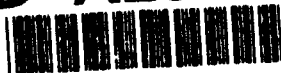


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PB82-158841
Volume III



MARITIME STANDARDS FOR COMPLIANCE SAFETY
AND HEALTH OFFICERS (INSTRUCTOR MANUAL)
VOLUME III

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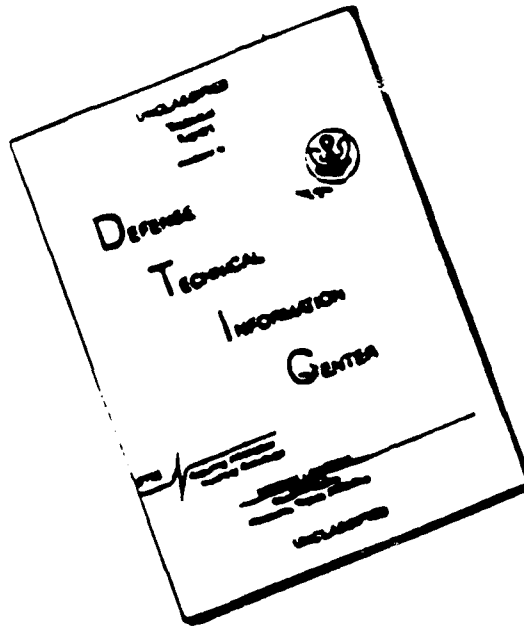
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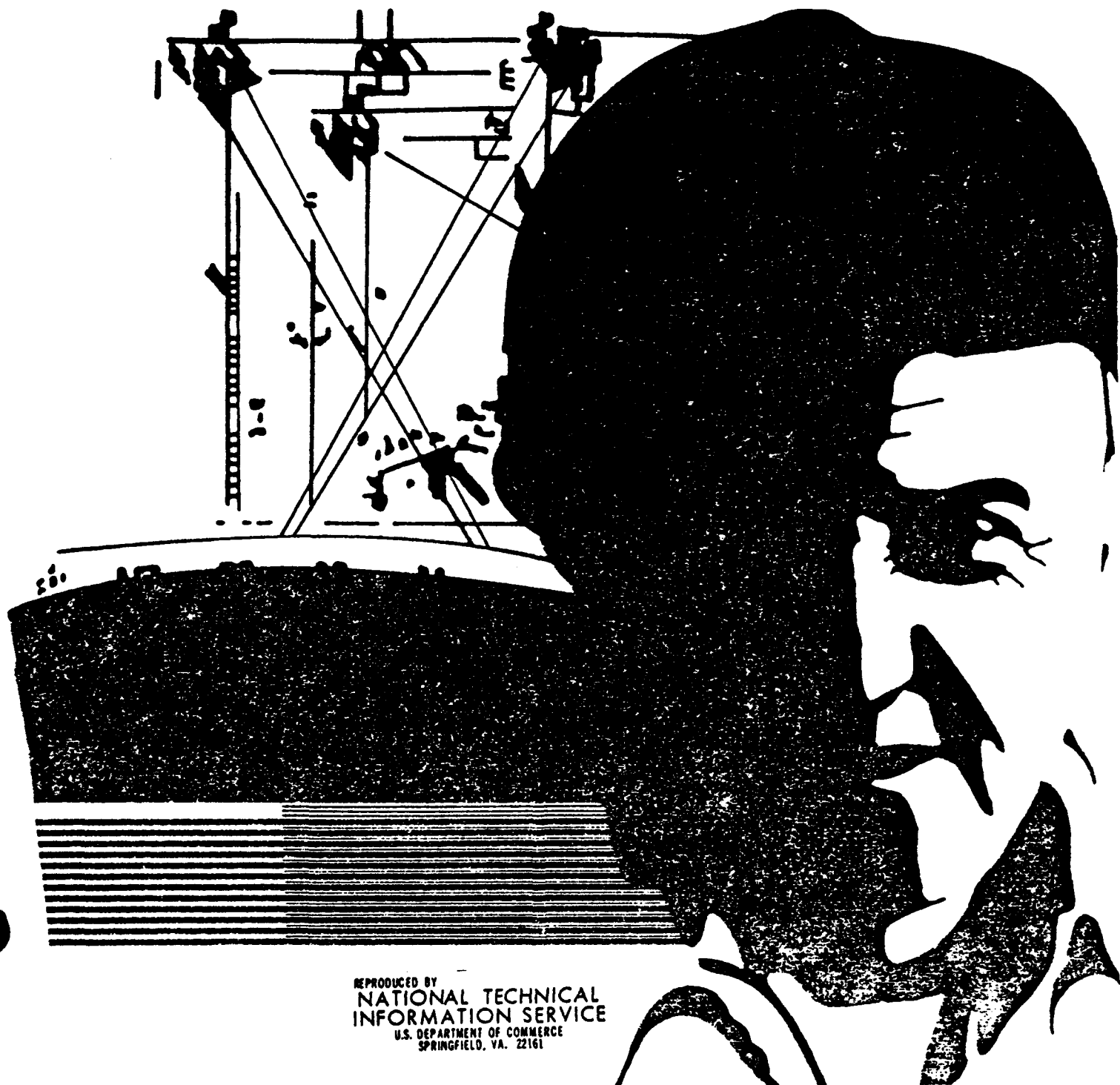
Maritime Standards for CSHOs

Volume III

PB82-158841

U.S. Department of Labor
Occupational Safety and Health Administration

Instructor Manual



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Lesson No. 34

Time 50 minutes

Title

Instrument Workshop

Objective

Upon completion of this lesson, the trainee will be able to properly calibrate, use, and maintain sampling instruments used in the field.

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Lesson No.

34

Title

Instrument Workshop

Technique	Content	Time
Lecture and Demonstration	I. Function of Sampling Instruments	35 minutes
	II. Calibration	15 minutes
	Total Time: 50 minutes	

Materials

- 1 Oxygen Meter - Edmont Oxygen Analyzer
- 1 Carbon Monoxide Indicator Tube and Pump Assembly
 - Bendex Gastech Pump and Carbon Monoxide Detector Tubes
- 1 Combustible Gas Indicator
 - MSA Explosimeter Model 2A

[Note: Instruments used in this workshop are to be those available to the instructor. The types and models listed above are suggestions only.]

References

1. American Conference of Governmental Industrial Hygienists. Air sampling instruments for evaluation of atmospheric contaminants. 5th edition. Cincinnati, OH, ACGIH, 1978.
2. Mine Safety Appliances Company. "Explosimeter combustible gas indicators. Data Sheet No. 08-00-03." Pittsburgh, PA, Mine Safety Appliances Company [n.d.].



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B. Carbon Monoxide Colorimetric Indicator	34-5
C. Combustible Gas Indicator	34-6
II. Calibration	34-7
A. Instruments Calibrated to a Reference Standard	34-7
B. Purpose and Accuracy of Calibration	34-7
C. Two Types of Calibration	34-8



Lesson No.

34

Title

Instrument Workshop

Notes

[To begin workshop, review the function of sampling instruments using the lecture format. After discussing each type of instrument, demonstrate its use. Then explain to the trainees that in the next hour of the session they will be divided into groups to conduct actual sampling themselves.]

Lesson Plan

I. FUNCTION OF SAMPLING INSTRUMENTS

A. Oxygen Meter

1. To determine oxygen content in content in atmosphere tested
2. Used prior to work in confined or enclosed spaces
3. Oxygen may be displaced or used up if:
 - o Inert gas is present
 - o Corrosion has occurred
 - o Space has carried oxygen-consuming cargo such as scrap iron, fresh fruit.
4. If oxygen insufficient to sustain life, space must be:
 - o Ventilated to restore oxygen content in atmosphere; or
 - o Breathing apparatus must be worn by person entering space.
5. Operating principle:
 - o Oxygen sensed directly by galvanic cell
 - Cell contains gold cathode and lead anode in basic electrolyte
 - Entire cell encased in plastic
 - Has sensor face made of fluorocarbon polymer



Lesson No.

34

Title

Instrument Workshop

Notes

[Demonstrate oxygen meter
by blowing up a balloon and
sampling the air inside, which
should be oxygen deficient.]

Lesson Plan

- o Oxygen diffuses through cell face
 - Initiates reaction which produces current
 - Current is proportional to oxygen partial pressure
- o Current signal is amplified through battery-powered, temperature-compensated circuit
- o Current converted to a proportional voltage which is then:
 - Displayed on indicator as percent of oxygen; or
 - Used to activate an alarm.

B. Carbon Monoxide Colorimetric Indicator

1. Used to determine whether carbon monoxide has built up to toxic levels
2. Carbon monoxide particularly insidious because it is odorless, colorless
3. Carbon monoxide presents problem in engine room, other areas where exhaust from combustion engines is present
4. Operating principle:
 - o Pump draws atmospheric sample through indicator
 - o Sample passes through catalyst bed which surrounds bridge circuit



Lesson No.
34

Title
Instrument Workshop

Notes

[Demonstrate carbon monoxide detector by lighting a cigarette and blowing into a balloon. With the contents of one draw of the cigarette, you should get a carbon monoxide reading on the detector tube.]

[Demonstrate the combustible gas detector by using the reference gas calibration balloon that comes with the meter.]

Lesson Plan

- o Any carbon monoxide present oxidizes and forms carbon dioxide
- o Heat of oxidation creates change in resistance in bridge circuit and produces proportional upscale in meter reading.

C. Combustible Gas Indicator

1. Used to determine whether combustible gas is present in concentrations above lower explosive or flammability limit
2. Calibrated for specific gas to be tested, if known
 - o Often calibrated to reference gas, such as pentane.
3. Some of the substances that can be tested include:
 - o Propane
 - o Methane
 - o Hexane
 - o Octane
 - o Acetone
 - o Benzene
 - o Methyl alcohol.



Lesson No.

34

Title

Instrument Workshop

Notes

Lesson Plan

4. Operating principle:

- o Most types use hot wire element for detection
 - Current is applied to element
 - Contaminant gas burns on wire surface without flame
 - Heat that is generated changes resistance of wire element which is part of bridge circuit
 - Resistance change produces meter reading proportional to quantity of explosive gas present
 - Indicator calibrated in percent of LEL
 - Instrument may be equipped with buzzer that will sound warning at preselected value of LEL.

II. CALIBRATION

A. Instruments Calibrated to a Reference Standard

1. Oxygen meter - oxygen
2. Carbon monoxide colorimetric indicator - carbon monoxide
3. Combustible gas detector - pentane or heptane if gas is unknown.

B. Purpose and Accuracy of Calibration

1. Purpose is to ensure accuracy of measurement
2. Oxygen meter (Edmont Oxygen Analyzer Model 60-620)
 - o Accurate to within $\pm 0.2\%$ oxygen in calibration ranges of 0-25% and 0-50% and temperature range from 54°F to 122°F.



Lesson No.

34

Title

Instrument Workshop

Notes

Lesson Plan

2. Carbon monoxide colorimetric indicator tubes are certified by NIOSH to ensure accuracy
 3. Combustible gas indicator (MSA Model 2A)
 - o Factory calibrated to pentane in air
 - Pentane is representative of most petroleum vapors
 - When testing other combustible gases and calibrated with pentane, readings generally err to high side which ensures safety.
- C. Two Types of Calibration
1. Field calibration
 - o Usually is as simple as a zero adjustment and a test reading with a reference sample.
 2. Shop calibration
 - o Precision adjustment of the instrument's internal workings, such as:
 - Potentiometers
 - Volt meters
 - Reference resistors
 - o Should only be performed by manufacturer or qualified technician.



Lesson No. 35

Time 50 minutes

Title

Instrument Workshop (Continued)

Objective

Upon completion of this lesson, the trainee will be able to properly calibrate, use, and maintain sampling instruments used in the field.

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Lesson No.

35

Title

Instrument Workshop (Continued)

Technique	Content	Time
Workshop	III. How to Use Sampling Instruments	40 minutes
	IV. Recording Data	10 minutes
	Total Time: 50 minutes	

Materials

Sufficient number of oxygen meters, carbon monoxide colorimetric indicators and pumps, and combustible gas detectors for size of class

Manufacturers' data sheets and operating instructions for above equipment

References

1. U.S. Occupational Safety and Health Administration. Industrial hygiene field operations manual. Washington, DC, U.S. Department of Labor, 1977.
2. Manufacturers' recommended operating procedures (various).
3. American Conference of Governmental Industrial Hygienists. Air sampling instruments for evaluating atmospheric contaminants. Cincinnati, OH, ACGIH, 1978.



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C. Combustible Gas Detector	35-6
IV. Recording	35-8
A. Indicator Readings	35-8
B. Continuous Monitoring	35-8
C. Recording Sampling Results	35-8



Lesson No.

35

Title

Instrument Workshop (Continued)

Notes

[Divide class into small manageable groups with a senior CSHO in charge. Arrange class so that groups will not interfere with each other. After reviewing each instrument, allow trainees to operate each instrument.]

Lesson Plan

III. HOW TO USE SAMPLING INSTRUMENTS

A. Oxygen Meter

1. Review oxygen meter function
2. Review purpose of field calibration before each use
3. Review oxygen meter operation:
 - o Use and arrangement of tubes, hoses, and sensors
 - o Power switch
 - o Battery test
 - o Calibration adjustment in ambient air to 21 percent
 - Make record of calibration
 - o Test operation by breathing on or into sensor
 - Reading should move from 21 percent to 16 percent
 - If instrument is equipped with an alarm, should sound at 19 percent.
4. Use of meter
 - o Do not immerse sensor in water or any other liquid
 - o Place sensor in atmosphere to be tested
 - o Note reading
 - o Record reading.



Lesson No.

35

Title

Instrument Workshop (Continued)

Notes

[Allow each trainee hands-on
experience with an oxygen
meter.]

Lesson Plan

5. Document the following:

- o Calibration date and time
- o Ambient condition
 - Temperature
 - Handling
 - Weather conditions
- o Findings.

B. Carbon Monoxide Colorimetric Indicator

1. Review the function of colorimetric indicators
2. Review purpose of using NIOSH-certified tubes and calibration of pumps
 - o Pumps are checked in a log for accuracy
 - o Perform leakage test of pump.
3. Review the steps in using colorimetric indicators
 - o Break tips off fresh detector tube
 - o Insert tube into pump inlet
 - o Place inlet end of tube in area to be sampled
 - Sample the breathing zone
 - o Pull handle out to desired stroke
 - o Wait for sample to fill pump



Lesson No.

35

Title

Instrument Workshop (Continued)

Notes

[Allow each trainee hands-on
experience with colorimetric
carbon monoxide indicator.]

Lesson Plan

- o Read the interface between stained and unstained reagent when staining stops
 - Refer to instructor sheet in each box of tubes for number of strokes, size of strokes and appropriate length of stain.

4. Document the following:

- o Time, date, and location
- o Pump identification number
- o Results
- o Name of calibrator
- o Ambient conditions
 - Temperature
 - Handling
 - Weather conditions.

C. Combustible Gas Detector

1. Review combustible gas detector function
2. Review the importance of field calibration before each use
3. Review the gas detector's operation
 - o Attach aspiration bulb and sampling tube
 - o Check batteries
 - o Turn on power
 - o Adjust to zero with ambient (fresh) air



Lesson No.

35

Title

Instrument Workshop (Continued)

Notes

Lesson Plan

- Adjust to zero after the second squeeze of the aspirator bulb to evacuate sampling chamber
- o Place sampling hose into atmosphere being tested
- Meter will give accurate readings on the second squeeze of the aspiration bulb with 5 feet of sampling tube.
- 4. Use of gas detector
 - o Sample for percent of LEL of calibrated gas
 - o Readings below 10 percent LEL are considered safe
 - Provides a 10:1 safety factor
 - o Steps in sampling a confined space
 - Test prior to entry
 - Test in and around entry way
 - Test corners, floors and ceilings for pockets of gas.
- 5. Record findings
 - o Calibration data
 - o Time, date and location
 - o Suspected combustible gas
 - o Results of tests
 - o Ambient conditions
 - Weather
 - Handling
 - Temperature.

[Allow each trainee hands-on experience with a combustible gas detector.]



Lesson No.

35

Title

Instrument Workshop (Continued)

Notes

Lesson Plan

IV. RECORDING

A. Indicator Readings

1. May be displayed as:

- o Percentage of gas in sample atmosphere; or
- o Units in parts per million (ppm); or
- o Percent of specified lower explosive limit.

B. Continuous Monitoring

1. Information displayed on recorder attached to device
2. Shows variations, if any, over time
3. Recorder may be attached to buzzer that sounds if certain reading is given.

C. Recording Sampling Results

1. In addition to actual reading given by sampling instrument, person performing sampling should record:
 - o Date and time sample taken
 - o Location
 - o Climatic conditions (if applicable)
 - o Activities underway at time of test
 - o Any interferences or inhibitors that may bias sample results.



Lesson No. 36

Time 50 minutes

Title Gas-Freeing	
Objective	Upon completion of this lesson, the trainee will be able to discuss the reasons for and the operation of a gas-freeing plant.
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Lesson No.

36

Title

Gas-Freeing

Technique	Content	Time
Lecture and Slides	I. Description of Gas-freeing Plant Equipment	15 minutes
	II. Description of Operations and Hazards	20 minutes
	III. Maintaining Gas-free Conditions	15 minutes
	Total Time: 50 minutes	
Materials		
30 Slides Slide Projector (35 mm)		
References		
1. National Fire Protection Association. "NFPA 306, 1975. Control of hazards on vessels to be repaired." Boston, MA, NFPA, 1975.		
2. National Fire Protection Association. "NFPA 312, 1976. Fire protection of vessels during construction, repair, and lay-up." Boston, MA, NFPA, 1976.		
3. U.S. Occupational Safety and Health Administration. "Safety and health standards for maritime employment." <u>Federal Register</u> , Vol. 39, No. 119, June 19, 1974.		

36-2



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B. Inerting	36-5
C. Waste Disposal Methods	36-5
D. Hazards Associated with Use of Solvents and Detergents	36-5
E. Hazards Associated with Work in Inert Atmospheres	36-6
F. Static Electricity	36-6
G. Hazards Associated with Hazardous Waste Materials	36-7
H. Fire Hazards	36-7
III. Maintaining Gas-free Conditions	36-7
A. Ship Repair	36-7
B. Shipbuilding	36-10
C. Shipbreaking	36-10
D. Competent Person	36-11

VISUAL AIDS

V-36-1	Photo Slide	Gas-freeing Berth (*)
V-36-2	Photo Slide	Berth Work Area (*)
V-36-3	Photo Slide	Cleaning Operations (*)
V-36-4	Photo Slide	Nitrogen Facilities (*)
V-36-5	Photo Slide	Vacuum Tanks (*)
V-36-6	Photo Slide	Steam and Hot Water Tanks (*)
V-36-7	Photo Slide	Oil/Water Separators (*)
V-36-8	Photo Slide	Special Berth (*)
V-36-9	Photo Slide	Flare Stack (*)
V-36-10	Photo Slide	Thermal Oxidizer (*)
V-36-11	Photo Slide	Wash-down Operation (*)
V-36-12	Photo Slide	Residue (*)
V-36-13	Photo Slide	Inerting (*)
V-36-14	Photo Slide	Space Flooded so Hot Work Can Take Place
V-36-15	Photo Slide	Burning Through Bulkhead
V-36-16	Photo Slide	Waste Disposal (*)
V-36-17	Photo Slide	Steam Cleaning Plant (*)
V-36-18	Photo Slide	Grounding to Vessel (*)
V-36-19	Photo Slide	Grounding Connection on Berth (*)
V-36-20	Photo Slide	Hazardous Material (*)
V-36-21	Photo Slide	Truck Disposal of Tank Washings (*)
V-36-22	Photo Slide	Berth Fire Protection (*)
V-36-23	Photo Slide	Blanked Piping
V-36-24	Photo Slide	Manholes Being Secured (*)

VISUAL AIDS (Continued)

V-36-25	Photo Slide	Competent Person Sampling Space
V-36-26	Word Slide	Duties of Competent Person
V-36-27	Photo Slide	Shipbreaking: Hot Work Above Deck
V-36-28	Photo Slide	Shipbreaking: Hot Work Below Deck
V-36-29	Photo Slide	Shipbreaking: Bunker Inner Bottom Space Exposed
V-36-30	Photo Slide	Shipbreaking: Hot Work on Bunker Space

(*) For internal Department of Labor training purposes only.



Lesson No.

36

Title

Gas-Freeing

Notes

V-36-1
Photo Slide:
GAS-FREEING BERTH

V-36-2
Photo Slide:
BERTH WORK AREA

V-36-3
Photo Slide:
CLEANING OPERATIONS

V-36-4
Photo Slide:
NITROGEN FACILITIES

V-36-5
Photo Slide:
VACUUM TANKS

V-36-6
Photo Slide:
STEAM AND HOT WATER TANKS

V-36-7
Photo Slide:
OIL/WATER SEPARATOR

V-36-8
Photo Slide:
SPECIAL BERTHS

V-36-9
Photo Slide:
FLARE STACK (LEFT)

Lesson Plan

I. DESCRIPTION OF GAS-FREEING PLANT EQUIPMENT

A. Facilities and Operations

1. Requires a special berthing area for cleaning, gas-freeing, or inerting
2. Area must be set apart from other ship repair operations with due regard to hazards
 - o Hazards at location
 - o Hazards of adjacent property.
3. Operations required to certify a compartment, vessel, or tank include:
 - o Cleaning or stripping
 - o Gas-freeing (degassing)
 - o Inerting.
4. Equipment and facilities used include:
 - o Nitrogen or other inert gas equipment
 - o Wastewater treatment
 - o Vacuum tanks
 - o Steam, detergent, and hot water cleaning equipment
 - o Oil/water separators
 - o Special berths
 - o Flare stack



Lesson No.

36

Title

Gas-Freeing

Notes

V-36-10
Photo Slide:
THERMAL OXIDIZER (LEFT)

V-36-11
Photo Slide:
WASH-DOWN OPERATION

V-36-12
Photo Slide:
RESIDUE

V-36-13
Photo Slide:
INERTING

V-36-14
Art Slide:
SPACE FLOODED SO HOT WORK
CAN TAKE PLACE

V-36-15
Photo Slide:
BURNING THROUGH BULKHEAD

V-36-16
Photo Slide:
WASTE DISPOSAL

Lesson Plan

- o Thermal oxidizer.

II. DESCRIPTION OF OPERATIONS AND HAZARDS

A. Cleaning

1. Insides of tanks washed down with hot or cold water
2. Steam and detergent cleaning techniques may be used
3. Cargo coils steamed and blown
4. Ventlines and piping flushed with water or blown with steam or air
5. Residue is removed.

