated ferrous metals is the largest proportion of the work carried on, an individual positive ventilation device for each operator shall be so designed and installed as to remove toxic fumes and dust at their source. This ventilation may be in the form of individual portable exhaust pipes, exhaust ducts from a central duct system, wall or roof fans, or any other equivalent means which will insure fume removal or dilution.

b. Toxic Exhaust Fumes. All ventilating devices installed, particularly portable temporary devices, shall be carefully scrutinized to insure that fumes, dust, etc., are not being exhausted into the same space or into other spaces, thus creating unrecognized hazards. Steps shall also be taken to insure that air replacing what is drawn is clean and respirable.

c. Hood Devices or Hose-Nozzles. The effectiveness of either a hood device or hose-nozzle in removing fumes at their source depends upon the nearness of the intake openings to the welding operation. In the following table, which sets the minimum air-flow standards for removal of welding fumes, dusts, and gases at their point of origin, allowance is made for variables in the welding zone services, ranging from below 8 inches up to 15 inches from the arc or torch to the exhaust intake:

INDIVIDUAL POSITIVE VENTILATION
DEVICES FOR INDOOR WELDING
(on uncoated ferrous metals)

Welding zone distance to exhaust intake from arc or torch	Class I 50,000 cu. ft. or over	Class II 5,000 to 50,000 cu. ft.	Class III under 5,000 cu. ft.
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Minimum air flow per operator - cu. ft. per minute.

Up to 8 inches	200	225	250
8 to 10 inches . . .	250	275	300
10 to 12 inches . . .	300	350	375
12 to 15 inches . . .	350	400	450

2-8-3⁴ GENERAL SHOP OR SPACE VENTILATION.

a. Wall or Roof Fans. During welding of uncoated ferrous metals in confined spaces where individual ventilating devices are unavailable, a fan or fans (wall or roof) or other positive ventilating device shall be installed to insure fume dilution and general space ventilation at the following minimum air rate:

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Space	Minimum air flow cubic feet per minute per operator	Or Complete air change ¹ each
Class I	350	20 minutes.
Class II	350	15 minutes.
Class III (space per operator)		
4-5,000 cu. ft.		4 minutes.
3-4,000 cu. ft.		3 minutes.
2-3,000 cu. ft.		2 minutes.
Less than 2,000		1 minute.

¹ The volume of the space divided by the cfm capacity of the blower, equals the theoretical time to change the air once.

² At least 1,000 cubic feet as well as the indicated space ventilation should be assured each operator.

b. Fan Efficiency. Particular attention is called to the necessity for selecting a type of fan capable of developing the required air volumes and pressure against the resistance of the exhaust system.

c. Screened Spaces. When electric welding must be performed in space entirely screened on all sides, the screens shall be so arranged that no serious restriction of ventilation exists. It is desirable to have the screens mounted on end posts so that their bottom edges are about two feet above the floor unless the work is performed at so low a level that the screen must be extended nearer the floor to protect nearby workers from welding glare. In the latter case the screens must clear the deck by several inches.

2-8-35 INDOOR WELDING OF GALVANIZED IRON OR STEEL, BRASS OR BRONZE,

a. Frequently and Regularly.

(1) The forced general ventilation prescribed in 2-8-34 shall be increased by at least 10 percent; or the individual ventilation devices prescribed in 2-8-33c. shall be used.

(2) Individual ventilating devices prescribed in the table in 3-8-33c. shall be provided. General shop ventilation standards are insufficient to protect the operator from the fumes of these metals.