B. Inerting

1. Nitrogen or other inert gas may be used
 - o Introduced into tank in sufficient volume to maintain the oxygen content of the air at or below 10 percent by volume, or 50 percent of the lower flammability limit (LFL), whichever is lower.
2. Spaces may be filled to top with water
 - o May be flooded provided that hot work is performed three feet below the water level
 - o Gas content of the atmosphere above water cannot exceed 10 percent of the lower explosive limit (LEL).

C. Waste Disposal Methods

1. Lighter offload to a smaller vessel such as a barge



Lesson No. 36

Title Gas-Freeing

Notes

V-36-17
Photo Slide:
STEAM CLEANING PLANT

Lesson Plan

2. Stored in shoreside holding tanks
3. Transported to a waste disposal site.
- D. Hazards Associated with Use of Solvents and Detergents
 1. Exposure to toxic chemicals
 - o Detergents
 - o Solvents
 - o Cargo residues
 - o Personal protective equipment required to protect routes of entry
 - Gloves, boots and face protection
 - Respiratory protection
 - Whole body protection.
 2. Burns and other effects from temperature extremes
 - o Burns from steam cleaning operations
 - Guards required on hot surfaces
 - o Working in hot environments
 - Heat stress
 - Heat cramps.
- E. Hazards Associated with Work in Inert Atmospheres
 1. Oxygen deficiency
 - o Entry prohibited unless worker is protected with a self-contained breathing apparatus.



Lesson No.

36

Title

Gas-Freeing

Notes

V-36-18
Photo Slide:
GROUNDING TO VESSEL

V-36-19
Photo Slide:
GROUNDING CONNECTION ON BERTH

V-36-20
Photo Slide:
HAZARDOUS MATERIAL STORAGE

V-36-21
Photo Slide:
TRUCK DISPOSAL OF TANK
WASHINGS

V-36-22
Photo Slide:
BERTH FIRE PROTECTION

Lesson Plan

F. Static Electricity

1. Grounding of vessel

- o Provides path to ground for static discharge
- o Prevents static charge from becoming a source of ignition.

G. Hazards Associated with Hazardous Waste Materials

1. Toxic and other chemical wastes

- o Mixture of cargo residue and solvents
- o Personal protective equipment required to protect routes of entry
 - Gloves, boots, and face protection
 - Respiratory protection
 - Whole body protection.

2. Radioactive wastes (1910.96)

3. Corrosive wastes

4. Flammable or combustible wastes

- o Should be handled in a closed system
- o All sources of ignition must be kept away.

H. Fire Hazards

1. Fire protection facilities.



Lesson No. 36

Title Gas-Freeing

Notes

V-36-23
Photo Slide:
BLANKED PIPING

V-36-24
Photo Slide:
MANHOLES BEING SECURED

Lesson Plan

III. MAINTAINING GAS-FREE CONDITIONS

A. Ship Repair (1915.14)

1. Pipelines which may convey hazardous substance into space certified safe for men and fire:
 - o Must be disconnected, blanked off, or other positive means used to prevent discharge into space.
2. Manholes, other closures which were secure during tests to remain secure
 - o If opened, otherwise altered, work to be stopped in affected spaces, areas until retested and recertified safe
 - Also applies if valves are manipulated.
3. All valve closures, vents connected to non-gas-free spaces below deck to be closed before hot work begins on weather deck over spaces not required to be gas-free or inerted
 - o Exception: valves, closures, vents which are vented up masts
 - o To remain closed until hot work complete
 - Exception: if hot work is stopped and area posted unsafe for fire
 - Notice to remain posted, hot work discontinued until area again made safe.
4. Employer to inform master, chief engineers of vessels of gas-freeing requirements
 - o Must confirm that they are aware of responsibilities and limitations



Lesson No.

36

Title

Gas-Freeing

Notes

V-36-25
Photo Slide:
COMPETENT PERSON SAMPLING
SPACE

Lesson Plan

- Must see that crew understands, obeys all warning signs
 - Must know limitations stated on Marine Chemist's certificate.
5. Competent person to ensure gas-free condition after Marine Chemist's certificate issued for work in tank
- o Applies if there is possibility of hazardous vapor release from residues, other sources
 - o Applies whether or not hot work is being performed
 - o If conditions have changed, e.g., if the competent person notes increase in the LEL of combustible gases:
 - Work to be stopped
 - New certificate must be issued before resuming work.
6. Before hot work on metal coated with preservative, special precautions must be taken
- o Testing for flammability
 - o Stripping of coating from area of work
 - o Availability of fire hose
 - o Employees equipped with air line respirators if necessary
 - o Artificial cooling of metal
 - o Work stopped until hazard eliminated if necessary.



Lesson No.

36

Title

Gas-Freeing

Notes

V-36-26

Word Slide:

DUTIES OF THE COMPETENT PERSON

V-36-27

Photo Slide:

SHIPBREAKING: HOT WORK ABOVE
DECK

Lesson Plan

B. Shipbuilding (1916, Subpart B)

1. Competent person

- o Responsible for ensuring gas-free conditions are maintained
- o Logs inspection and test results
- o Conducts the following tests:
 - Oxygen deficiency
 - Flammable atmosphere tests
 - Toxic substance tests
- o Tests to be conducted:
 - During cleaning and cold work
 - Prior to hot work after issuance of a Marine Chemist's certificate
 - In enclosed spaces
 - On hollow metal structures.

C. Shipbreaking (1917.14)

1. Hot work in the open

- o Applies to hot work performed:
 - From open decks
 - In tanks or compartments with overhead removed
 - Boundaries of tanks carrying flammables, fuel tanks, pipelines to these tanks, unless filled with water
- o Competent person to make frequent tests to ensure:
 - Inert atmosphere maintained
 - Concentration of flammable vapors remains less than 10% LEL.



Lesson No.

36

Title

Gas-Freeing

Notes

V-36-28

Photo Slide:

SHIPBREAKING: HOT WORK BELOW
DECKS

V-36-29

Photo Slide:

SHIPBREAKING: BUNKER INNER
BOTTOM SPACE EXPOSED

V-36-30

Photo Slide:

SHIPBREAKING: HOT WORK ON
BUNKER SPACE

Lesson Plan

2. Hot work below decks

- o Applies to following below deck spaces:
 - Tank vessel cargo tanks used to carry bulk flammable cargo and adjacent spaces
 - Fuel tanks and their boundaries and connections
 - Dry cargo vessel tanks used to carry bulk flammable cargo
 - Spaces adjacent to cargo tanks that carry flammable cargo unless hot work done more than 25 feet away
- o If there is possibility of hazardous vapor release after Marine Chemist has certified space:
 - Competent person to test to ensure space remains gas-free
 - Must test whether or not hot work is done
 - Work to be stopped if competent person finds conditions altered
 - New certificate required before work is resumed.

D. Competent Person

1. Criteria

- o Employer-designated person qualified by experience and training to fulfill applicable requirements



Lesson No.

36

Title

Gas-Freeing

Notes

[Review Forms OSHA-73 and
OSHA-74.]

Lesson Plan

- o Ability to understand and carry out
 - Meaning and designation of Marine Chemist's certifications
 - Written and oral instructions of the Marine Chemist
- o Ability to use applicable sampling instruments
- o Knows and understands the applicable standards
- o Ability to perform required tests and inspections.
- 2. Recordkeeping
 - o OSHA-73 - designation record of competent persons
 - Must be filed in the local OSHA area office
 - o OSHA-74 - record of tests and inspections conducted by the competent person
 - Separate log for each vessel
 - Must be maintained for at least 3 months
 - Must be made available for inspection by OSHA representative.



Lesson No. 37

Time 50 minutes

Title

Surface Preparation

Objective

Upon completion of this lesson, the trainee will be able to discuss the various methods of surface preparation, specifically pointing out the safety and health hazards and the necessary abatement methods to control the hazards.

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Lesson No.

37

Title

Surface Preparation

Technique	Content	Time
Lecture and Slides	I. Overview of Surface Preparation	10 minutes
	II. Chemical Solvents	10 minutes
	III. Chemical Paint and Preservative Removers	10 minutes
	IV. Mechanical Paint Removers	10 minutes
	V. Health Hazards in Surface Preparation Operations	10 minutes
		Total Time: 50 minutes
Materials 29 Slides Slide Projector (35 mm) 1 Handout		
References 1. Sax, N.I. <u>Dangerous properties of industrial materials</u> . 4th edition. New York, Litton Educational Publishing, Inc. and Van Norstrand Reinhold Company, 1975. 2. U.S. Occupational Safety and Health Administration. "Safety and health standards for maritime employment." <u>Federal Register</u> , Vol. 39, No. 119, June 19, 1974.		



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A. Power Tools	37-14
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C. Abrasive Blasting	37-16
D. Other Health Hazards in Surface Preparation Operations	37-18

VISUAL AIDS

V-37-1	Photo Slide	Chemical Cleaning Operation
V-37-2	Photo Slide	Chemical Paint Removing Operation
V-37-3	Photo Slide	Needle Gun
V-37-4	Photo Slide	Abrasive Blasting
V-37-5	Photo Slide	Ethylene Dichloride in Use
V-37-6	Photo Slide	Dip Tanks
V-37-7	Photo Slide	Ventilation Aboard Ship (*)
V-37-8	Photo Slide	Employee with Protective Equipment (*)
V-37-9	Photo Slide	No Smoking Around Flammable Storage (*)
V-37-10	Photo Slide	Testing Area Around Cleaning Operation
V-37-11	Photo Slide	Covered Rag Container
V-37-12	Photo Slide	Explosion-proof Lighting (*)
V-37-13	Photo Slide	Fire Extinguishers
V-37-14	Photo Slide	Face and Eye Protection Against Chemicals
V-37-15	Photo Slide	Ventilation for an Enclosed Operation (*)
V-37-16	Photo Slide	Power Tool Used in Paint Removing
V-37-17	Photo Slide	Grinding Tool
V-37-18	Photo Slide	Mechanical Exhaust System for Confined Spaces (*)
V-37-19	Photo Slide	Respiratory Protection in Use
V-37-20	Photo Slide	Grounded Hose System
V-37-21	Photo Slide	Hose Coupling
V-37-22	Photo Slide	Sandblasting Nozzle
V-37-23	Photo Slide	Sandblaster Holding Dead Man Control
V-37-24	Photo Slide	Hoses Being Inspected

VISUAL AIDS (Continued)

V-37-25	Photo Slide	Blaster's Protective Hood
V-37-26	Photo Slide	Abrasive Blasting in the Open
V-37-27	Photo Slide	Abrasive Material
V-37-28	Photo Slide	Work in Elevated Basket
V-37-29	Word Slide	Summary of Health Hazards in Surface Preparation Operations

(*) For internal Department of Labor training purposes only.



HANDOUT

1. Summary of Health Hazards in Surface Preparation Operations



Lesson No.

37

Title

Surface Preparation

Notes

V-37-1
Photo Slide:
CHEMICAL CLEANING OPERATION

V-37-2
Photo Slide:
CHEMICAL PAINT REMOVING
OPERATION

Lesson Plan

I. OVERVIEW OF SURFACE CLEANING OPERATIONS IN
SHIPBUILDING AND REPAIR

A. Chemical Cleaning Solvents

1. Used in cleaning and degreasing
operations prior to application of
protective coatings such as:
 - o Oil-based paints
 - o Epoxy paints
 - o Preservative coatings.
2. Hazards include:
 - o Toxicity
 - o Flammability.

B. Chemical Paint and Preservative Removers

1. Used to remove paint and preserva-
tives prior to hot or cold work on
the surface
2. Contain substances such as:
 - o Volatile solvents
 - Methanol
 - Denatured ethyl alcohol
 - Toluene
 - Benzene
 - Ethyl acetate
 - Acetone
 - o Evaporation retardants which
prolong the action of the
solvent
 - Paraffin is a common
retardant



Lesson No.

37

Title

Surface Preparation

Notes

V-37-3
Photo Slide:
NEEDLE GUN

V-37-4
Photo Slide:
ABRASIVE BLASTING

V-37-5
Photo Slide:
ETHYLENE DICHLORIDE IN USE

Lesson Plan

- o Caustic removers

- Sodium phosphate
- Sodium silicate
- Caustic soda.

C. Mechanical Paint Removers

1. Mechanical removal of paints and coatings may be done by:

- o Hand tools

- o Flame removal

- o Abrasive blasting.

2. Hazards include

- o Flying chips
- o Noise
- o Vibration
- o Compressed air
- o Confined spaces
- o Dust.

II. TOXIC CHEMICAL CLEANING SOLVENTS (1915.21, 1916.21)

A. Types of Toxic Solvents and Their Hazards

1. Ethylene dichloride

- o Colorless liquid with pleasant odor and sweet taste



Lesson No.

37

Title

Surface Preparation

Notes

Lesson Plan

- o May cause death or permanent injury if ingested or inhaled
- o Has narcotic action similar to chloroform
- o Has toxic effects on liver and kidneys.

2. Perchloroethylene

- o Colorless liquid with chloroform-like odor
- o Dangerous if heated to decomposition
 - Emits highly toxic chloride fumes
- o Highly toxic if inhaled or ingested
 - Has effects on nervous system
 - Can cause nausea and vomiting
- o Contact with skin causes redness, burning, general dermatitis.

3. Toluene

- o Colorless liquid derived from coal tar with benzol-like odor
- o Presents dangerous fire hazard if exposed to heat
- o Moderate explosion hazard if exposed to flame
- o Inhalation causes impairment of coordination and reaction time
- o High level, prolonged exposure has narcotic effect.



Lesson No.

37

Title

Surface Preparation

Notes

Lesson Plan

V-37-6
Photo Slide:
DIP TANKS

V-37-7
Photo Slide:
VENTILATION ABOARD SHIP

4. Xylene

- o Colorless liquid
- o Presents extreme fire hazard when exposed to heat or flame
- o Moderately explosive in vapor form when exposed to heat
- o May cause slight to moderate acute and chronic health effects when absorbed through skin, inhaled, or ingested.

5. Naphtha (coal tar)

- o Common air contaminant and recognized carcinogen
- o Presents moderate fire, slight explosion hazards when exposed to heat or flame
- o May cause death or permanent injury to person exposed to small amount for short period of time.

B. Requirements in 1915.21 and 1916.21
for Toxic Cleaning Solvent Use

1. Use in enclosed operations

- o Cleaning operation to be completely enclosed if toxic solvent used
 - Prevents escape of vapor into working space.



Lesson No.

37

Title

Surface Preparation

Notes

V-37-8
Photo Slide:
EMPLOYEE WITH PROTECTIVE
EQUIPMENT

[Refer to American Conference
of Governmental Industrial
Hygienists Recommended Thresh-
old Limit Values for the
substances discussed in this
lesson: naphtha, ethylene
dichloride, toluene, xylene,
perchloroethylene.]

Lesson Plan

2. Ventilation

- o Either natural or mechanical exhaust
- o Must remove vapor at source and dilute concentration in work space
 - Concentration must remain at safe level during entire work period.

3. Respiratory protection

- o Employees to be protected against toxic vapors by suitable respiratory protective equipment
 - Bureau of Mines or NIOSH approved
 - Regularly inspected and well-maintained
 - Cleaned and disinfected after use
 - Employees trained in use
 - Attendant stationed outside during work inside space
 - Equipment appropriate to hazardous vapor involved.

4. Threshold limit values (TLV's)

- o To be used to determine what is safe concentration of an air contaminant
- o TLV's for all substances regulated by OSHA found in 29 CFR 1910.1000



Lesson No.

37

Title

Surface Preparation

Notes

V-37-9
Photo Slide:
NO SMOKING AROUND FLAMMABLE
STORAGE

V-37-10
Photo Slide:
TESTING AREA AROUND CLEANING
OPERATION

V-37-11
Photo Slide:
COVERED RAG CONTAINER

V-37-12
Photo Slide:
EXPLOSION-PROOF LIGHTING

V-37-13
Photo Slide:
FIRE EXTINGUISHERS

Lesson Plan

- Expressed in parts per million (ppm) or milligrams per cubic meter of air (mg/m^3) for 8-hour time-weighted average exposure limit
- TLV for naphtha = 500 ppm, $2,000 \text{ mg}/\text{m}^3$
- TLV for ethylene dichloride = 50 ppm
- TLV for toluene = 200 ppm.

5. Flammable solvents

- o No smoking, open flame, arcs, or spark-producing equipment in area of use
- o Ventilation to keep concentration below 10% LEL
- Competent person to test frequently to ensure safe concentration level
- o Soaked rags, scrapings to be kept in covered metal container
- o Only approved explosion-proof lights to be used
- o All power and lighting cables to be inspected by competent person
- o Suitable fire extinguishing equipment immediately available, ready for use.



Lesson No.

37

Title

Surface Preparation

Notes

[Review the different types
of paint and preservative
removers.]

Lesson Plan

III. CHEMICAL PAINT AND PRESERVATIVE REMOVERS
(1915.22, 1916.22)

A. Types of Chemical Paint and Preserva-
tive Removers and Their Hazards

1. Benzol (benzene, coal naphtha)

- o Clear, colorless liquid
- o Dangerous fire hazard when
exposed to heat or flame
 - Can react vigorously with
oxidizing materials
- o Moderate explosion hazard when
vapors exposed to flame
- o Causes acute poisoning when
inhaled in large amounts
 - Narcotic effect on nervous
system
 - Continued exposure causes
death from respiratory
failure
- o Chronic rather than acute
poisoning concern to industry
 - Recognized carcinogen of
blood-forming cells.

2. Acetone

- o Colorless liquid with fragrant,
mintlike odor
- o Dangerous fire hazard when
exposed to heat or flame
 - Can react vigorously with
oxidizing materials



Lesson No.

37

Title

Surface Preparation

Notes

Lesson Plan

- o Moderate explosion hazard when vapor is exposed to flame
- o Narcotic in high concentrations
- o Few injurious effects reported in industry
 - Headache from prolonged inhalation
 - Skin irritation.

3. Amyl acetate

- o Colorless liquid with pear or banana-like odor
- o Dangerous fire hazard when exposed to heat or flame
- o Moderate explosion hazard when exposed to flame
- o Narcotic effects when inhaled
- o Low order chronic toxicity
- o Inhalation of high concentrations may cause irritation to eye, nose, and throat, headache, fatigue.

4. Acids and alkalis

- o Likely to be highly toxic and corrosive
- o Pose fire and explosion hazards
 - Often are powerful oxidizers
 - May ignite upon contact with combustibles
 - Produce toxic fumes when heated



Lesson No.

37

Title

Surface Preparation

Notes

Lesson Plan

- o Adverse health effects from ingestion, inhalation, and skin contact

- Burns
- Ulceration
- Serious internal tissue damage.

5. Detergents

- o Many cause dermatitis from drying action if skin contact is prolonged
- o Some have carcinogenic potential
- o May have toxic effect if ingested
- o If used in steam cleaning operations, potential for burns from high-temperature steam.

B. Requirements for Chemical Paint and Preservative Remover Use in 1915.22 and 1916.22

1. Employee protection during handling and application

- o Protection against skin contact

- o Protection against eye injury

- Goggles, or
- Face shields in accordance with 1915.81, 1916.81.

V-37-14

Photo Slide:

FACE AND EYE PROTECTION
AGAINST CHEMICALS



Lesson No.

37

Title

Surface Preparation

Notes

[Review flammable material precautions.]

V-37-15
Photo Slide:
VENTILATION FOR AN ENCLOSED
OPERATION

Lesson Plan

2. Flammable paint and preservative removers

- o Precautions to be taken as required in 1915.25, 1916.25
 - No fire or sparks in area
 - Ventilation to keep vapors below 10% LEL
 - Frequent tests of atmosphere
 - Safe disposal of rags, scrapings
 - Explosion-proof lights only
 - Inspection of power and lighting cables
 - Fire extinguishing equipment available and ready for use.

3. Toxic paint and preservative removers

- o Applies to removers containing both toxic and/or volatile solvents
 - Benzol
 - Acetone
 - Amyl acetate
- o Provisions of 1915.21, 1916.21 apply
 - Enclosure of operations
 - Use of ventilation
 - Respiratory protection equipment



Lesson No.

37

Title

Surface Preparation

Notes

Lesson Plan

- Enforcement of TLV's
- Precautions for use of flammable liquids.

4. Protection when using acids and alkalis

- o Acids and alkalis commonly used to remove paint and rust
- o Employees to be protected by suitable face shields
- Prevent chemical burns on neck and face.

5. Protection when using steam guns

- o All employees within blast range to wear suitable face shields
- o Metal parts of gun to be insulated
- Protects operator from burns.

IV. MECHANICAL PAINT REMOVERS (1915.23, 1916.23)

A. Power Tools

1. Employees using power tools to be protected with eye goggles or suitable face shield
 - o Includes use of the following:
 - Chipping guns
 - Needle guns
 - Hand-held grinders
 - Scrapers
 - Scamps.

V-37-16

Photo Slide:

POWER TOOL USED IN PAINT
REMOVING



Lesson No.

37

Title

Surface Preparation

Notes

V-37-17
Photo Slide:
GRINDING TOOL

V-37-18
Photo Slide:
MECHANICAL EXHAUST SYSTEM
FOR CONFINED SPACES

V-37-19
Photo Slide:
RESPIRATORY PROTECTION IN USE

Lesson Plan

2. Portable rotating tools to be adequately guarded against flying objects

- o Must protect both operator and employees nearby

- o Guards include:

- Governors to prevent excess speed

- Blade guards

- Breakaway preventers.

3. Portable electric tools to be properly grounded (1915.72, 1916.72)

4. When used in confined space:

- o Mechanical exhaust ventilation to keep dust concentration to minimum; or

- o Employees provided with appropriate respiratory protective equipment.

B. Flame Removal

1. Hardened coatings not to be removed by flame in enclosed spaces

- o Exception: if employees exposed to fumes protected by air line respirators as required in 1915.82, 1916.82.

2. Fume filter-type respirator required for employees who:

- o Perform flame removal in open air

- o Are exposed to fumes from flame removal operations.



Lesson No. 37

Title Surface Preparation

Notes

V-37-20
Photo Slide:
GROUNDED HOSE SYSTEM

V-37-21
Photo Slide:
HOSE COUPLING

V-37-22
Photo Slide:
SANDBLASTING NOZZLE

V-37-23
Photo Slide:
SANDBLASTER HOLDING DEAD
MAN CONTROL

Lesson Plan

C. Abrasive Blasting

1. Equipment

o Hoses

- Must be of type to prevent shocks from static electricity

o Hose couplings

- Must be metal
- Secured outside hose to prevent erosion, weakening of couplings

o Nozzles

- Attached to hose by fittings that prevent nozzle from becoming unintentionally disengaged
- Made of metal
- Fit to hose externally

o Dead man control

- At nozzle end of blasting hose
- To provide direct cut-off; or
- Signal pot tender visually and audibly to cut off flow
- Pot tender to be available for immediate response at all times
- Necessary in case blaster loses control of hose.



Lesson No.

37

Title

Surface Preparation

Notes

V-37-24
Photo Slide:
HOSES BEING INSPECTED

V-37-25
Photo Slide:
BLASTER'S PROTECTIVE HOOD

V-37-26
Photo Slide:
ABRASIVE BLASTING IN THE OPEN

V-37-27
Photo Slide:
ABRASIVE MATERIAL

Lesson Plan

2. Replacement of equipment

- o Hoses, all fittings to be inspected frequently for wear
 - Ensures replacement before equipment becomes unsafe.

3. Personal protective equipment

- o Work in enclosed spaces
 - All blasters to be protected by hoods and air-fed respirators; or
 - Positive pressure air helmets as required in 1915.82, 1916.82
- o Work in open
 - Hoods and air-fed respirators or positive pressure air helmets required unless free silica is less than 1% of abrasive
 - If silica level less than 1%, filter-type respirators acceptable
 - Filter respirators must be approved by Bureau of Mines for lead dust exposure
- o Other workers in blasting area
 - If unsafe concentrations of abrasive material present, must wear appropriate eye, respiratory protective equipment



Lesson No.

37

Title

Surface Preparation

Notes

V-37-28
Photo Slide:
WORK IN ELEVATED BASKET

V-37-29
Word Slide:
SUMMARY OF HEALTH HAZARDS
IN SURFACE PREPARATION
OPERATIONS

Handout 1
SUMMARY OF HEALTH HAZARDS
IN SURFACE PREPARATION
OPERATIONS

Lesson Plan

- o Protective clothing
 - Blaster to be protected from blast by appropriate protective clothing
 - Must include gloves
- o Work at elevation
 - Surges in hoseline can throw blaster off of staging
 - Must wear safety belt if adequate protection against falls cannot be provided by railings.

4. Communications

- o Positive communication between the employer handling the blast nozzle and the tender required
 - Radio communication; or
 - Signal system on hand line
- o Used to warn abrasive blaster of danger.

D. Other Health Hazards in Surface Preparation Operations

1. Lead

- o Systemic effects from lead poisoning
 - Carcinogenicity
 - Liver and kidney damage
 - Anemia



Lesson No.

37

Title

Surface Preparation

Notes

Lesson Plan

o Exposure due to:

- Chipping lead-based paints
- Burning and flame removal of lead-based paints.

2. Noise

- o Temporary threshold shift
- o Effects of shipyard noise
 - May cause hearing impairments
 - Prolonged exposure may result in hearing loss.

3. Vibration

- o "White fingers" (Raynaud's Syndrome)
 - Caused by prolonged use of hand-held pneumatic tools
 - Particularly pronounced in cold climatic situations
 - Preventive measures include vibration dampening, warm gloves, limiting time of exposure.

4. Silica

- o Exposure problem during abrasive blasting operations
- o Prolonged exposure causes disabling pulmonary fibrosis called silicosis.

5. Chromates

- o Used in primer paints on vessel hulls, other structural steel



Lesson No.

37

Title

Surface Preparation

Notes

Lesson Plan

- o May cause death, permanent injury after very short exposure to small quantities

- Recognized carcinogens

- Cause deep, slow-healing ulcers and lesions in body tissue.

6. Asbestos

- o Prolonged exposure causes asbestosis, mesothelioma

- o Particular hazard during rip out operations

- Protection required against inhalation and ingestion

- Change of clothes required.

SUMMARY OF HEALTH HAZARDS IN
SURFACE PREPARATION OPERATION .

<u>Hazard</u>	<u>Effects</u>	<u>Operation</u>
Lead	o Systemic Poisoning	o Chipping, burning, and flame removal of lead-base paints
Noise	- o Temporary threshold shift - o Permanent hearing loss	o Chipping, grinding, hammering
Vibration	o "White Fingers" (Raymand's syndrome)	o Prolonged use of vibrating tools
Silica	o Pulmonary fibrosis (silicosis)	o Abrasive blasting
Chromates	o Carcinogenic effects, ulceration and lesions in body tissue	o Chromate primer paints
Asbestos	o Pulmonary fibrosis (asbestosis)	o Insulation material installation and rip out

Source: Sax, N.I. Dangerous properties of industrial materials. 4th Edition. New York, Litton Educational Publishing, Inc., and Van Nostrand Reinhold Company, 1973.



Lesson No. 38

Time 50 minutes

Title

Surface Painting and Preservation

Objective

Upon completion of this lesson, the trainee will be able to discuss the various methods of painting and surface preservation found in shipyard work. The trainee will be able to identify safety and health hazards and respective controls for each.

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Lesson No.
38

Title
Surface Painting and Preservation

Technique	Content	Time
Lecture and Slides	I. Overview	10 minutes
	II. Painting with Toxic Solvents	10 minutes
	III. Flammable Liquids	10 minutes
	IV. Paints and Tank Coatings and Highly Toxic Tank Coatings	10 minutes
	V. Other Hazardous Substances	10 minutes
		Total Time: 50 minutes
Materials 21 Slides Slide Projector (35 mm) 1 Handout		
References 1. American Mutual Insurance Alliance. <u>Handbook of organic industrial solvents</u> . 4th edition. Chicago, AMIA, 1972. 2. Factory Mutual Engineering Corporation. <u>Handbook of industrial loss prevention</u> . 2nd edition. New York, McGraw-Hill, 1967.		



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C. Brush Application	38-4
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VISUAL AIDS

V-38-1	Photo Slide	Spraying in the Open (*)
V-38-2	Photo Slide	Brush Application
V-38-3	Photo Slide	Preservative Application Operations (*)
V-38-4	Word Slide	Review of Definitions
V-38-5	Word Slide	Explosive Range and Limits
V-38-6	Art Slide	Fire Tetrahedron
V-38-7	Photo Slide	No Smoking Sign Posted in Hazardous Area (*)
V-38-8	Photo Slide	Ventilation in a Paint Facility (*)
V-38-9	Photo Slide	Compartment Not Safe for Fire (*)
V-38-10	Photo Slide	Explosion-proof Lighting (*)
V-38-11	Photo Slide	Inspecting Power Cable (*)
V-38-12	Photo Slide	Fire Extinguisher (*)
V-38-13	Art Slide	Ventilation Scheme for Ship's Double Bottom Tank
V-38-14	Art Slide	Ventilation Directed by Ship's Structure
V-38-15	Art Slide	Fan Duct Arrangements
V-38-16	Photo Slide	Explosion-proof Motor Starter
V-38-17	Photo Slide	Nonferrous Duct (*)
V-38-18	Word Slide	Review of Selected Requirements for Work with Volatile, Toxic and Flammable Solvents
V-38-19	Photo Slide	Employee Spray Painting (*)
V-38-20	Word Slide	Review of Employee Protection Requirements
V-38-21	Word Slide	Review of Hazardous Substances in Shipyards

(*) For internal Department of Labor training purposes only.



HANDOUT

1. Handbook of Organic Industrial Solvents



Lesson No.

38

Title

Surface Painting

Notes

[Review the methods of surface painting and preservation.]

V-38-1

Photo Slide:

SPRAYING IN THE OPEN

V-38-2

Photo Slide:

BRUSH APPLICATION

V-38-3

Photo Slide:

PRESERVATIVE APPLICATION
OPERATIONS

Lesson Plan

I. OVERVIEW OF SURFACE PAINTING AND PRESERVATION METHODS IN TODAY'S SHIPYARDS

A. Spray Painting in Open Areas

1. Principle safety problems include:
 - o Personal protection of the worker
 - o Storage and mixing of paints to minimize flammable gas and vapor accumulations.

B. Spray Painting in Vessel Inner Bottoms and Confined Spaces

1. Principle safety problems include:
 - o Personal protection from inhalation of toxic vapors
 - o Accumulation of combustible or flammable vapors in spaces
 - o Egress from spaces.

C. Brush Application

1. Principle safety problem is mixing and storage of paints to minimize flammable vapor or gas accumulation.

D. Coating and Preservative Application

1. Principle safety problems are:
 - o Personal protection from toxic coatings for employees
 - o Control of flammable vapors and gases liberated from the application and drying of coatings and preservatives.



Lesson No.

38

Title

Surface Painting

Notes

Handout 1

HANDBOOK OF ORGANIC INDUSTRIAL
SOLVENTS

Lesson Plan

II. PAINTING WITH TOXIC SOLVENTS

A. Oil-based Paint Solvents

1. Components of oil-based paint-

- o Binder such as linseed oil or other drying oil used as a film-forming agent
- o Solvent that serves as thinner and promotes rapid drying
- o Binder and solvent together, known as the vehicle
- o Pigment that provides paint color.

B. Epoxies

1. Components of epoxies

- o Synthetic resins that act as binder
 - Typically mixed in two parts
 - Include substances such as epichlorohydrin and piperazine
- o Solvents that make up thinner portion of vehicle
 - Toluene and xylene are typical solvents.

C. Anti-fouling Paints and Coatings

1. Special paints which include anti-corrosive agents and herbicides

- o Chief ingredients are metal naphthenate, copper naphthenate, and mercury compounds.

D. Hazards

1. Health effects



Lesson No.

38

Title

Surface Painting

Notes

Lesson Plan

- o Narcosis
- o Lung irritation
- o Systemic poisoning
- o Dermatitis
- o Nervous system disorder
- o Liver and kidney disfunction.

E. Control Methods and Responsibility
for Controlling Hazards

1. Substitution

- o Alternative paints and
preservatives may be used
 - Example: latex paints
instead of epoxies
- o Alternative methods of
application may be chosen
 - Example: brush application
instead of spray painting.

2. Isolation

- o Painting and preservation
activities can be enclosed
so that toxic or flammable
vapors do not escape
 - Closed systems and containers
 - Spray booths.

3. Engineering controls

- o Local ventilation
 - Remove vapors at the point
of generation
- o General or dilution ventilation
 - Dilutes comparatively small
amounts of vaporized solvents



Lesson No.

38

Title

Surface Painting

Notes

Lesson Plan

- Can keep solvent concentrations below flammable limits
- In general, if concentrations are below health hazard limits then the concentration also will be within flammable limits
- o Make-up air
 - Fresh air added to a space or area from which air is exhausted.

4. Personal protective equipment

- o Respirators
- o Eye and face protection
- o Body protection
 - Gloves
 - Boots
 - Coveralls.

III. FLAMMABLE LIQUIDS

A. Principles of Flammable Liquids and Vapors (Review Definitions)

1. Flash point

- o Lowest temperature at which a vapor of a flammable substance ignites with a flash
- o Substances typically found in shipyard work and their flash points are listed below:
 - Gasoline -45°F (-43°C)
 - Toluene 40°F (4°C)
 - Xylene 90°F (32°C)
 - Naphtha 50°F (10°C)
 - Kerosene 100°F (38°C)
 - No. 6 Fuel oil 150°F (41°C).



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Surface Painting

Notes

Lesson Plan

2. Boiling point

- o Temperature at which specified liquid boils
- o Temperature at which vapor pressure of specified liquid equals atmospheric pressure.

3. Vapor pressure

- o Pressure at any given temperature of a vapor in equilibrium with its solid or liquid form
- o Also called vapor tension.

4. Vapor density

- o The weight of a volume of pure vapor or gas compared to an equal volume of dry air at the same temperature
- o A vapor with density less than one is lighter than air and will tend to rise
- o A vapor with density greater than one is heavier than air and will tend to seek lowest level.

5. Ignition temperature

- o Temperature at which a specified substance will catch on fire.

6. Explosive range

- o The range of flammable vapor/air or gas/air mixture between the upper and lower explosive limits.

7. Explosive limits

- o When a flammable gas or vapor mixes with air there is a minimum and maximum concentration where the propagation of flame does not occur

V-38-5

Word Slide:

EXPLOSIVE RANGE AND LIMITS



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Notes

Lesson Plan

V-38-6
Art Slide:
FIRE TETRAHEDRON

- o At these boundaries, if ignited the flammable mixture will only propagate flame
- o Within these boundaries and if ignited, a more rapid flame may develop and an explosion is likely
- o These limits are usually expressed as percent by volume of gas in air.

8. Common sources of ignition in a shipyard

- o Static electricity
- o Electric arc or spark from electrical equipment or machinery
- o Smoking
- o Open flame
 - Burning and cutting
 - Welding.

9. Fire tetrahedron

- o Four elements necessary for propagation of fire
 - Fuel
 - Oxygen
 - Heat
 - Self-sustaining chain reaction.

B. Flammable Liquids Commonly Used in Shipyards (1915.25)

1. Petroleum products

- o Fuels



Lesson No.

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Title

Surface Painting

Notes

Lesson Plan

- o Petroleum-derived solvents

- Naphtha

- o Tar products (asphalt).

2. Solvents

- o Acetone

- o Carbon tetrachloride

- o Benzene

- o Heptane

- o Naphtha

- o Toluene

- o Trichloroethylene

- o Xylene.

3. Liquified fuel gases

- o Used primarily for hot work

- o Stored in pressurized cylinders

- o Include the following:

- Acetylene

- Liquified propane gas

- Butane.

4. Liquid oxygen

- o Not flammable liquid but an oxidizer

- o Promotes rapid combustion of flammable materials if involved in fire or explosion.



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Notes

V-38-7
Photo Slide:
NO SMOKING SIGN POSTED IN
HAZARDOUS AREA

V-38-8
Photo Slide:
VENTILATION IN A PAINT
FACILITY

V-38-9
Photo Slide:
COMPARTMENT NOT SAFE FOR
FIRE

V-38-10
Photo Slide:
EXPLOSION-PROOF LIGHTING

Lesson Plan

5. Paints and coatings

- o May be oil-based or based on flammable solvent such as xylene or naphtha
- o Includes epoxy paints, flammable resins and curing agents.

C. Requirements for Work with Flammable Liquids (1915.25, 1916.25)

1. If liquid solvents, paints, removers, other vehicles capable of producing flammable atmospheres are used, following precautions required:

- o No smoking, open flames, arcs, or spark-producing equipment in work area
- o Ventilation used to be sufficient to keep vapor concentration below 10% LEL
 - Competent person to test frequently to ensure concentration level is acceptable
- o Scrapings, rags soaked in flammable liquids to be kept in covered metal container
- o Only explosion-proof lights acceptable for use
 - Must be approved by Underwriters' Laboratories for use in Class I, Group D atmospheres; or



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Notes

V-38-11
Photo Slide:
INSPECTING POWER CABLE

V-38-12
Photo Slide:
FIRE EXTINGUISHER

[Review common solvents.]

Lesson Plan

- Approved by Bureau of Mines;
or
- Approved by Coast Guard
- o Competent person to inspect all
power and lighting cables to
ensure:
 - Insulation is in excellent
condition, free of cracks,
worn spots
 - No connections within 50 feet
of operation
 - No overloaded lines
 - Lines suspended with suffi-
cient slack to prevent undue
stress, chafing
- o Suitable fire extinguishing
equipment to be immediately
available
- To be maintained ready
for immediate use.

IV. PAINTS AND TANK COATINGS DISSOLVED IN
HIGHLY VOLATILE, TOXIC AND FLAMMABLE
SOLVENTS

A. Common Solvents Used

1. Acetone
2. Carbon tetrachloride
3. Benzene
4. Heptane
5. Naphtha



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Notes

[Review common sources of
ignition.]

V-38-13
Art Slide:
VENTILATION SCHEME FOR
SHIP'S DOUBLE BOTTOM TANK

V-38-14
Art Slide:
VENTILATION DIRECTED BY
SHIP'S STRUCTURE

Lesson Plan

6. Toluene

7. Trichloroethylene

8. Xylene.

B. Common Sources of Ignition

1. Welding and other hot work

2. Static sparks produced by friction

3. Engine exhaust

4. Electrical arcing and sparking

5. Smoking

6. Any open flame

C. Requirements for Work with Volatile,
Toxic, and Flammable Solvents
(1915.24(b), 1916.24(b))

1. Ventilation is required at start
of work using solvents with
flash points below 80°F

2. Special precautions to be taken
include:

o Sufficient exhaust ventilation

- Solvent vapors to be kept
below 10% LEL

- Competent person to test
frequently to ensure level
remains safe

o If ventilation fails or
concentration rises above
10% LEL:

- Painting to be stopped



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Title

Surface Painting

Notes

V-38-15
Art Slide:
FAN DUCT ARRANGEMENTS

V-38-16
Photo Slide:
EXPLOSION-PROOF MOTOR
STARTER

V-38-17
Photo Slide:
NONFERROUS DUCT

V-38-18
Word Slide:
REVIEW OF SELECTED
REQUIREMENTS FOR WORK WITH
VOLATILE, TOXIC AND FLAMMABLE
SOLVENTS

Lesson Plan

- Compartment evacuated until level falls below 10% LEL
- If concentration remains high after painting is stopped, ventilation required to reduce level
- o Ventilation to continue after painting is complete until space is gas-free
- Final determination made after ventilation equipment shut off for at least 10 minutes
- o Exhaust ducts to discharge away from work area and possible ignition sources
- Periodic tests required to ensure that exhausted vapors do not accumulate in other areas within, around vessel or dry dock
- o Motors, control equipment to be:
 - Explosion-proof
 - Properly maintained and grounded
- o Fan blades and portable air ducts to be nonferrous
- o Non-sparking paint buckets, spray guns, tools to be used
- o Metal parts of paint brushes, rollers to be insulated
- o Staging to be erected so that it will be non-sparking



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Title

Surface Painting

Notes

V-38-19
Photo Slide:
EMPLOYEE SPRAY PAINTING

V-38-20
Word Slide:
REVIEW OF EMPLOYEE
PROTECTION REQUIREMENTS

Lesson Plan

- o Explosion-proof lights required to be approved by:
 - Underwriters' Laboratories for Class I, Group D atmospheres; or
 - Bureau of Mines; or
 - Coast Guard
- o Competent person to inspect power and lighting cables to ensure:
 - Insulation in good condition, no cracks or worn spots
 - No connections within 50 feet of operations
 - No overloaded lines
 - Lines suspended with sufficient slack to prevent undue stress, chafing
- o Employee protection requirements include:
 - Face, eye, head, hands, other exposed parts of body protected
 - Footwear to be nonsparking, e.g., rubbers or rubber-soled shoes without nails
 - Coveralls, other outer clothing to be cotton
 - Rubber gloves to be used because plastic may produce static sparks



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Surface Painting

Notes

[Review other requirements
under 1915.25(b) and
1916.25(b).]

V-38-21

Word Slide:

REVIEW OF HAZARDOUS
SUBSTANCES IN SHIPYARDS

Lesson Plan

- o Matches, lighted cigarettes, cigars, or pipes and cigarette lighters, other ferrous articles prohibited in work area
- o Solvent drums taken into compartments to be placed on nonferrous surface and grounded to vessel
 - Metallic contact to be maintained between containers and drums when materials are transferred between them
- o Spray guns, paint pots, metal tubing to be bonded and grounded to vessel
- o Personal protective equipment required:
 - Air line respirators and suitable protective clothing for employees continuously in compartments during painting
 - Filter cartridge-type respirators for employees entering compartments for limited time
 - Filter cartridge-type respirators and suitable protective clothing for employees doing exterior paint spraying.

V. REVIEW OF HAZARDOUS SUBSTANCES

- A. Commonly Encountered Toxic Substances Other than Paints Mixed in Toxic and Flammable Solvents



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Lesson Plan

1. Anti-fouling bottom paints
 - o Contain toxic substances such as mercury.
2. Epoxy resins
 - o Contain toxic organic epoxides and plasticizers such as ethylene oxide and epichlorohydrin
 - o Primary exposure route is through inhalation
 - o Some are suspected carcinogens.
3. Methylene ketone (MEK)
 - o Produces local irritation and narcosis, but does not have high degree of chronic toxicity.
4. Methyl butyl ketone (MBK)
 - o Acute systemic hazard that may cause death or permanent injury after short exposure to small quantities through inhalation or ingestion
 - o Also may cause reversible or irreversible change as external local irritant.
5. Toluene
 - o Derived from coal tar and may contain residual benzene
 - o Few cases of acute poisoning known, but has narcotic effect when inhaled or ingested in concentrations greater than 200 ppm.



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6. Chromates

- o Serious corrosive action on skin and mucous membranes
- o Recognized carcinogens of the lungs, nasal cavity, and sinuses; experimental carcinogen of the stomach and larynx.

7. Trichloroethylene

- o Inhalation of high concentrations causes narcosis, anesthesia
- o Chronic exposure may cause damage to liver, other organs
- o Acute exposure may lead to death from ventricular fibrillation that causes cardiac arrest.

8. Nitrogen oxide (NO₂)

- o Acute local and systemic hazard
 - Absorption, inhalation, or ingestion of small amounts over short period of time may cause death or permanent injury
- o Chronic exposure may cause reversible or irreversible damage.

B. Inert Substances

1. Carbon dioxide (CO₂)

- o Generally regarded as a simple asphyxiant
 - Symptoms result when concentration is so high that oxygen is insufficient to support life



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- o Symptoms include headache, dizziness, shortness of breath, muscular weakness

- Rapid recovery after removal from exposure.

2. Argon

- o Simple asphyxiant gas that acts by excluding oxygen from lungs

- Oxygen must be reduced to two-thirds of normal percentage in air before symptoms develop

- When argon level reaches 50% of atmosphere, marked symptoms result; 75% concentration is fatal in minutes.

C. Flammable Substances

1. Gasoline

2. Xylene

3. Naphtha

4. Kerosene

5. No. 6 fuel oil.

Handbook of **ORGANIC INDUSTRIAL SOLVENTS**

Fourth Edition



AMERICAN MUTUAL INSURANCE ALLIANCE
20 NORTH WACKER DR., CHICAGO, ILLINOIS 60606



Lesson No. 39

Time 50 minutes

Title

Welding, Cutting, and Heating

Objective

Upon completion of this lesson, the trainee will be able to discuss the use of welding, cutting and heating in shipyard work today. The trainee will be able to discuss the hazards the employees are exposed to as a result of such activities and list the measures to be taken to protect those workers.

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Lesson No.

39

Title

Welding, Cutting, and Heating

Technique	Content	Time
Lecture and Slides	I. Overview	10 minutes
	II. Ventilation and Protection	10 minutes
	III. Confined Spaces	10 minutes
	IV. Toxic Metals	10 minutes
	V. Inert Gas and Metal Arc Welding	10 minutes
		Total Time: 50 minutes

Materials

30 Slides
Slide Projector (35 mm)
2 Handouts

References

1. Krieg, A.H. The problems with welding fume and how to solve them. Naugatuck, CT, Widder Corporation, 1979.
2. National Safety Council. Accident prevention manual for industrial operations. 7th Edition. Chicago, National Safety Council, 1977.
3. Olishifski and McElroy (ed.) Fundamentals of Industrial Hygiene. Chicago, National Safety Council, 1971.
4. U.S. Occupational Safety and Health Administration. "Safety and health standards for maritime employment." Federal Register, Vol. 39, No. 119, June 19, 1974.



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VISUAL AIDS

V-39-1	Photo Slide	Fabrication (*)
V-39-2	Photo Slide	Fitting (*)
V-39-3	Photo Slide	New Construction (*)
V-39-4	Photo Slide	Ship Repair (*)
V-39-5	Photo Slide	Shipbreaking
V-39-6	Art Slide	Local Exhaust Hoods
V-39-7	Photo Slide	Local Exhaust Ducts (*)
V-39-8	Art Slide	Types of Exhaust Fans
V-39-9	Art Slide	General Ventilation Fan Location
V-39-10	Word Slide	Review of Ventilation Requirements
V-39-11	Photo Slide	Confined Space (*)
V-39-12	Photo Slide	No Natural Ventilation (*)
V-39-13	Photo Slide	Power Cables Restricting Opening (*)
V-39-14	Photo Slide	Employee in Confined Space--Exhaust Required (*)
V-39-15	Photo Slide	Means of Access (*)
V-39-16	Photo Slide	Duct Restricting Access (*)
V-39-17	Photo Slide	Air Line Respirator
V-39-18	Word Slide	Toxic Metals
V-39-19	Photo Slide	Employee Welding Zinc-based Metal
V-39-20	Photo Slide	Local Exhaust and Zinc-based Metals Being Welded
V-39-21	Art Slide	Oxygen Acetylene Setup
V-39-22	Photo Slide	Oxygen Acetylene Cart
V-39-23	Art Slide	Arc Welds

VISUAL AIDS (Continued)

V-39-24	Photo Slide	Arc Welding (*)
V-39-25	Art Slide	Gas Tungsten Arc Equipment
V-39-26	Photo Slide	TIG Welding Operations
V-39-27	Word Slide	Summary of Welding Hazards
V-39-28	Photo Slide	Shielded Welding Operations (*)
V-39-29	Photo Slide	Employees Protected by Filtered Lenses While Watching Welding (*)
V-39-30	Photo Slide	Welders Working Together (*)

(*) For internal Department of Labor training purposes only.



HANDOUTS

1. The Problems with Welding Fume and How to Solve Them
2. Toxic Hazards Associated with Welding and Brazing



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Welding, Cutting, and Heating

Notes

[Review shipyard operations.]

V-39-1

Photo Slide:
FABRICATION

V-39-2

Photo Slide:
FITTING

V-39-3

Photo Slide:
NEW CONSTRUCTION

V-39-4

Photo Slide:
SHIP REPAIR

V-39-5

Photo Slide:
SHIPBREAKING

Lesson Plan

I. OVERVIEW OF WELDING, CUTTING, AND HEATING
OPERATIONS FOUND IN SHIPYARDS

A. Fabrication

1. Stick welding
2. Sub arc welding
3. Inert-gas welding
4. Flame cutting and burning.

B. Fitting

1. Tack welding
2. Stick welding
3. Flame cutting and burning.

C. New Construction and Outfitting

1. Sub arc welding
2. Electro slag welding
3. Inert-gas welding
4. Stick welding
5. Flame cutting and burning.

D. Ship Repair

1. Stick welding
2. Sub arc welding
3. Flame cutting and burning.

E. Shipbreaking

1. Flame cutting and burning
2. Stick welding.



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Welding, Cutting, and Heating

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Handout 1
THE PROBLEMS WITH WELDING
FUME AND HOW TO SOLVE THEM

V-39-6
Art Slide:
LOCAL EXHAUST HOODS

V-39-7
Photo Slide:
LOCAL EXHAUST DUCTS

V-39-8
Art Slide:
TYPES OF EXHAUST FANS

V-39-9
Art Slide:
GENERAL VENTILATION FAN
LOCATION

[Review ventilation
requirements.]

V-39-10
Word Slide:
REVIEW OF VENTILATION
REQUIREMENTS

Lesson Plan

II. VENTILATION AND PROTECTION

A. Elements of Local and General Exhaust
Systems

1. Local exhaust system

- o Hoods
- o Ducts
 - Flexible
 - Fixed

- o Fans
 - Axial flow
 - Centrifugal.

2. General ventilation

- o Dilution ventilation
- o Make-up air
 - Necessary for efficient
system operation.

B. Mechanical Ventilation Requirements
(1915.31(a), 1916.31(a), 1917.31(a))

1. Either general mechanical
ventilation or local exhaust
system permissible
2. General ventilation requirements
 - o Sufficient capacity; and
 - o Designed so that air is changed
often enough to keep fumes,
smoke in safe limits.



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Lesson Plan

3. Local exhaust ventilation requirements

- o To have freely movable hoods
 - Welder or burner can place as close as practicable to work
- o Sufficient capacity and arranged so that:
 - Fumes and smoke are removed at source
 - Fume and smoke concentration kept at safe level.

4. Contaminated exhaust to be discharged into open air or otherwise clear of intake air

5. All replacement air to be clean and respirable

6. Use of oxygen prohibited for:

- o Ventilation
- o Comfort cooling
- o Blowing dust, dirt from clothing
- o Cleaning work area.

V-39-11
Photo Slide:
CONFINED SPACE

V-39-12
Photo Slide:
NO NATURAL VENTILATION

III. HOT WORK IN CONFINED SPACES

A. How Confined Spaces Compound Hazards Associated with Hot Work

1. Access/egress is limited or restricted
2. Little or no natural ventilation present



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V-39-13
Photo Slide:
POWER CABLES RESTRICTING
OPENING

V-39-14
Photo Slide:
EMPLOYEE IN CONFINED SPACE--
EXHAUST REQUIRED

V-38-15
Photo Slide:
MEANS OF ACCESS

V-39-16
Photo Slide:
DUCT RESTRICTING ACCESS

V-39-17
Photo Slide:
AIR LINE RESPIRATOR

Lesson Plan

3. Power cables, fuel gas lines can further block openings and increase fire and explosion potential.

B. Requirements for Hot Work in Confined Spaces (1915.31(b), 1916.31(b), 1917.31(b))

1. Either general mechanical or local exhaust ventilation required for all hot work in confined spaces

2. More than one means of access to be provided

o Exception: if structure or arrangement of space makes this impossible.

3. If ventilation ducts pass through means of access, ducts to be of such type and arranged so that employee has free passage through at least two accessways

o Exception: if it is impossible to provide more than one access, only that access must provide free passage.

4. Requirements if ventilation cannot be provided without blocking access:

o Employees in confined space to wear approved air line respirators

o Attendant stationed outside space to maintain communications, assist in emergency.



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Welding, Cutting, and Heating

Notes

[Review toxic metals and
their health effects.]

V-39-18

Word Slide:

TOXIC METALS

Lesson Plan

IV. TOXIC METALS

A. Places Where Toxic Metals are
Commonly Found

1. Pipe hangers
 - o Often are zinc-coated.
2. Pipe supports
3. Railings and stairs and ladder
ways
4. Equipment foundations
5. Lead-based materials
 - o Paints
 - o Solder.

B. Health Effects

1. Metal fume fever
 - o Results from inhalation of zinc
fumes
 - o Symptoms include:
 - Chills and sweating
 - Leg pains
 - Headaches
 - Tightening in the chest
 - o Actual cause unknown but is
assumed to be protein reaction
in the lungs.
2. Siderosis
 - o Caused by exposure to iron
 - o May occur as pneumoconiosis from
inhalation of iron fumes
 - o May also result in excess amounts
of iron in blood and tissue.



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Welding, Cutting, and Heating

Notes

Lesson Plan

3. Poisoning

- o Can be caused by inhalation of fumes from following metals:
 - Lead
 - Manganese
 - Mercury
 - Beryllium
 - Copper
 - Nickel.

4. Pulmonary edema

- o Fumes from stick electrodes that contain cadmium very dangerous
- o May cause death from pulmonary edema 8 to 10 hours after heavy exposure.

5. Respiratory problems

- o Pneumoconiosis from beryllium fumes
- o Lung irritation from manganese, vanadium, fluoride, bromide, chloride fumes
- o Pneumonitis from nickel fumes
- o Silicosis from metal silicates.

6. Carcinogenic potential of fumes from:

- o Stainless steel
- o Lead
- o Chromium
- o Nickel.



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Welding, Cutting, and Heating

Notes

V-39-19
Photo Slide:
EMPLOYEE WELDING ZINC-BASED
METAL

V-39-20
Photo Slide:
LOCAL EXHAUST OVER ZINC-BASED
METALS BEING WELDED

Lesson Plan

C. Requirements for Hot Work on Toxic
Metals (1915.31(c), 1916.31(c),
1917.31(c))

1. Either general mechanical or local
exhaust ventilation required for
any hot work in enclosed spaces
involving following metals:

- o Zinc-bearing base or filler
metals or metals coated with
zinc compounds
- o Lead-based metals
- o Cadmium-bearing filler materials
- o Chromium-bearing metals or
metals coated with chromium
compounds.

2. Local exhaust ventilation or air
line respirators required for all
hot work in confined spaces
involving following metals:

- o Metals containing lead, other
than as impurity, or coated
with lead compounds
- o Cadmium-bearing or coated
base metals
- o Metals coated with mercury-
bearing metals
- o Beryllium-containing base or
filler metals
- Both local exhaust and
air line respirators
required for work with
beryllium because of high
toxicity.



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Welding, Cutting, and Heating

Notes

V-39-21
Art Slide:
OXYGEN ACETYLENE SET UP

V-39-22
Photo Slide:
OXYGEN ACETYLENE CART

V-39-23
Art Slide:
ARC WELDS

V-39-24
Photo Slide:
ARC WELDING

V-39-25
Art Slide:
GAS TUNGSTEN ARC EQUIPMENT

V-39-26
Photo Slide:
TIG WELDING OPERATIONS

Lesson Plan

3. Filter-type respirators required for employees doing hot work on toxic metals in open air
 - o Exception: work with beryllium requires air line respirators.
4. Other exposed employees to have same protection as employees doing actual hot work.

V. WELDING PROCESSES, HAZARDS, AND CONTROLS

A. Common Types of Welding

1. Gas welding
 - o Fuel (usually acetylene) is mixed with oxygen then burned to produce heat for welding.
2. Arc welding
 - o Metals are fused together using electric arc as heat source
3. Gas metal-arc welding
 - o Uses a continuously-fed consumable electrode and a shielding gas
 - o Includes metal inert-gas (MIG) welding and tungsten inert-gas (TIG) welding
 - Difference between the two based on type of metal used in electrode
 - Type used depends on metal that is to be welded
 - Inert gases used include carbon dioxide and argon.



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Title

Welding, Cutting, and Heating

Notes

V-39-27

Word Slide:

SUMMARY OF WELDING HAZARDS

Handout 2

TOXIC HAZARDS ASSOCIATED WITH
WELDING AND BRAZING

[Review the safety and
health hazards associated
with welding.]

Lesson Plan

B. Welding Hazards

1. Metal fumes and dusts
2. Vapors and gases given off in arc
and gas welding
3. Acetylene
 - o Anesthetic
 - o Explosion hazard.
4. Natural gas
 - o Explosion hazard.
5. Propane
 - o Explosion hazard
 - o When used for pre-heating
structures prior to arc welding,
produces carbon monoxide.
6. Asphyxiation potential of inert
gas
7. Oxides of nitrogen
 - o Produced in all welding and
cutting operations
 - o Can cause pulmonary edema.
8. Ozone
 - o Occurs when ultraviolet light,
which is produced by all
welding, reacts with oxygen
in air
 - o Largest amount produced by
inert-gas metal-arc welding.



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Welding, Cutting, and Heating

Notes

Lesson Plan

9. Fumes from solvent decomposition

- o Solvents such as trichloroethylene decompose under heat, ultraviolet radiation
- o Give off phosgene, acid vapors
- o Particular problem in MIG welding because inert gases help in production of poisonous fumes.

10. Acrolein and aldehydes

- o Acrolein produced by heating, burning asphalt products
- o Aldehydes produced by oxidation of organic materials
- o Both produce intense eye irritation.

11. Handling and storing gas cylinders

- o Fire and explosion hazard.

12. Ultraviolet radiation

- o Produced during all welding operations
- o May cause serious eye damage.

C. Control Requirements for Inert-gas Metal-arc Welding (1915.31(d), 1916.31(d))

1. Precautions must be taken to protect employees from:

- o Ultraviolet (UV) radiation
 - Inert-gas metal-arc welding produces UV radiation 5 to 30 times that produced during shielded metal-arc welding

V-39-28

Photo Slide:

SHIELDED WELDING OPERATIONS



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Title

Welding, Cutting, and Heating

Notes

V-39-29
Photo Slide:
EMPLOYEES PROTECTED BY
FILTERED LENSES WHILE
WATCHING WELDING

V-39-30
Photo Slide:
WELDERS WORKING TOGETHER

Lesson Plan

- o Decomposition of chlorinated solvents by UV rays
- o Liberated toxic fumes, gases.
- 2. Employees prohibited from engaging in, being exposed to inert-gas welding unless following steps taken:
 - o Chlorinated solvents kept at least 200 feet from exposed arc
 - Surfaces prepared with chlorinated solvents must be totally dry before welding
 - o Employees nearby not protected by proper screening must wear appropriate filter lenses
 - o When two or more welders exposed to each other's arc, must wear approved filter lens goggles under helmets or hand shields
 - Protect welder from flashes, radiant energy when helmet lifted or shield removed
 - o Welders and other employees exposed to UV radiation to have skin completely protected against burns, other damage
 - Helmets and hand shields to be free of leaks, openings, highly reflective surfaces
 - o Special precautions required for inert-gas welding on stainless steel
 - Must use local ventilation air line respirators to protect against nitrogen dioxide.

The Problems With Welding Fume and How To Solve Them



by

A. H. Krieg*
Chairman, Widder Corporation
Arc/Gas/Welding and Cutting

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TOXIC HAZARDS ASSOCIATED WITH
WELDING AND BRAZING

I. Welding, Brazing, Soldering

- A. Welding may be described as a metal-working process in which metals are joined by heating them to the melting point, and allowing the molten portions to fuse or flow together.
- B. Soldering may be described as a metal-working process in which metals not melted are joined together by a third metal which has a melting point below 800°F.
- C. Brazing may be described as a metal-working process in which metals not melted are joined together by a third metal which has a melting point above 800°F.

II. Common Types of Welding

- A. Gas welding: the fuel (usually acetylene) is mixed with oxygen and burned, producing the heat for welding.
- B. Arc welding: Fusing two metals together using an electric arc as the source of heat.
- C. Gas metal-arc welding: Welding using a continuously-fed consumable electrode and a shielding gas.
- D. Resistance welding: Welding metals using the resistance of the metals to the flow of electricity as the source of heat.
- E. Atomic welding: Welding using heat created by hydrogen atoms, created by an electric arc recombining to form hydrogen molecules. The heat is used to weld delicate joints and the hydrogen forms a shield over the weld.
- F. Thermit welding: The process consists of mixing iron oxide and aluminum, both in a powder form, placing them in a hopper above a mold which surrounds the joint area, then bringing this mixture to a temperature of 2000 to 2500°F. The aluminum will then combine chemically with the oxygen molecules in the iron oxide producing a temperature of approximately 5000°F to initiate the weld.
- G. Cold welding: Consists of forcing metal together under considerable pressure, producing a true fusion condition without the use of heat.
- H. Ultrasonic welding: Consists of joining the metals under pressure while vibrating them at high frequency. The high intensity, high frequency vibrations cause a joining of the metals being joined.
- I. Electron beam welding: Usually performed in a vacuum. The metals are brought rather close together and a concentrated stream of high energy electrons is directed into the gap between the metals causing fusion to take place.
- J. Friction welding: The type of weld in which the necessary welding heat is generated by revolving one part against the other part under very heavy pressure.
- K. Laser welding: Consists of firing a brilliant light (capacitor discharges into xenon tubes or almost instant ignition of aluminum or magnesium foil or wire). The laser may operate 1/10,000 of a second, and the rest of the second is a cooling period.

- L. Plasma arc welding: The plasma torch provides an electric arc between a tungsten electrode and a water-cooled copper nozzle. Gases such as helium or hydrogen are forced through the arc and nozzle with the result that they are heated and become ionized and the stream from the nozzle (plasma) is used to effect the weld. Temperatures of 60,000°F have been attained using this procedure.

III. Toxic Hazards Encountered in Welding

A. Metal fumes and dusts

1. Aluminum is often encountered in welding. It is absorbed in the lungs. When inert gas arc welding aluminum, there is a possibility that the ultraviolet frequency is right to form ozone. This gas is toxic and may cause lung damage.
2. Beryllium is extremely toxic. It is believed to have possible carcinogenic effects. Target tissue is primarily the lungs.
3. Cadmium: Recently, solders containing cadmium in varying amounts with Cu, Pb, Zn and Ag have been used. Remelting of scrap and the use of a blowtorch in working cadmium plated steel pipes is dangerous because the presence of cadmium is not suspected. In 1942, Lafitte and Goos (Hamilton & Hardy 1949, pp. 150-151) described the syndrome: First a pain develops in the lower back and legs. Soon the patient becomes unable to walk. X-ray picture: scapula, ilium, femur showed signs of pseudo fractures known as millemais syndrome. Prior to the onset of signs and symptoms, the death of the workers so exposed to cadmium had a characteristic appearance: the enamel of the teeth took on a yellow color. Also, sternal pain, throat irritation and coughing. Intense exposures to cadmium can cause fatal pulmonary edema.
4. Copper: The vaporization temperature of copper is high: 2350°C; a temperature that is rarely encountered. Ulcerative lesions of the nose as a result of inhaling copper dust have been reported. After intense exposure of long duration to copper, skin, hair, and teeth could turn green. This is considered to be a harmless effect. (HLH)
5. Lead: Causes generalized damage to the systems of the body, notably the control and peripheral nervous system. Welders can be exposed to lead by burning through lead-painted steel with an acetylene or electric torch. The standard methods of physiological lead exposure has been the appearance of the lead line and the wrist drop. However, it has been noted that the lead line consists of the black sulfide of lead produced by contact of the absorbed lead with the hydrogen sulfide produced by decay of protein matter between the teeth. It is seldom found in people who take care of their teeth. Work showed that animals fed on a vegetable diet never show a lead line while animals fed on a meat diet show it.

It should be noted that any heavy metal will combine with H_2S to form the black sulfide.

The earliest signs of wrist drop is the dropping of the two middle fingers when the hands are held out with fingers separated and extended. However, chronaxia is replacing this method of detection.

Chromaxia: The minimum length of time a farvantic current of standard strength takes to induce muscular contraction. A reaction slower than normal, showing a fall in muscle excitability, is the danger signal.

The anemia in plumbism has definite characteristics including hyperplasia of erythroblasts, and granuloblasts accelerated in subacute poisonings, delayed in chronic.

6. **Magnesium:** Magnesium oxide has been shown to induce metal fume fever. Problems - chemical gas gangrene from metallic magnesium. Wounds, scratches or cuts that are caused or contaminated by magnesium are slow to heal. It can also cause peptic ulcers and gastrointestinal upsets.
7. **Manganese:** Produces neurological symptoms such as sleeplessness, muscular twitching and progresses to destruction of the nonvital areas of the neuromuscular system. Slight neurological abnormalities should be noted.
8. **Nickel:** Nickel-iron alloys are used in heavy machinery, automotive parts. Nickel-chromium alloys are used in gas turbine and jet engines. Nickel-aluminum alloys are used in auto and airplane parts.

Nickel eczema or "nickel itch" is common in welding operations using nickel compounds. Problems: Inhalation exposure to nickel carbonyl even in extremely low concentrations. Symptoms: headache, drowsiness, nausea and vomiting appear first followed by chest pain, tightness, dry cough, dyspnea, cyanosis and extreme weakness.

9. **Silver solder:** Contains the toxic substance cadmium. Fluxes containing fluoride used with silver solder present another hazard independent of silver or cadmium.
10. **Tellurium:** Small amounts are used in making chilled cor wheels and chilled iron castings. One of the symptoms of selenium and tellurium poisoning is garlic breath. Schroeder et al (1967) discovered that the garlic plant is high in a tellurium compound, nethyl telluride, hence the garlic odor.
11. **Tin:** Modern pewter is made with up to 90% tin. Industrial workers exposed to dusts or fumes of tin may develop stannosis, a benign dust disease. X-rays reveal dense bilateral nodular infiltrates.
12. **Titanium:** Used in the manufacture of welding rods. At this time, it is considered harmless.
13. **Vanadium:** Used in the manufacture of steel alloys. Can cause several unusual disturbances, notably "green tongue" in addition to pallor and emaciation. The green tongue is caused by the reduction of vanadium pentoxide to trioxide and the formation of green salts by the ptyalin and acid-forming bacteria in the mouth.
14. **Zinc:** Chief problem in welding is "zinc chills".

15. Metal fume fever: Causes - fumes from heated metal. Kuh et al (1946) believed that metal fume fever results from the absorption of endotoxins liberated in the lungs as a result of the killing of the microorganisms of the lower respiratory tract. The immunity which often follows an attack would then be due to the temporary stabilization of the tract and would be lost with the organisms began to multiply again. Burns et al (1961) proposed that an endogenous pyrogen is produced by the direct effect of metal fumes on white blood cells.

Symptoms: The symptoms come on a few hours after exposure, often after the worker has reached home. Chilling is often a precipitating factor. The actual chills are followed by a dryness in the throat, with cough, a sense of lassitude and oppression in the chest, sometimes nausea but rarely vomiting. Occasionally the temperature rises from 101-103°F, reaching a maximum 10-12 hours after exposure.

Note: Arc welders get more serious attacks than men in brass foundries since they must work in small, confined spaces and receive intense exposure to metal fumes. Such exposures may include the hazard of inhalation of nitrogen oxides.

B. Nonmetallic Hazardous Substances Encountered in Welding

1. Fluorides: Occasionally found in fluxes. Fluoride is quickly absorbed into the system. It is absorbed largely in the bones.
2. Ozone: Mucous membranes of the eye, nose and throat as irritated by ozone concentrations. It is a powerful oxidant which can injure alveolar walls and may produce pulmonary edema at relatively low concentrations. Ozone is extremely toxic and can cause chronic poisoning manifested as bronchitis and bronchiolitis. The working level for healthy men during a 40-hour work week is at present 0.1 ppm in the U.S. Patty (1963, p. 916) states: A safe level can be 0.05 ppm. Arc welding can produce ozone.

Note: Thorium is toxic. When thoriated electrodes are used alpha emissions are produced and ozone is formed.

3. Nitrogen dioxide: A mucous membrane irritant occasionally produced in an atmosphere where welding is employed.
4. Oil smoke: Aromatics such as 3-4 benzpyrile are produced upon occasion. They are considered by some researchers to be carcinogenic.
5. Carbon monoxide: An asphyxiant produced upon occasion in reducing furnaces.
6. Cyanide may be formed when the special flux, containing sodium cyanide (used to silver braze tungsten to copper) is used or stored improperly, allowing it to get wet or to come in contact with acids, nitrates, or other oxidizing agents.

Page 5-Toxic Hazards Associated with Welding and Brazing

IV. Methods of Air Sampling for Common Hazardous Substances Found in:
a Welding Shop

<u>Substance</u>	<u>Collection Method</u>	<u>Rate/Time</u>	<u>Analytical Method</u>
Cadmium			
dust/fume	MCEF 0.8 μ	1.5 lpm for 15 min.	AAS
Cobalt metal			
dust/fume	MCEF 0.8 μ	1.5 omp/15 min.	AAS
Copper dust/			
fume	MCEF 0.8 μ	1.5 lpm/15 min.	AAS
Fluoride	MCEF 0.8 μ	1.5 lpm/30 min.	ISE
Hydrogen	MI 15 ml of	1.0 lpm/100 min.	ISE
Cyanide	0.1 in NaOH		
Iron Oxide	MCEF 0.8 μ	1.5 opm/100 min.	AAS
Fume			
Lead	MCEF 0.8 μ	1.5 lpm/2 hrs.	AAS
Magnesium	MCEF 0.8 μ	1.5 lpm/100 min.	AAS
Oxide Fume			
Manganese	MCEF 0.8 μ	1.5 lpm/15 min.	AAS
Mercury	Silver	50 cc/min/20 min.	AAS
	Chromasorb-P		flameless
	Sampling tube		
Nickel	MCEF 0.8 μ	1.5 lpm/60 min.	AAS
Ozone	MI 10 ml of	10 lpm/200 min.	colorimetric
	trapping agent		alkaline KI
Silver	MCEF 0.8 μ	1.5 lpm/60 min.	AAS
Tellurium	MCEF 0.8 μ	1.5 lpm/2 hrs.	AAS
Tin	MCEF 0.8 μ	1.5 lpm/2 hrs.	AAS/colorimetric
Vanadium	MCEF 0.8 μ	1.5 lpm/30 min.	AAS
Zinc	MCEF 0.8 μ	1.5 lpm/60 min.	AAS
Oxide Fume			

MCEF: Mixed cellulose ester filter

ISE : Ion specific electrode

MI : Midget impinger

AAS : Atomic absorption

V. Regulations Pertaining to Welding Operations

Beryllium	.242(f) (8)	23749
Cadmium	.252(f) (1) (v), (9)	23748, 23749
Cleaning Compounds	.252(f) (11)	23749
Concentrations		
Maximums Allowable	.252(f) (1) (iv)	23748
Containers	.252(d) (3)	23747
Contamination	.252(f) (1) (i)	23748
Definitions	.251	23737
Exhaust Hood	.252(f) (3)	23749
Fire Protection	.252(d) (2) (i)	23746, 23747
	(ii), (xv)	
First Aid Equipment	.252(f) (13)	23749
Fluorine Compounds	.252(f) (1) (v), (5)	23748
Hazards	.252(c) (5)	23746
Labels	.252(f) (i) (v)	23748
Ladders, Fixed	.27 (b) (6)	23519
Lead	.252(f) (7)	23749
Liquefied Petroleum Gases	.110(b) (4)	23643
Mercury	.252(f) (10)	23749
Piping Systems, Mechanical	.252(g) (2)	23750
Personal Protection	.252(e)	23747
Precautions	.252(c) (6), (d) (2)	23746
Prohibited Areas	.252(d) (2) (vi)	23746
Screens	.252(d) (1) (iii)	23748
Spot and Seam	.252(c) (2)	23745
Stainless Steels	.252(f) (12)	23749
Standards Sources	.253	23750
Supervisory Responsibility	.252(d) (2) (xiv)	23747
Transmission Pipelines	.252(g) (1)	23750
Ventilation	.252(f) (1) (ii)	23749
	(f) (2) - (4)	
Zinc	.252(f) (6)	23749
Welding Machines, Portable	.252(c) (3)	23746
Counterbalance	.252(c) (3) (i)	23746
Grounding	.252(c) (3) (vi)	23746
Holder, movable	.252(c) (3) (v)	23746
Safety Chains	.252(c) (3) (ii)	23746
Switch Guards	.252(c) (3) (iv)	23746

REFERENCES:

- Hamilton, Alice and Harriet L. Hardy, Industrial Toxicology, Publishing Sciences Group, Inc., Acton, Mass; 1974
- Althousa, Andrew D., Carl H. Turnquist and Wm. Bowditch, Modern Welding, Good-Willcox Co., Inc., South Holland, Ill., 1970
- Handbook of Industrial Hygiene, USDL, OSHA



Lesson No. 40

Time 50 minutes

Title Welding, Cutting, and Heating (Continued)	
Objective	Upon completion of this lesson, the trainee will be able to discuss the use of welding, cutting and heating in shipyard work today. The trainee will be able to discuss the hazards the employees are exposed to as a result of such activities and list the measures to be taken to protect those workers.
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Lesson No.

40

Title

Welding, Cutting, and Heating (Continued)

Technique	Content	Time
Lecture and Slides	VI. Fire Prevention	20 minutes
	VII. Hot Work in Way of Preservative Coatings	15 minutes
	VIII. Hot Work on Hollow Metal Containers	15 minutes
	Total Time: 50 minutes	
Materials		
17 Slides Slide Projector (35 mm)		
References		
1. Krieg, A.H. <u>The problems with welding fume and how to solve them.</u> Naugatuck, CT, Widder Corporation, 1979.		
2. National Safety Council. <u>Accident prevention manual for industrial operations.</u> 7th Edition. Chicago, National Safety Council, 1977.		
3. Olishifski and McElroy (ed.) <u>Fundamentals of industrial hygiene.</u> Chicago, National Safety Council, 1971.		
4. U.S. Occupational Safety and Health Administration. "Safety and health standards for maritime employment." <u>Federal Register</u> , Vol. 39, No. 119, June 19, 1974.		

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A. Hazards	40-6
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VIII. Hot Work on Hollow Metal Containers and Structures Not Covered by 1915.11	40-8
A. Hazards	40-8
B. Requirements for Hot Work	40-9

VISUAL AIDS

V-40-1	Photo Slide	Hot Work at Safe Distance From Combustibles
V-40-2	Photo Slide	Hot Work Away From Flammable Materials (*)
V-40-3	Photo Slide	Fire Extinguishing Equipment
V-40-4	Photo Slide	Auxiliary Water Supply
V-40-5	Photo Slide	Fire Watch
V-40-6	Art Slide	Hot Work on Bulkheads
V-40-7	Photo Slide	Gas and Oxygen Supply Manifold (*)
V-40-8	Photo Slide	Hose Removed from Space and Racked (*)
V-40-9	Word Slide	Hazards of Hot Work in Way of Preservative Coatings
V-40-10	Word Slide	Controls for Hot Work in Way of Preservative Coatings
V-40-11	Photo Slide	Hollow Metal Structure (*)
V-40-12	Art Slide	Precautions for Welding on a Drum
V-40-13	Photo Slide	Skeg and Bilge Keel (*)
V-40-14	Photo Slide	King Posts
V-40-15	Photo Slide	Boom
V-40-16	Photo Slide	Rudder (*)
V-40-17	Photo Slide	Jacketed Piping (*)

(*) For internal Department of Labor training purposes only.



Lesson No.

40

Title

Welding, Cutting, and Heating (Continued)

Notes

[Review welding, cutting
and burning fire prevention
requirements.]

V-40-1

Photo Slide:

HOT WORK AT SAFE DISTANCE
FROM COMBUSTIBLES

V-40-2

Photo Slide:

HOT WORK AWAY FROM FLAMMABLE
MATERIALS

V-40-3

Photo Slide:

FIRE EXTINGUISHING EQUIPMENT

V-40-4

Photo Slide:

AUXILIARY WATER SUPPLY

V-40-5

Photo Slide:

FIRE WATCH

Lesson Plan

VI. FIRE PREVENTION

A. Requirements for Fire Prevention
(1915.32, 1916.32, 1917.32)

1. Object to be moved to designated
safe location before hot work
 - o Exception: if object not
readily movable
 - All fire hazards to be
removed to safe place
 - Includes residues of
combustible bulk cargo in
vicinity.
2. If neither object nor fire hazards
can be moved, positive means to be
taken to confine heat, sparks,
slag and to protect fire hazards
from them
3. No hot work in way of flammable
paints, other flammable compounds,
heavy dust concentrations
4. Suitable fire extinguishing equip-
ment to be immediately available,
ready for instant use
 - o If hot work done on vessel and
pressure unavailable for ship's
fire system, auxiliary water
supply required
 - To be consistent with avoid-
ing freezing of lines, hoses.
5. If hot work operations such that
normal fire precautions inadequate,
additional personnel to be assigned
to guard against fire
 - o Fire guard during hot work and
for sufficient time afterwards
to ensure no possibility of
fire exists



Lesson No.

40

Title

Welding, Cutting, and Heating (Continued)

Notes

V-40-6
Art Slide:
HOT WORK ON BULKHEADS

V-40-7
Photo Slide:
GAS AND OXYGEN SUPPLY
MANIFOLD

[CO₂ and halon extinguishers
are prohibited in enclosed
spaces.]

Lesson Plan

- o Fire guard personnel to be trained in anticipated hazards and use of fire fighting equipment.
- 6. Same precautions to be taken on side opposite side where hot work is performed when the hot work is done on:
 - o Tank shells
 - o Decks
 - o Overheads
 - o Bulkheads.
- 7. During hot work in confined spaces, torch gas supply to be positively shut off at point outside space when torch is unused, left unattended for length of time, e.g., lunch hour
 - o Eliminates possibility of fire in confined space due to gas leak.
- 8. Torch and hose to be completely removed overnight, at shift change
- 9. Open end fuel gas, oxygen hoses to be immediately removed from confined space when disconnected from torch, other gas-consuming device
- 10. Vaporizing liquid extinguishers prohibited in enclosed spaces
- 11. Containers that contain or contained flammables to be closed except when contents are being removed or transferred



Lesson No.
40

Title
Welding, Cutting, and Heating (Continued)

Notes

Lesson Plan

12. Empty containers to be removed
to safe area

- o Away from hot work, open
flames.

B. Overview of Coast Guard 46 CFR
146.02-20

1. Covers repairs involving hot work
and dangerous cargoes
2. Requires that no hot work be
done unless vessel or space is
gas-free

C. Scope of 1910, Subpart L

1. Prohibited extinguishers
 - o Carbon tetrachloride
 - o Soldered-seam invert-type
extinguisher.
2. Fire brigade
 - o Personal protection
 - o Training.

VII. HOT WORK IN WAY OF PRESERVATIVE COATINGS

A. Hazards

1. May produce toxic fumes, vapors
2. May be flammable or explosive
3. Particular hazard when working in
confined or enclosed space
 - o Lack of ventilation
 - o High vapor concentration levels.

V-40-9
Word Slide:
HAZARDS OF HOT WORK IN
WAY OF PRESERVATIVE COATINGS



Lesson No.

40

Title

Welding, Cutting, and Heating (Continued)

Notes

V-40-10
Word Slide:
CONTROLS FOR HOT WORK IN
WAY OF PRESERVATIVE COATINGS

Lesson Plan

B. Requirements for Controls (1915.33,
1916.33, 1917.33)

1. Test for flammability by competent person required before any hot work on surface covered by preservative of unknown flammability
 - o Considered highly flammable if scrapings burn very rapidly.
2. Precautions required for hot work in way of highly flammable, hardened preservative coatings:
 - o Coatings to be stripped from hot work area
 - o Fire hose 1-1/2 inches or larger with fog nozzle to be uncoiled, under pressure, available for immediate use
 - Availability to be consistent with avoiding hose freezing.
3. Precautions for hot work in way of toxic preservative coatings:
 - o In enclosed spaces, toxic preservatives to be stripped for minimum of 4 inches around area of heat application
 - o Employees to wear approved air line respirators
 - o Filter-type cartridge respirators required for work in open air
 - o If preservative in enclosed space is soft and greasy, such as rudders, masts, cofferdams, following are required:



Lesson No.

40

Title

Welding, Cutting, and Heating (Continued)

Notes

Lesson Plan

- Competent person to test atmosphere for explosive vapors because these preservatives may have lower-than-expected flash point
- No hot work if vapors are detected until precautions taken to ensure safety
- Preservative coatings to be stripped from metal for sufficient distance to ensure temperature of unstripped metal does not rise appreciably
- Heat or flame shall not be used to remove coatings
- Artificial cooling of surrounding metal permissible to decrease size of area needed to be stripped
- No flame or heat to be used to strip soft and greasy coatings
- Competent person to test at outset, frequently during work to ensure no flammable vapors produced
- If flammable vapors detected, operation to cease until precautions taken to ensure safety of work.

V-40-11
Photo Slide:
HOLLOW METAL STRUCTURE

VIII. HOT WORK ON HOLLOW METAL CONTAINERS AND
STRUCTURES NOT COVERED BY 1915.11

A. Hazards

1. Principle hazard is penetration of high energy heat source
2. Pressure buildup from the ignition of flammable or combustible material



Lesson No.

40

Title

Welding, Cutting, and Heating (Continued)

Notes

V-40-12
Art Slide:
PRECAUTIONS FOR WELDING
ON A DRUM

V-40-13
Photo Slide:
SKEG AND BILGE KEEL

V-40-14
Photo Slide:
KING POSTS

V-40-15
Photo Slide:
BOOM

V-40-16
Photo Slide:
RUDDER

Lesson Plan

B. Requirements for Hot Work

1. Drums, containers, other hollow structures that contained flammables must be made safe before hot work
 - o Filled with water; or
 - o Cleaned, ventilated, and tested.
2. Vent or opening required in drum, container, hollow structure before applying heat
 - o Allows release of built-up pressure.
3. Competent person to inspect, test for flammables if necessary, and ensure object is safe before hot work on structural voids such as:
 - o Skegs
 - o Bilge keels
 - o Fair waters
 - o Masts and king posts
 - o Booms
 - o Support stanchions
 - o Pipe stanchions
 - o Railings
 - o Rudders.



Lesson No.

40

Title

Welding, Cutting, and Heating (Continued)

Notes

V-40-17
Photo Slide:
JACKETED PIPING

Lesson Plan

4. Objects such as those listed above also to be inspected for water, other non-flammable liquids that would build up excessive pressure when heated
 - o If such liquids present, object must be vented, cooled, otherwise made safe for hot work.
5. Jacketed vessels to be vented before hot work to release any pressure build up.



Lesson No. 41

Time 50 minutes

Title

Scaffolds, Ladders, and Other Working Surfaces

Objective

Upon completion of this lesson, the trainee will be able to discuss the various walking and working surfaces that shipyard workers will encounter and will be able to identify unsafe conditions and recommend the appropriate abatement.

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Lesson No.

41

Title

Scaffolds, Ladders, and Other Working
Surfaces

Technique	Content	Time
Lecture and Slides	I. Scaffolds and Staging	50 minutes
		Total Time: 50 minutes
Materials 43 Slides Slide Projector (35 mm) 1 Handout		
References U.S. Occupational Safety and Health Administration. "Safety and health standards for maritime employment." <u>Federal Register</u> , Vol. 39, No. 119 June 19, 1974.		



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H. Scaffold or Platform Planking	41-18
I. Backrails and Toeboards	41-18

VISUAL AIDS

V-41-1	Word Slide	Scaffold Materials
V-41-2	Art Slide	Lean-to and Shore Scaffolds
V-41-3	Photo Slide	Worker on Scaffold Suspended by a Crane (*)
V-41-4	Photo Slide	Shackle Block (*)
V-41-5	Photo Slide	Hook Without Mousing or Safety Clip
V-41-6	Word Slide	Requirements for Independent Pole Wood Scaffolds
V-41-7	Art Slide	Independent Pole Scaffold (Isometric View)
V-41-8	Word Slide	Other Requirements for Independent Pole Wood Scaffolds
V-41-9	Art Slide	Independent Pole Scaffold (End and Back Views)
V-41-10	Art Slide	Mobile Scaffold
V-41-11	Word Slide	Requirements for Independent Pole Metal Scaffolds
V-41-12	Photo Slide	Mobile Pole Scaffold
V-41-13	Photo Slide	Fixed Pole Scaffold (*)
V-41-14	Photo Slide	Fixed Pole Scaffold System (*)
V-41-15	Photo Slide	Positive Fastening Device between Upright and Cross Bracing (*)
V-41-16	Word Slide	Requirements for Wood Trestle and Extension Ladders
V-41-17	Art Slide	Swinging Scaffold
V-41-18	Word Slide	Requirements for Painter's Suspended Scaffolds
V-41-19	Art Slide	Ship-type Float Scaffold
V-41-20	Art Slide	Needle Beam-type Scaffold

VISUAL AIDS (Continued)

V-41-21	Art Slide	Horse Scaffold
V-41-22	Photo Slide	Fabricated Metal Scaffold (*)
V-41-23	Photo Slide	Mobile Tubular Scaffold (*)
V-41-24	Photo Slide	Tubular Scaffold, Single Unit (*)
V-41-25	Photo Slide	Tubular Scaffold, Double Unit (*)
V-41-26	Photo Slide	Fixed Scaffolds (*)
V-41-27	Photo Slide	Scaffolds Supported by Welded Brackets (*)
V-41-28	Photo Slide	Scaffold Suspended by Welded Brackets (*)
V-41-29	Photo Slide	Brackets Welded to Hull
V-41-30	Photo Slide	Scaffold Requirements Do Not Apply if Scaffold is Less Than 5 Feet Above Solid Surface (*)
V-41-31	Photo Slide	Defective Planking (*)
V-41-32	Photo Slide	Correct Planking Overlap (*)
V-41-33	Photo Slide	Planking Not Cleated Against Displacement (*)
V-41-34	Photo Slide	Planking - No Guard Rails (*)
V-41-35	Photo Slide	Railings on Ramp (*)
V-41-36	Photo Slide	No Rails Required While Working Less Than 5 Feet Above a Solid Surface
V-41-37	Photo Slide	Steel Rail (*)
V-41-38	Photo Slide	Platforms Without Railings
V-41-39	Photo Slide	Railings May Be Omitted (*)
V-41-40	Photo Slide	Work Vest Required (*)
V-41-41	Photo Slide	Railing Up Against Ship's Hull (*)
V-41-42	Photo Slide	Work Platform Subject to Swinging (*)
V-41-43	Photo Slide	Toeboards on Metal Scaffolds (*)

(*) For internal Department of Labor training purposes only.



HANDOUT

1. U.S. Bureau of Labor Standards. Maritime safety data: shipyard scaffolding. Washington, DC, U.S. Department of Labor [n.d.].



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41

Title
Scaffolds, Ladders, and Other Working
Surfaces

Notes

Handout 1
SHIPYARD SCAFFOLDING

V-41-1
Word Slide:
SCAFFOLD MATERIALS

Lesson Plan

I. SCAFFOLDS OR STAGING

A. General Requirements

1. Must be capable of supporting load they are designed to carry with minimum safety factor of 4
 - o Applies to scaffolds and supports whether of lumber, steel, or other materials.
2. Types of lumber allowed for scaffold construction:
 - o Spruce
 - o Fir
 - o Long leaf yellow pine
 - o Oregon pine
 - o Wood of strength equal to above.
3. Types of lumber prohibited:
 - o Hemlock
 - o Short leaf yellow pine
 - o Short fiber lumber.
4. Lumber dimensions in standards are nominal unless given in fractions of an inch



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V-41-2
Art Slide:
LEAN-TO AND SHORE
SCAFFOLDS

[The competent person must be knowledgeable about scaffold design and construction and hazards associated with work from scaffolds, and must have authority to take corrective action to abate these hazards.]

Lesson Plan

5. Requirements for all lumber used in scaffold construction:
 - o Sound
 - o Straight-grained
 - o Free from cross grain, shakes, and large, loose, or dead knots
 - o Free from dry rot, large checks, worm holes, other defects.
6. Scaffolds to be maintained safely, securely
 - o Any broken, burned, otherwise defective component to be replaced.
7. Following are prohibited from use as working platform or planking support:
 - o Lean-to and shore scaffolds
 - o Barrels
 - o Boxes
 - o Cans
 - o Loose bricks
 - o Other unstable objects.
8. Competent person must supervise scaffold erection, moving, dismantling, alteration
9. Hot work prohibited on staging suspended by fiber rope



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Notes

V-41-3

Photo Slide:
WORKER ON SCAFFOLD
SUSPENDED BY A CRANE

V-41-4

Photo Slide:
SHACKLE BLOCK

V-41-5

Photo Slide:
HOOK WITHOUT MOUSING
OR SAFETY CLIP

V-41-6

Word Slide:
REQUIREMENTS FOR
INDEPENDENT POLE WOOD
SCAFFOLDS

V-41-7

Art Slide:
INDEPENDENT POLE
SCAFFOLD (ISOMETRIC
VIEW)

[Use Word Slide to review
requirements and Art Slide
to point out component parts
which are being discussed.]

Lesson Plan

10. Lifting bridles on work platforms
suspended by cranes must meet
following requirements:

- o Have 4 legs
- o Be attached in a way that plat-
form is made stable
- o Attached by shackles to lower
lifting blocks or other posi-
tive means used to prevent
disengagement from crane hook
- Exception: if crane hook has
safety latch or is moused.

B. Independent Pole Wood Scaffolds

1. All pole uprights set plumb

- o Foundation to be sufficiently
large and strong to distribute
load, prevent displacement.

2. If light duty scaffold is 24 feet
in height or lower:

- o Poles may be spliced by over-
lapping ends at least 4 feet
- Must be securely nailed
together



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Scaffolds, Ladders, and Other Working
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Notes

Lesson Plan

V-41-8
Word Slide:
OTHER REQUIREMENTS FOR
INDEPENDENT POLE WOOD
SCAFFOLDS

V-41-9
Art Slide:
INDEPENDENT POLE
SCAFFOLD (END AND BACK
VIEWS)

- o Substantial cleat to be nailed to lower section, form support for upper section

- Exception: if bolt connections used.

3. All other poles to be spliced must be:

- o Squared at ends of each splice

- o Abutted

- o Rigidly fastened by at least 2 cleats

- To be nailed or bolted securely to poles

- Cleats to overlap each end by at least 2 feet

- Cleats same width as poles

- Cleat cross-sectional area to be at least that of the poles.

4. Requirements for ledgers:

- o Extend over 2 consecutive pole spaces

- o Overlap poles at each end by at least 4 inches

- o Left in position to brace poles as platform is raised during work



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[Use Word Slide to review requirements and Art Slide to point out component parts of an independent wood pole scaffold.]

V-41-10
Art Slide:
MOBILE SCAFFOLD

Lesson Plan

- o Must be level
- o Must be securely nailed or bolted to pole
- o To be placed against inside face of each pole.
- 5. Greater dimension of bearers to be set vertical
 - o Bearers also to extend beyond ledgers on which they rest
- 6. Bracing requirements:
 - o Diagonal bracing between parallel poles
 - o Cross bracing between inner and outer poles or from outer poles to ground.
- 7. Dimensions and spacing of members to conform with Table E-1 in 1915.68, 1916.68
- 8. Platform planking to conform with applicable requirements for planking in paragraph (h)
- 9. Backrails, toeboards to meet requirements of paragraph (i).
- C. Independent Pole Metal Scaffolds
 - 1. Maintained in good condition, no corrosion



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Scaffolds, Ladders, and Other Working
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Notes

V-41-11

Word Slide:

REQUIREMENTS FOR INDEPENDENT
POLE METAL SCAFFOLDS

V-41-12

Photo Slide:

MOBILE POLE SCAFFOLD

V-41-13

Photo Slide:

FIXED POLE SCAFFOLD

V-41-14

Photo Slide:

FIXED POLE SCAFFOLD SYSTEM

Lesson Plan

2. Fasteners to form positive connection
 - o Coupler, or
 - o Other locking device with no loose parts.
3. Posts to be kept plumb during erection
 - o Scaffold to be kept plumb and rigid with adequate bracing.
4. Posts to be fitted with braces supported on firm foundation
 - o Work to distribute load
 - o Braces to be fastened to sills if used.
5. Location of bearers:
 - o At each set of posts
 - o At each level
 - o At each intermediate level where there are working platforms.
6. Lengthwise and crosswise tubular bracing to be used as required
7. Planking to conform to paragraph (h)
8. Backrails and toeboards to conform to paragraph (i).



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Notes

V-41-15
Photo Slide:
POSITIVE FASTENING DEVICE
BETWEEN UPRIGHTS AND CROSS
BRACING

V-41-16
Word Slide:
REQUIREMENTS FOR WOOD
TRESTLE AND EXTENSION
LADDERS

Lesson Plan

D. Wood Trestle and Extension Trestle
Ladders

1. No trestle ladders, extensions, or
bases longer than 20 feet allowed
 - o Exception: total height of base
and extension may exceed 20 feet.
2. Minimum dimensions of side rails and
base sections:
 - o Ladders 16 feet long or less to
have side rails of at least
1 5/16 x 2 3/4-inch lumber
 - o Ladders over 16 feet and up to
20 feet long to have side rails
of at least 1 5/16 x 3-inch
lumber.
3. Requirements for side rails of exten-
sion section of extension trestle
ladder:
 - o Must be parallel
 - o Must have following dimensions:
 - Ladders 12 feet or less in
length to have side rails of
at least 1 5/16 x 2 1/4-inch
lumber
 - Ladders over 12 feet and up to
16 feet long to have side rails
of at least 1 5/16 x 2 3/4-inch
lumber



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Scaffolds, Ladders, and Other Working
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Notes

Lesson Plan

- Ladders over 16 feet and up to 20 feet long to have side rails of at least 1 5/16 x 2 3/4-inch lumber.
- 4. Spread of trestle at bottom of trestle or extension trestle ladders to be at least 5 1/2-inches per foot of ladder length
- 5. Width between side rails at bottom of trestle or extension trestle ladder to be at least 21 inches for ladders or sections 6 feet long or shorter
 - o If longer than 6 feet, width to increase one inch for each foot of length
 - o Width between side rails on extension sections to be at least 12 inches.
- 6. To limit spreading, top ends of side rails must be:
 - o Beveled, or
 - o Equivalent construction, and
 - o Provided with metal hinge.
- 7. Metal spreader or locking device to be component of each trestle or extension trestle ladder
 - o Holds front and back sections open
 - o Secures extension section in elevated position.



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Lesson Plan

V-41-17
Art Slide:
SWINGING SCAFFOLD

V-41-18
Word Slide:
REQUIREMENTS FOR PAINTER'S
SUSPENDED SCAFFOLDS

8. Requirements for rungs:

- o Parallel and level
- o Spaced at least 8 inches and no more than 18 inches apart on trestle ladder or base of extension trestle ladder
- o Spaced at least 6 inches and no more than 12 inches apart on extension sections.

9. Platform planking to meet requirements in paragraph (h)

- o Exception: Width of platform no greater than distance between siderails.

10. Backrails and toeboards to meet requirements in paragraph (i).

E. Painter's Suspended Scaffolds

1. Requirements for supporting hooks of swinging scaffolds:

- o To be equivalent in strength to mild steel or wrought iron
- o Forged with care
- o At least 7/8-inch in diameter
- o Anchored safely at all times.



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Lesson Plan

2. Requirements for supporting ropes of swinging scaffolds:
 - o Strength equivalent to first-grade 3/4-inch diameter manila rope
 - o Properly rigged into set of standard 6-inch blocks
 - At least one double and one single block.
3. Manila and wire ropes to be examined before use and as frequently as necessary during use to ensure safety
4. Each end of scaffold to be supported by stirrup or hanger
 - o Either mild steel or wrought iron
 - o To be supported in turn by suspension ropes.
5. Requirements for stirrups:
 - o Strength equivalent to 3/4-inch wrought iron
 - o Formed with horizontal bottom member to support platform
 - o Have means to support guardrail and midrail
 - o Have loop or eye at top to secure supporting hook on block.
6. Bridging distance between two or more swinging platforms with planks or other platform prohibited



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Lesson Plan

7. Two employees are maximum permitted at one time on scaffold built to minimum requirements
 - o If heavier construction used, number of employees who can work on scaffold depends on size, safe working load of scaffold.
8. Backrails and toeboards to meet requirements of paragraph (i)
9. Requirements for ladder-type platforms made of boards on horizontal ladder-type structure with parallel rails
 - o Side rails to be:
 - No more than 20 inches apart
 - As strong as beam of clear-grained spruce as required by Table E-2 in 1916.68, 1917.68
 - Tied together with rods at least 5/16-inch diameter, 5 feet or less apart, passed through rails, riveted tight against washers at both ends
 - Made with rungs of straight-grained oak, ash, hickory of at least 1 1/8-inches diameter with 7/8-inch tenons mortised mortised to side rails at least 7/8-inch, spaced 18 inches or less on centers
 - Made with flooring strips 5/8-inch apart or less, except at side rails where 1-inch spacing permitted, and
 - Cleated on underside.



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Notes

V-41-19
Art Slide:
SHIP-TYPE FLOAT
SCAFFOLD

V-41-20
Art Slide:
NEEDLE BEAM-TYPE SCAFFOLD

Lesson Plan

10. Requirements for plank-type platforms made of planks supported on stirrups or hangers:
 - o Planks to be made of at least 2 x 10-inch lumber
 - o Platform no more than 2 feet wide
 - o Cleats that tie planks together must be:
 - Made of lumber at least 1 x 6-inches
 - Nailed on undersides at intervals of 4 feet or less
 - o Planks extended at least 6 inches, no more than 18 inches beyond stirrups
 - o Cleat to be nailed across platform on underside at each end and outside stirrup to keep platform in stirrup
 - o Stirrup supports no more than 10 feet apart.
11. Requirements for beam-type platforms with side stringers and cross beams set on edge and spaced no more than 4 feet apart on which platform planks are laid:
 - o Side stringer requirements:
 - Made of sound, straight-grained lumber
 - No knots in lumber
 - At least 2 x 6-inch lumber set on edge



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Lesson Plan

- Supported on stirrups with clear span between stirrups of 16 feet or less
- Attached to stirrups with U-bolts passing through stirrups and bolted through stringers with nuts tight on inside face
- Ends of stringers to extend beyond stirrups at least 6 inches, no more than 12 inches at each platform end

- o Platform to be supported on 2 x 6-inch cross beams between side stringers nailed securely to beams and spaced 4 feet or less on centers

- o Platform to be 2 feet wide or less

- o Platform to be made of boards 7/8-inch x at least 6 inches, nailed tightly together, extending to stringers' outside face

- o Ends of platform boards to rest on top of cross beams, securely nailed, no cantilever ends at any intermediate point of platform.

V-41-21

Art Slide:

HORSE SCAFFOLD

F. Horse Scaffolds

1. Minimum dimensions prescribed in Table E-3 of 1915.68, 1916.68
2. Made of materials of equivalent strength, rigidity, security as horses made of lumber



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Scaffolds, Ladders, and Other Working
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Notes

V-41-22

Photo Slide:

FABRICATED METAL SCAFFOLD

V-41-23

Photo Slide:

MOBILE TUBULAR SCAFFOLD

V-41-24

Photo Slide:

TUBULAR SCAFFOLD, SINGLE UNIT

V-41-25

Photo Slide:

TUBULAR SCAFFOLD, DOUBLE UNIT

V-41-26

Photo Slide:

FIXED SCAFFOLDS

V-41-27

Photo Slide:

SCAFFOLDS SUPPORTED BY

WELDED BRACKETS

V-41-28

Photo Slide:

SCAFFOLD SUSPENDED BY

WELDED BRACKET

V-41-29

Photo Slide:

BRACKETS WELDED TO HULL

Lesson Plan

3. Lateral spread of legs to equal at
least one-third height of horse

4. Kept in good repair and always
properly secured

5. Platform planking to conform to
requirements in paragraph (h)

6. Backrails and toeboards to conform
to requirements in paragraph (i).

G. Other Types of Scaffolds

1. Scaffolds not covered by standards
to be made according to:

o Recognized principles of design

o Accepted standards covering such
equipment.



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Title
Scaffolds, Ladders, and Other Working
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Notes	Lesson Plan
V-41-30 Photo Slide: SCAFFOLD REQUIREMENTS DO NOT APPLY IF SCAFFOLD LESS THAN 5 FEET ABOVE SOLID SURFACE V-41-31 Photo Slide: DEFECTIVE PLANKING V-41-32 Photo Slide: CORRECT PLANKING OVERLAP V-41-33 Photo Slide: PLANKING NOT CLEATED AGAINST DISPLACEMENT V-41-34 Photo Slide: PLANKING - NO GUARD RAILS V-41-35 Photo Slide: RAILINGS ON RAMP	H. Scaffold or Platform Planking 1. Planking to be at least 2 x 10-inch lumber unless otherwise stated 2. Planing to be made of straight- grained lumber free from large or loose knots, either rough or dressed 3. Platforms to be at least two 10-inch planks in width - o Exception: if impossible because of vessel structure or width of trestle ladders. 4. Planking to project at least 6 inches, no more than 12 inches beyond support- ing members - o Exception: if planks are fastened to supporting members. 5. Table E-4 in 1915.68, 1916.68 to guide determination of planks' safe load. I. Backrails and Toeboards 1. Top rail with upper surface 42 to 45 inches above platform surface and midrail halfway between top rail and platform required for:



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Notes

V-41-36
Photo Slide:
NO RAILS REQUIRED
WHILE WORKING UNDER
5 FEET ABOVE A SOLID
SURFACE

V-41-37
Photo Slide:
STEEL RAIL

V-41-38
Photo Slide:
PLATFORMS WITHOUT RAILINGS

V-41-39
Photo Slide:
RAILINGS MAY BE OMITTED

V-41-40
Photo Slide:
WORK VEST REQUIRED

V-41-41
Photo Slide:
RAILING UP AGAINST SHIP'S
HULL

Lesson Plan

- o Scaffolds, staging, runways,
working platforms more than
5 feet above solid surface
- o Any distance above water.
- 2. Rails to be made of:
 - o 2 x 4-inch lumber, or
 - o Flat bar, or
 - o Pipe, or
 - o Taut wire or rope if used with
rigid supports.
- 3. Rails must be equivalent in strength
to 2 x 4-inch lumber if supports more
than 8 feet apart
- 4. Rails to be firmly secured
- 5. Rope rails prohibited if hot work or
chemicals used
- 6. Rails may be omitted if vessel
structure prevents use
 - o If omitted and employees work more
than 5 feet above solid surface,
must wear appropriate safety belts,
life lines
 - o If omitted and employees work over
water, must wear appropriate
buoyant work vests.
- 7. Employees to be protected from falling
toward vessel by railing or safety
belt and life line attached to back-
rail if:



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Title Scaffolds, Ladders, and Other Working
Surfaces

Notes

V-41-42
Photo Slide:
WORK PLATFORM SUBJECT
TO SURGING

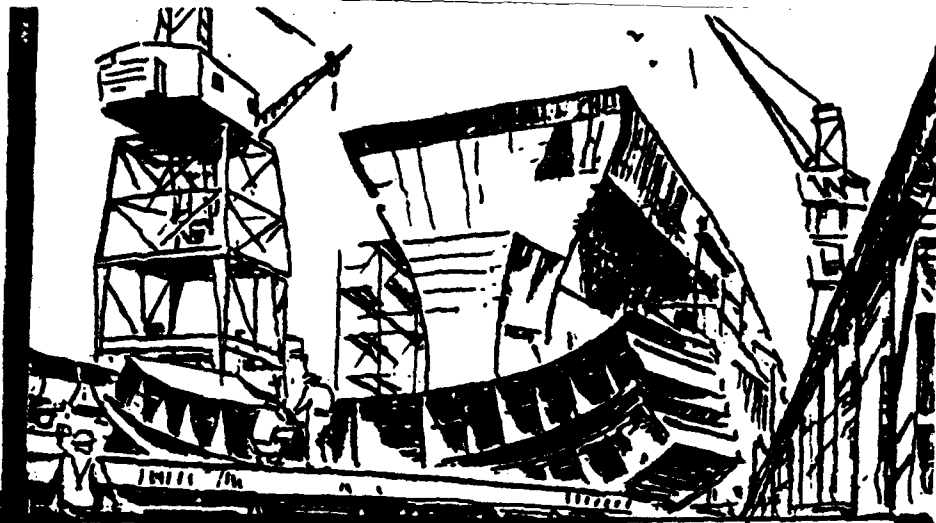
V-41-43
Photo Slide:
TOEBOARDS ON METAL SCAFFOLD

Lesson Plan

- o Working from swinging scaffolds
triced out of vertical line below
supports; or
- o Working from scaffolds or paint
floats subject to surging.
- 8. Toeboards of at least 1 x 4-inch
lumber required when necessary
- o To prevent tools, materials from
falling on employees below.

Maritime Safety Data

FOR SHIPYARDS



FILE WITH

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MSD LS-74

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10.65

The data in this presentation are devoted to promotion of safety in typical hazardous areas of ship repairing, shipbuilding, and shipbreaking operations.

SHIPYARD SCAFFOLDING

U. S. DEPARTMENT OF LABOR
Bureau of Labor Standards
Washington, D. C. 20210

- LESSON 41

HANDOUT 1

INTRODUCTION

The many types of scaffolding in use in the large and small shipyards throughout the country have been a contributory factor in the number of accidents which have occurred in these shipyards.

An analysis of these accidents which have occurred over the past 5 years has revealed that only a few of these accidents were due to structural failure. The large majority occurred because of improper erection; missing backrails, stanchions, and planking; or unsafe acts of employees, such as using jury rigs or taking shortcuts from one level to another.

This data sheet describes the various types of scaffolding and their proper erection and maintenance. In addition, suggested safe work practices are listed for the employees.

The Safety and Health Regulations covering the general requirements for scaffolding are also included.

This data sheet was prepared by Roland Belanger, Division of Maritime Safety, Bureau of Labor Standards, U. S. Department of Labor.

I. Types of Scaffolding, Their Construction and Use

A. Independent Pole

The American Standard Safety Code for Building Construction describes this type of scaffolding as follows: "A scaffold supported from the base by a double row of uprights, independent of support from the walls and constructed of uprights, ledgers, horizontal platform bearers, and diagonal bracing."

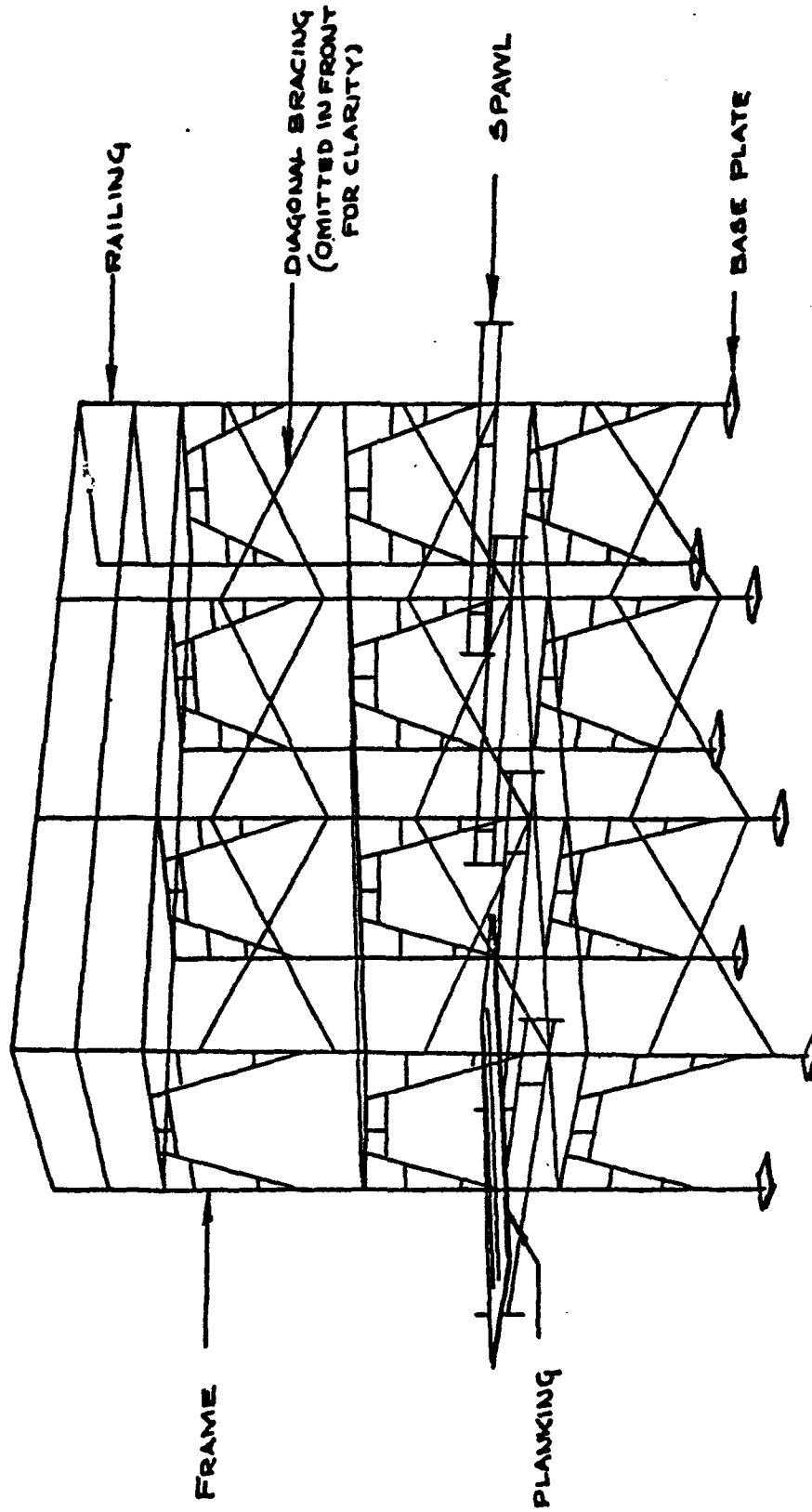
The independent or double-pole scaffold is one of the most common types used in shipyards. Some form of this type is used in most of the repair and building yards throughout the country. (See figure 1.)

Supporting poles for the double-pole scaffold vary in different shipyards. Some of these are: steel channel, wooden individual uprights, built-up pipe members, and fabricated steel towers up to 100 feet in height. In extensive repair work on the hull of a ship, or in new construction work, many yards use latticed channel uprights in heights from 60 to 80 feet with wide supporting bases. Crossmember bearers are run through openings in the uprights.

The erection of the double-pole scaffold should begin with a solid base. Pole uprights should be set plumb and should rest on a foundation of sufficient size and strength to distribute the load and to prevent displacement. Diagonal bracing should be provided between the poles, and cross bracing should be provided between the inner and outer poles.

The working platform for this type of scaffold, along with other types, is usually a 3- by 12-inch nominal size wood planking of spruce or fir in lengths from 14 to 24 feet. Planks should not be less than 2 by 10 inches in size, and the entire width of the platform should not be less than that of two 10-inch planks. Another important consideration is the hazard of planking that extends too far beyond the supporting members. Platform planking should project beyond the supporting members at either end by no more than 12 inches unless the planks are fastened to the supporting members.

An all too familiar sight in many yards is the independent pole scaffold or, for that matter, any type of scaffold that meets all erection requirements except for backrails. If the work platform is more than 5 feet above a solid surface or is over water, a railing which has a top rail whose upper surface is from 42 to 45 inches above the upper surface of the platform and a midrail should be provided.



DOUBLE-POLE SCAFFOLD

3 SECTIONS - 3 TIERS

Figure 1

The sectional metal tubular scaffold is the most popular type used in shipyards and can be considered a form of the double-pole scaffold. Towers up to 60 feet high can be erected quickly by assembling these sections. A tier of this scaffold consists of two ladder-type end frames which are bridged top and bottom by removable pipe sections. Toggle pins are used to tie the four sections into one unit and also to lock unit tiers together. Each side is strengthened by cross bracing fore and aft, fastened by a locking device which prevents this diagonal bracing from coming free. To permit adjustment of the scaffold height, frames are usually made in 5- and 3-foot lengths. The built-in ladder permits easy access to any part of the erected towers, and the rungs provide support for intermediate staging levels. The sectional metal tubular scaffold can be used in a variety of jobs, such as work on the hull of a vessel in drydock, work on the superstructure, housing, bulkheads, masts, or anywhere that permits the erection of the base tier. This type is also used frequently and to good advantage in hard-to-get-at high places, such as the deckhead in the cargo spaces of a tanker. On this job, the alternative method of providing a work platform would require the difficult and sometimes hazardous work of hanging a suspended scaffold.

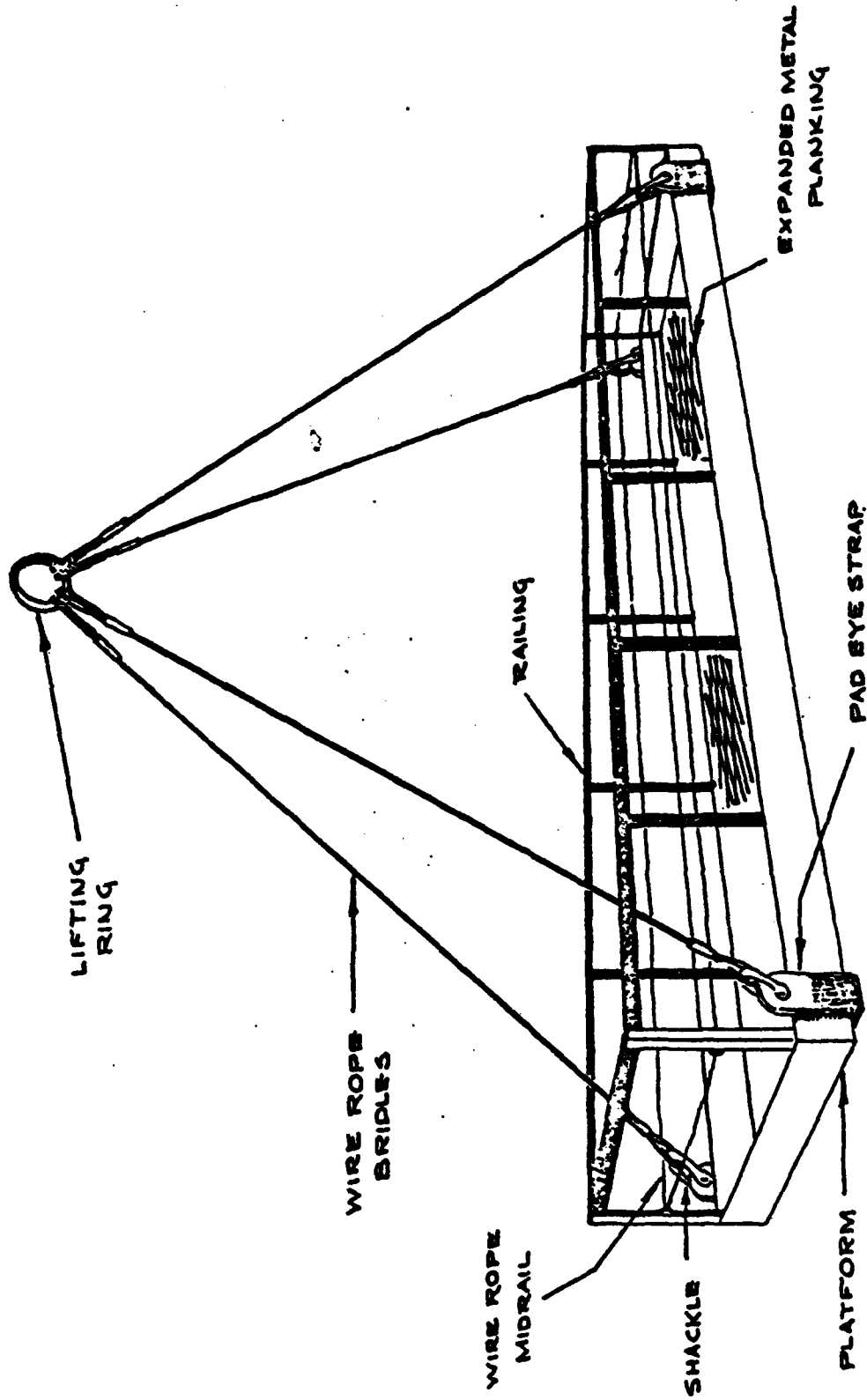
B. Suspended Scaffold

The term "suspended" or "swinging" scaffold can apply to any type of work platform that is suspended or hung by means of a manila line, wire rope, block and tackle, or other hoisting device from the overhead, beam, mast, crane, or from the ship's housing or hull. (See figure 2.)

If a choice can be made, a scaffold built up from a solid surface should be used rather than the suspended scaffold. When a suspended work platform is used, circumstances usually dictate that this is the only way the job could be done. For instance, in an emergency job or one of short duration on the hull, a work platform or "basket" suspended by a crane is often used. In using this crane-suspended work platform, in addition to having the proper guardrails and meeting the other requirements for a suspended scaffold, such as using a 4-legged bridle to assure stability, it is recommended that a tag line be used to further steady the platform and to keep it in position.

Another type is the suspended scaffold, often referred to as a painter's suspended scaffold. In this type, two 2- by 10-inch or 2- by 12-inch planks 8 to 16 feet long are secured together by battens.

These planks are supported at each end by a wrought-iron or mild steel stirrup or hanger. The suspension rope, supporting the scaffold,



SUSPENDED SCAFFOLD
(FROM CRANE)

Figure 2

can be of manila or wire rope, and should be equivalent in strength to first grade 3/4-inch diameter manila rope properly rigged into a set of, one double and one single, standard 6-inch blocks. The stirrup should be provided with means to support the guardrail and midrail, and should have an eye at the top for securing the supporting block.

Besides the types mentioned, a variety of other types of suspended scaffolding is used by shipyards. One type consists of a work platform made of expanded metal supported by wrought iron or mild steel crossmembers which are suspended by wire rope cable. Sockets provided on the platform permit stanchions for backrails to be erected. Many yards have devised their own type of work platform that is designed to be used as a suspended scaffold. These platforms are suspended by block and tackle, wire rope, or by a crane. The wire rope suspension cable is overhauled by hand or by powered winches. When using any type of suspended scaffold, care should be taken that suspension lines are protected from sharp edges. Manila and wire ropes should be examined carefully before each operation and as frequently as necessary to ensure their safe condition during the job. Welding or burning should not be permitted on any scaffolding suspended by fiber rope.

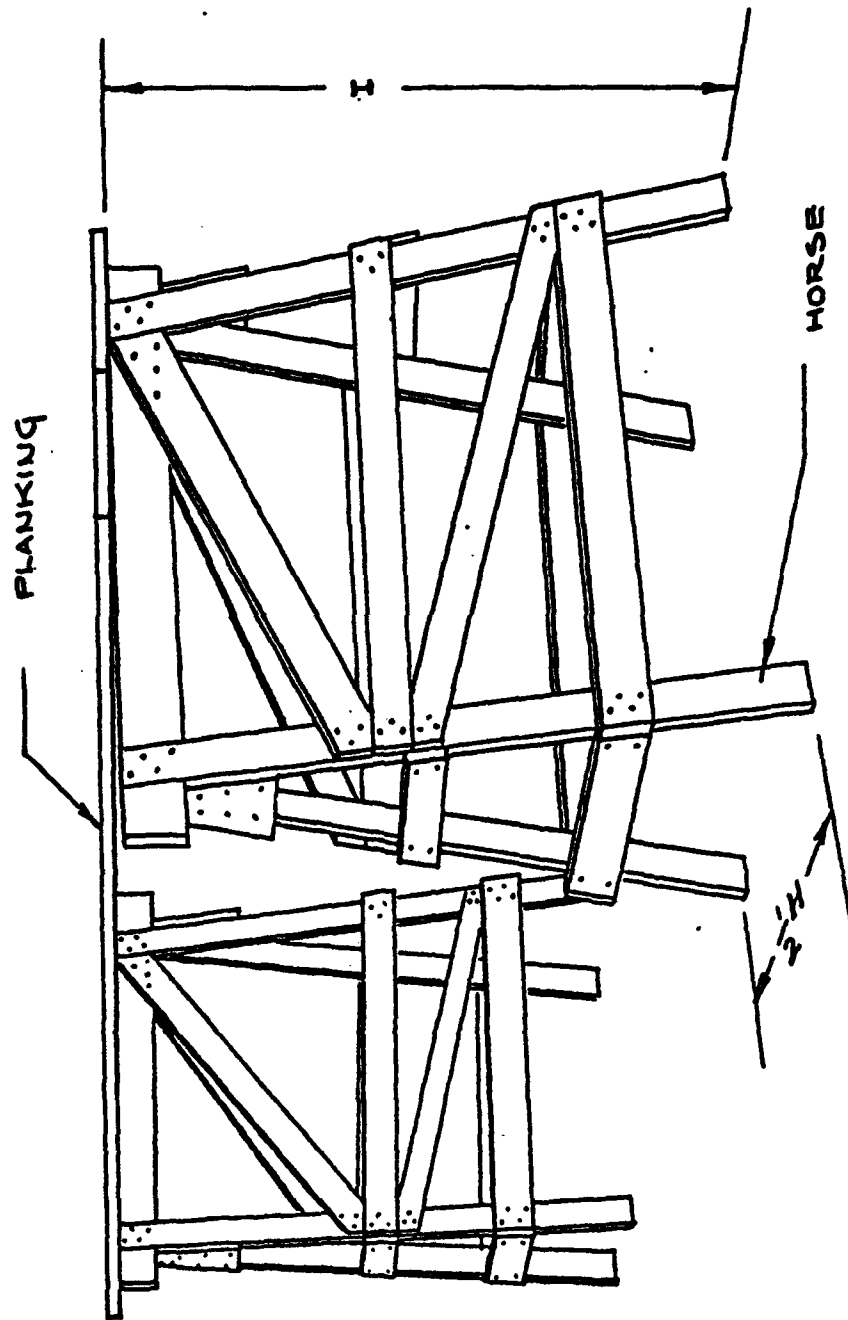
A limitation with this type is often the erection itself. As mentioned in the previous section, the alternative to using any type of built-up scaffolding for work on the deckhead in the cargo space of a tanker would be the hanging of a work stage. This would necessitate sending riggers aloft, using long extension ladders, or using other means to thread cable through holes in the beams. In some cases, it would be necessary to burn holes in the beams or to install beam clamps, thereby increasing the number of employees exposed to the hazard.

Many accidents involving the use of suspended scaffolding occur during shifting or rerigging the work platform. Men who work with suspended scaffolding should be thoroughly familiar with the mechanics of raising and lowering the staging.

Man lifts, personnel baskets, and tower lifts are other elevating devices that carry men and materials from one level to another. They are operated by electric, pneumatic, or hydraulic hoisting engines. Here, again, the operators of these devices should be familiar with the control mechanisms and their safety features in order to operate them safely.

C. Horse Scaffolds

Horse scaffolds can be made by laying planking across staging horses which act as supports. (See figure 3.) Horses range in size from



HORSE SCAFFOLD

Figure 3

the common 3- or 4-foot saw horse to the A-frame type horse 10 to 16 feet in height. Horse scaffolds are usually used for overhead work in tween deck spaces, work on the hull of small vessels and barges in dry-dock, on marine railways, and for tail shaft, wheel, and rudder jobs.

Horses used for scaffolding should always be solidly constructed and should rest upon a firm and level foundation. Because of the lack of cross bracing between horses, this scaffold is less solid and stable than other types, such as the pole scaffold. Setting up a horse scaffold to work on the hull of a vessel on a marine railway presents a particular problem because the ground is soft or soggy. When it becomes necessary to extend the legs of a horse, do so with sound, strong material. The work should be done carefully and the legs should be adequately spliced at the joints to develop the proper strength. Horses between 10 and 16 feet high should be provided with additional cross braces to prevent racking. The practice of erecting successive tiers of horses is not recommended. But if it is necessary to do so, erect them no more than three tiers high. The total height of a horse scaffold should not exceed 16 feet. Platform planking and backrails should be the same as those required for the independent pole scaffold.

Barrels, boxes, cans, loose bricks, or other unstable objects are used sometimes as a substitute for horses to support work platform planking. This practice has led to many falls and injuries and should not be permitted. Strict prohibition of this practice will also prevent welders and burners from using empty or partially empty barrels containing flammable vapors as supports to stand on or for planking.

D. Other Types of Scaffolding

1. Hull Scaffolding

Hull scaffolding is generally used when scaffolding cannot be built up from the floor or deck. The work platform is supported by a welded triangular brace which is secured to the hull or bulkhead. One method used in erecting this type is to weld a slotted clip to the hull for inserting and attaching the ends of the angle brace. Another method is to weld the brace directly to the bulkhead itself. A spud piece is usually welded to the outer end of the brace to hold pipe stanchions and permit the erection of backrails. This type of scaffolding is particularly suited to work done at a fixed level on the hull or stack. While this type is used mostly on the hull, it is also ideal for working on small bulkhead repairs and other types of work which require a small staging and where the welded bulkhead clips need not be removed. Using this type of scaffold eliminates climbing and working from high ladders.

It is apparent that the strength of this type of scaffolding depends almost entirely on the weld holding the clip or the brace. Therefore, particular attention should be paid to the soundness and extent of the weld. (See figure 4.)

2. Adjustable Hull Scaffolding

The adjustable hull scaffold is used by some yards for extensive hull work that is done at different levels. The supporting brackets or braces, similar to those mentioned, are inserted into vertical metal spawls which are secured to the ship's fishplate and then hung over the side. Slotted holes running the length of the spawl permit the work platform to be installed at varying levels. (See figure 5.)

3. Single-Pole Scaffold

Another type, which can be considered hull scaffolding, is the single-pole scaffold. The American Standard Safety Code for Building Construction defines single-pole scaffolding as follows: "A platform resting on putlogs or crossbeams, the outer ends of which are supported on ledgers secured to a single row of posts or uprights and the inner ends on a wall or holes in a wall." The inner ends of the crossbeams must be secured by clips or by other means. Requirements for this type, such as the work platform and backrails, are the same as those for the independent-pole scaffold.

While not frequently used in shipyards, the single-pole scaffold is used occasionally for work on the vessel's housing or superstructure, particularly on smaller vessels.

4. Floating Scaffolds

For work on the hull of a vessel afloat, independent pole-type scaffolding built up on, and secured to, a work barge or pontoon is often used. In addition to following the general requirements for wood-pole and tubular-pole scaffolding, consideration should be given to the construction of a floating scaffold that will ensure adequate rigidity under sudden surges, such as those caused by swells, waves, or by the wake of a passing vessel. The combined center of gravity of the barge and scaffold should be kept as low as possible, and the barge should have a minimum of 1 foot of freeboard. While the work barge is being shifted from one location to another, men should not remain on the scaffold work platforms. When the floating scaffold is being used between two vessels or between the pier and the ship, "camels" or "fenders" built wider than the barge should be provided to prevent crushing the barge. When the barge is in the vicinity of the ship's

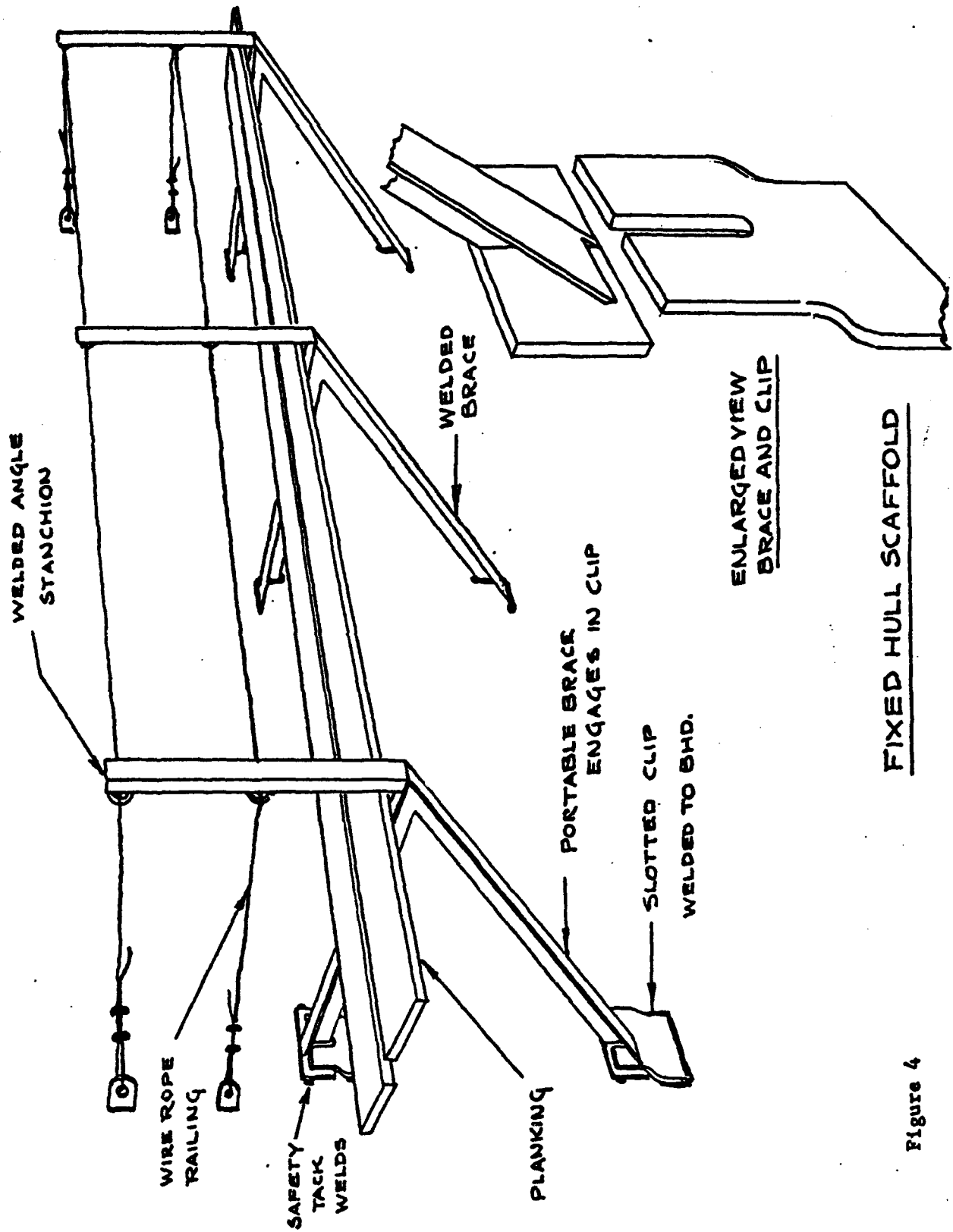
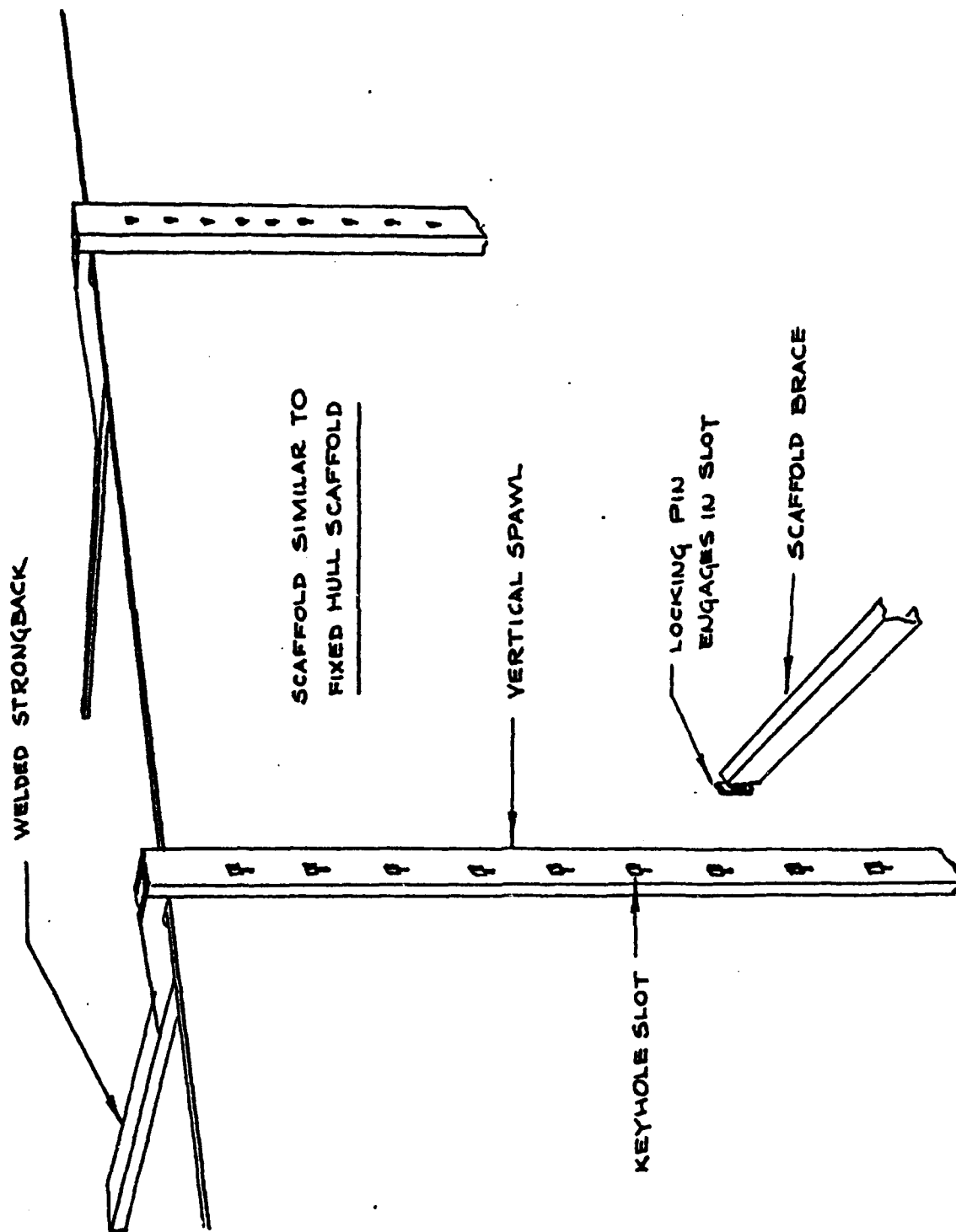


Figure 4



ADJUSTABLE HULL SCAFFOLD

Figure 5

propeller, a warning sign should be hung in a conspicuous location in the engine room calling attention to this fact. The sign should not be removed until it is determined that the work is completed and the floating scaffold is clear of the propeller.

E. Access to Scaffolding

A safe means of access should be provided when erecting a safe work platform. Scaffolds often are erected in accordance with all construction requirements except a means of access to the platform levels. Access from below to staging should consist of well-secured stairways, cleated ramps, or fixed or portable ladders. Ladders should be located so employees will step no more than 1 foot from the ladder to any intermediate landing or platform. Access from above to staging more than 3 feet below the point of access should consist of a straight portable ladder or a Jacob's ladder properly secured. Ladders which form an integral part of the scaffold, such as those built onto the tubular sectional type, would eliminate the need for any of the means of access just mentioned.

II. Erection of Scaffolding

Anyone erecting a scaffold assumes a responsibility for the safety of the men who are to use it, including himself. Everytime someone goes up on a scaffold, he is staking his life and limb on its soundness. There should be no doubt in anyone's mind that the scaffold is well constructed and is safe in all respects.

While the need for a good scaffold is usually recognized when work is to be done at a great height, it is often not recognized for work at lower levels. A fall from a 5-foot height can result in an injury as serious as one from a 20-foot fall. Safety instruction and education should point out the hazards of such unsafe practices as using empty kegs, cans, boxes, and other unsound supports.

The following list of recommended practices for erecting scaffolding should be followed:

1. Allow only experienced men who are thoroughly familiar with the various types of scaffolding to erect or dismantle them.
2. Use the right scaffold for the job. A light-duty scaffold should not be used when heavy equipment or material will be loaded on it.
3. Only components, such as locking devices designed for the type of scaffold, should be used.

4. When erecting wood-pole scaffolding, always drive the nails in all the way. The structure is weakened by leaving nail heads protruding. The use of double headed nails will keep damage to a minimum when the scaffold is dismantled.
5. Follow safe load capacities for each prefabricated scaffold, as given by the manufacturer. Research companies spend many years and dollars to determine maximum capacities. To exceed these rated capacities is foolhardy.
6. The scaffold and its components, such as stanchions and backrails, should be thoroughly checked visually before allowing men to work on it.
7. Use bracing at all points provided; and, when in doubt, add extra bracing to ensure more rigidity and stability.
8. As a fire prevention measure, the amount of wood scaffolding used inside a vessel should be held to a minimum. Combustible scaffolding material should be removed from the inside as soon as its purpose has been served. Combustible scaffolding components should be treated with an approved flame-retardant compound to resist ignition from sparks and to retard the spread of fire.
9. In assigning a job to be performed at an elevated location, the supervisor should personally make sure that a safe work platform is provided. He should not assume that his men will obtain or erect the proper work platform on their own.
10. A scaffold which has been partially dismantled or otherwise weakened should not be used as a work platform, even for a job operation of short duration.
11. Yard safety rules and departmental procedures governing the issuance, erection, and use of all types of scaffold equipment should be observed and followed faithfully.
12. When dismantling scaffolds, it is particularly important that diagonals remain in place as long as possible to prevent folding of the structure.

III. Maintenance of Scaffolding

In order to maintain scaffolding and its components in good condition, a scheduled preventive maintenance program should be established and

carried out. A good maintenance program is essential to provide a safe working environment which will produce efficient production.

In addition to a preventive maintenance program which calls for periodic inspections and repairs, checks should be made regularly by the safety director, his assistants, and the appropriate supervisors on the condition of prefabricated scaffolding, before, during, and after its use. The following is a list of recommended preventive maintenance procedures:

1. Dirt and grime should be cleaned from threaded studs of brace locks. Use grease or other lubricants on threads to keep securing nuts running free.
2. Bent legs of tubular-type scaffolding should be straightened so that insert or coupling pins can be seated fully or withdrawn without binding.
3. Rust and scale should be removed and frames and braces repainted where needed.
4. If through damage or mistreatment metal scaffolding is damaged and needs to be welded, it should be withdrawn from use and repaired by electric arc welding.
5. All rollers, as well as screw-type leveling jacks, should be inspected periodically. Dirt and grime should be removed and the parts lubricated.
6. Lumber used for scaffolding should be set aside and stored when not in use; it should be protected from the weather to avoid warping, cracking, and splitting.
7. Planking should not be painted over, as this will conceal defects.
8. When dismantling wood scaffolds, all nails should be immediately withdrawn from the lumber.
9. Scaffolding sections that cannot be repaired should be immediately removed or destroyed to avoid the possibility of being reused.
10. Repairs should be made by qualified employees only.

IV. Safe Work Practices

Standards, codes, and regulations have been developed that spell out how each type of scaffold should be built to make it safe. However, scaffolds that have been built to meet all specifications will not provide protection to employees who commit unsafe acts while working on them. Supervisors and employees should be instructed in, and regularly reminded about, the do's and don'ts of working safely on all kinds of scaffolding. The following recommendations on safe work practices should be followed. For the most part, these recommendations represent just plain common sense.

1. Skylarking or clowning has no place on scaffolding and should not be tolerated.
2. Employees who show nervousness or fear of heights should not be sent aloft on high scaffolding.
3. Employees should familiarize themselves with their surroundings on high scaffolding before starting work.
4. Men should not reach out or hang precariously to perform a job. The work platform should be erected so all parts of the work can be reached easily.
5. Shortcuts should not be taken in climbing up or down to the work platform of the scaffold. Only reliable ladders or trestle rungs built as part of the scaffold should be used as a means of access to the work platform.
6. When pulling or pushing on an object, do so with care to maintain a proper balance--the object might come free suddenly.
7. Scaffolding of any kind should not be moved or rolled while employees are on it.
8. Employees should be urged to keep scaffolds clean and free of debris, loose tools, and materials to avoid tripping hazards.
9. When material is dropped from an elevated working area, such as a scaffold, the area below should be roped off, or signs posted, warning men on the lower level of the hazard.
10. Welding cable and burning hose should be run along back-rails and not allowed to clutter the walking and working surfaces of scaffolding.

11. When backrails have been temporarily removed, precautions should be taken to prevent other crafts from working on that scaffolding until the backrails are replaced.

V. Regulations on Scaffolding - General Requirements

Sections 1501.41 and 1502.41 of the Safety and Health Regulations for Ship Repairing and Shipbuilding give the requirements for scaffolding. Since space does not permit listing the entire subpart dealing with the various types of scaffolding, only some of the general requirements are listed here.

1. Section .41(a)(1) states that all scaffolds and their supports, whether of lumber, steel, or other material, shall be capable of supporting the load they are designed to carry with a safety factor of not less than four (4).
2. Section .41(a)(2) states that all lumber used in the construction of scaffolds shall be spruce, fir, longleaf yellow pine, Oregon pine or wood of equal strength. The use of hemlock, shortleaf yellow pine, or short fiber lumber is prohibited.
3. Section .41(a)(4) states that all lumber used in the construction of scaffolds shall be sound, straight-grained, free from cross grain, shakes and large, loose or dead knots. It shall also be free from dry rot, large checks, worm holes, or other defects which impair its strength or durability.
4. Section .41(a)(5) states that scaffolds shall be maintained in a safe and secure condition. Any component of the scaffold which is broken, burned or otherwise defective shall be replaced.
5. Section .41(a)(6) states that barrels, boxes, cans, loose bricks or other unstable objects shall not be used for the support of planking intended as scaffolds or working platforms.
6. Section .41(a)(7) states that no scaffold shall be erected, moved, dismantled or altered except under the supervision of competent persons.
7. Section .41(a)(8) states that no welding, burning, riveting or open flame work shall be performed on any staging suspended by means of fiber rope.

8. Section .41(a)(9) states that lifting bridles on working platforms suspended from cranes shall consist of four legs so attached that the stability of the platform is assured.

9. Section .41(a)(10) states that unless the crane hook has a safety latch or is moused, the lifting bridles on working platforms suspended from cranes shall be attached by shackles to the lower lifting block or other positive means shall be taken to prevent them from becoming accidentally disengaged from the crane hook.

10. Section .41(h)(1) states that platform planking shall be of not less than 2 x 10 inch lumber. Platform planking shall be straight-grained and free from large or loose knots and may be either rough or dressed.

11. Section .41(h)(2) states that platforms of staging shall be not less than two 10-inch planks in width except in such cases as the structure of the vessel or the width of the trestle ladders make it impossible to provide such a width.

12. Section .41(h)(3) states that platform planking shall project beyond the supporting members at either end by at least 6 inches but in no case shall project more than 12 inches unless the planks are fastened to the supporting members.

13. Section .41(i)(1) states that scaffolding, staging, runways, or working platforms which are supported or suspended more than 5 feet above a solid surface, or at any distance above the water, shall be provided with a railing which has a toprail whose upper surface is from 42 to 45 inches above the upper surface of the staging, platform, or runway and a mid-rail located halfway between the upper rail and the staging, platform, or runway.

14. Section .41(i)(2) states that rails shall be of 2 x 4 inch lumber, flat bar or pipe. When used with rigid supports, taut wire or fiber rope of adequate strength may be used. If the distance between supports is more than 8 feet, rails shall be equivalent in strength to 2 x 4 inch lumber. Rails shall be firmly secured.

15. Section .41(i)(3) states that rails may be omitted where the structure of the vessel prevents their use. When rails are omitted employees working more than 5 feet above solid surfaces shall be protected by safety belts and life lines meeting the requirements of Section 1501.84(b), and employees

working over water shall be protected by buoyant working vests meeting the requirements of Section 1501.84(a).

The other sections of the regulations for ship repairing, shipbuilding, and shipbreaking dealing with scaffolding should be studied so that their intent and requirements are followed accordingly.



Lesson No. 42

Time 50 minutes

Title

Scaffolds, Ladders, and Other Working Surfaces (Continued)

Objective

Upon completion of this lesson, the trainee will be able to discuss the various walking and working surfaces that shipyard workers will encounter and will be able to identify unsafe conditions and recommend the appropriate abatement.

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Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Technique	Content	Time
Lecture and Slides	I. Scaffolds and Staging (Continued)	10 minutes
	II. Guarding Deck Openings and Edges	10 minutes
	III. Access to Vessels	10 minutes
	IV. Access to and Guarding of Dry Docks and Marine Railways	10 minutes
	V. Access to Cargo Spaces and Confined Spaces	5 minutes
	VI. Other Working Surfaces	5 minutes
		Total Time: 50 minutes

Materials

53 Slides
Slide Projector (35 mm)
1 Handout

References

U.S. Occupational Safety and Health Administration. "Safety and health standards for maritime employment." Federal Register, Vol. 39, No. 119, June 19, 1974.



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VISUAL AIDS

V-42-1	Photo Slide	Staging Without Access (*)
V-42-2	Photo Slide	Staging with Bridged Tré ^l stle (*)
V-42-3	Photo Slide	Railings on Access to Staging (*)
V-42-4	Photo Slide	Staging with Access from Above (*)
V-42-5	Photo Slide	Defective Ladder (*)
V-42-6	Photo Slide	Portable Ladder Lashed at Top (*)
V-42-7	Photo Slide	Portable Folding Ladder (*)
V-42-8	Photo Slide	Rails of Ladder 3 Feet Above Level (*)
V-42-9	Photo Slide	Wood Ladder Used Unsafely (*)
V-42-10	Photo Slide	Improper Storage of Wood Ladders (*)
V-42-11	Word Slide	Requirements for Portable Wood Cleated Ladder
V-42-12	Art Slide	Shop-made Ladder
V-42-13	Photo Slide	Wood Cleated Ladder
V-42-14	Photo Slide	Width of Ladder
V-42-15	Photo Slide	Secured Cleats with Filler Blocks (*)
V-42-16	Photo Slide	Ladder as Access to Barge (*)
V-42-17	Photo Slide	Ladder Width (*)
V-42-18	Photo Slide	Cleats and Side Rails (*)
V-42-19	Photo Slide	Flush Deck Hole (*)
V-42-20	Photo Slide	Poorly Guarded Deck Opening
V-42-21	Art Slide	Standard Guardrail and Toeboard
V-42-22	Photo Slide	Large Deck Opening (*)
V-42-23	Photo Slide	Guarded Deck Edges (*)
V-42-24	Photo Slide	Employee on Unguarded Edge Without Life Vest (*)

VISUAL AIDS (Continued)

V-42-25	Photo Slide	Floor Gratings Removed (*)
V-42-26	Photo Slide	Floor Gratings Replaced by Wood Deck (*)
V-42-27	Photo Slide	Walkway Surface Provided (*)
V-42-28	Photo Slide	Ladder Section Replaced with Inadequate Ladder (*)
V-42-29	Photo Slide	Gangway to Floating Dry Dock (*)
v-42-30	Photo Slide	Gangway (*)
V-42-31	Photo Slide	Ladder Way to Vessel
V-42-32	Photo Slide	Jacob's Ladder (*)
V-42-33	Photo Slide	Jacob's Ladder Rungs (*)
V-42-34	Photo Slide	Railings on Gangway (*)
V-42-35	Photo Slide	Cleated Duckboards Not Used (*)
V-42-36	Photo Slide	Net Under Gangway
V-42-37	Photo Slide	Steps Required When Gangway Rests on Bulwark
V-42-38	Photo Slide	Access Between Vessels (*)
V-42-39	Photo Slide	Unsafe Walkway Between Ramp and Barge (*)
V-42-40	Photo Slide	Access Between Dry Dock and Pier
V-42-41	Photo Slide	Permanent Stairway on Dry Dock (*)
V-42-42	Photo Slide	Railing on Dock Edge (*)
V-42-43	Photo Slide	Railings on Wing Wall (*)
V-42-44	Photo Slide	Railings on Floating Dry Dock (*)
V-42-45	Photo Slide	Stanchion on Dry Dock (*)
V-42-46	Photo Slide	Access Between Wing Wall and Dry Dock Floor (*)
V-42-47	Photo Slide	Ladder to Confined Space (*)
V-42-48	Photo Slide	Fixed Ladder to Confined Space (*)

VISUAL AIDS (Continued)

V-42-49	Photo Slide	Ventilation to Confined Spaces (*)
V-42-50	Photo Slide	Employee in Boiler (*)
V-42-51	Photo Slide	Employee on Scaffold
V-42-52	Photo Slide	Employee with Restricted Vision
V-42-53	Photo Slide	Work in Restricted Area (*)

(*) For internal Department of Labor training purposes only.



HANDOUT

1. U.S. Bureau of Labor Standards. Maritime safety data: ladders and other means of access used on vessels in shipyards. Washington, DC, U.S. Department of Labor [n.d.].



Lesson No. 42

Title Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes	Lesson Plan
V-42-1 Photo Slide: STAGING WITHOUT ACCESS V-42-2 Photo Slide: STAGING WITH RIGID TRESTLE V-42-3 Photo Slide: RAILINGS ON ACCESS TO STAGING V-42-4 Photo Slide: STAGING WITH ACCESS FROM ABOVE	I. SCAFFOLDS AND STAGING (Continued) J. Access to Staging 1. If staging more than 5 feet above floor, deck or ground, access must be: - o Well secured stairway, or - o Cleated ramp; or - o Appropriate fixed or portable ladder (1915.42, 1916.42, 1917.42); or - o Rigid-type non-collapsible trestle - Must have parallel, level rungs. 2. 36-inch handrails with mid-rails required on ramps, stairways 3. Ladders located or other preventive measures taken so that distance between ladder and intermediate landing or platform is one foot or less 4. Requirements apply to ladders that are integral parts of prefabricated staging 5. Access from above to staging more than 3 feet below must be: - o Appropriate straight, portable ladder (1915.42, 1916.42, 1917.42); or - o Properly secured Jacob's ladder (1915.44(d), 1916.44(d), 1917.44(d)).



Lesson No. 42

Title Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

Handout 1
LADDERS AND OTHER MEANS
OF ACCESS USED ON VESSELS
IN SHIPYARDS

V-42-5
Photo Slide:
DEFECTIVE LADDER

V-42-6
Photo Slide:
PORTABLE LADDER LASHED
AT TOP

Lesson Plan

II. LADDERS (1915.42, 1916.42, 1917.42)

A. General Requirements

1. Use of ladders prohibited if:

- o Steps, rungs broken or missing
- o Side rails broken or split
- o Construction is otherwise faulty, defective.

2. Ladders to be inspected for corrosion, other defects

- o If found defective, must be immediately removed from use.

3. Requirements if sections of ladders are spliced

- o Ends to be abutted
- o At least 2 cleats nailed or bolted to each rail
 - Cleats' cross sectional area to be at least that of side rail
 - Dimensions of side rails for total length to be as specified in standard.

4. Requirements for portable ladders:

- o Lashed, blocked, otherwise secured



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-7
Photo Slide:
PORTABLE FOLDING LADDER

V-42-8
Photo Slide:
RAILS OF LADDER 3 FEET
ABOVE LEVEL

V-42-9
Photo Slide:
WOOD LADDER USED UNSAFELY

V-42-10
Photo Slide:
IMPROPER STORAGE OF WOOD
LADDERS

V-42-11
Word Slide:
REQUIREMENTS FOR PORTABLE
WOOD CLEATED LADDER

Lesson Plan

- o If metal, strength to be equivalent to wood ladders
 - Must meet U.S. Standard Safety Code for Portable Metal Ladders, A14.2
 - o If metal, not to be used near electrical conductors, electric arc welding operations
 - o Manufactured portable wood ladders supplied by employer to meet requirements of U.S. Standard Safety Code for Portable Wood Ladders, A14.1.
5. Side rails of ladders used for access to any level to extend at least 3 feet above level
- o Exception: if impractical, grab rails that provide secure grip to be installed.

B. Construction of Portable Wood Cleated Ladders Up to 30 Feet in Length



Lesson No. 42

Title Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-12
Art Slide:
SHOP-MADE LADDER

V-42-13
Photo Slide:
WOOD CLEATED LADDER

Lesson Plan

1. Requirements for construction of
wood side rails

o Made from:

- West Coast hemlock; or
- Eastern spruce; or
- Sitka spruce; or
- Wood of equivalent strength

o Wood must be:

- Seasoned
- Straight-grained
- Free from shakes, checks,
decay, other defects

o Low density wood prohibited

o Dressed on all sides

o Kept free of splinters

o Knots to be sound, hard

- Loose knots prohibited
- No knots on rail's narrow face
- Knots on side face not more
than 1/2-inch diameter, not
within 1/2-inch of rail edge,
not nearer than 3 inches to
tread or rung

o Requirements for pitch pockets in
wood side rails

- Not to exceed 1/8-inch in
width, 2 inches in length,
1/2-inch in depth



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-14
Photo Slide:
WIDTH OF LADDER

V-42-15
Photo Slide:
SECURED CLEATS WITH
FILLER BLOCKS

Lesson Plan

- Not more than one pocket per 4 feet of rail.
- 2. Width between side rails at base of ladder
 - o At least 11-1/2 inches for ladder up to 10 feet long
 - o If more than 10 feet long, width to increase at least 1/4-inch for each 2 feet increase in ladder length.
- 3. Side rails to have cross section of at least 1-5/8 x 3-5/8 inches
- 4. Requirements for cleats:
 - o Made of types of materials permitted for side rails
 - Straight-grained, free from knots
 - o Mortised 1/2-inch into side rail edge; or
 - o Filler blocks used
 - o Secured to each rail by:
 - Three 10d common wire nails; or
 - Through bolts; or
 - Other fasteners of equivalent strength
 - o Uniformly spaced 12 inches or less apart



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-16
Photo Slide:
LADDER AS ACCESS TO BARGE

V-42-17
Photo Slide:
LADDER WIDTH

V-42-18
Photo Slide:
CLEATS AND SIDE RAILS

V-42-19
Photo Slide:
FLUSH DECK HOLE

Lesson Plan

- o If 20 inches or less long, to be 25/32 x 2 inches or greater in cross section
- o If over 20 inches but less than 30 inches long, to be 25/32 x 3-3/4 inches or greater in cross section.

C. Construction of Portable Wood Cleated
Ladders from 30 to 60 Feet in Length

1. Must meet same requirements as ladder up to 30 feet long with following exceptions:

- o Rails to be at least 2 x 6-inch lumber
- o Cleats to be at least 1 x 4-inch lumber
- o Cleats to be attached with:
 - Five 10d common wire nails; or
 - Through bolts; or
 - Other fastenings of equivalent strength.

III. GUARDING OF DECK OPENINGS AND EDGES
(1915.43, 1916.43)

- A. Flush Manholes and Other Small Openings in Decks and Working Surfaces



Lesson No. 42

Title Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-20
Photo Slide:
POORLY GUARDED DECK
OPENING

V-42-21
Art Slide:
STANDARD GUARDRAIL AND
TOEBOARD

V-42-22
Photo Slide:
LARGE DECK OPENING

V-42-23
Photo Slide:
GUARDED DECK EDGES

V-42-24
Photo Slide:
EMPLOYEE ON UNGUARDED
EDGE WITHOUT LIFE VEST

Lesson Plan

1. Must be suitably covered; or
2. Must be guarded to height of at least 30 inches

- o Exception: if use of guards is impractical because of work in progress.

B. Open Hatches and Other Large Openings

1. Must be guarded by coaming at least 2 feet high; or
2. Must be guarded in working area to height of 36 to 42 inches

- o Exceptions: if use of guards is impractical because of work in progress.

C. Unguarded Edges

1. Applies to unguarded edges on decks, platforms, flats, similar surfaces over 5 feet above solid surface
2. Adequate guardrails required for these edges
 - o Exception: if work in progress or physical conditions prohibit use, installation of guardrails
3. If employees work near unguarded edges of decks on vessels afloat, must wear appropriate buoyant work vests (1915.84, 1916.84)



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-25
Photo Slide:
FLOOR GRATINGS REMOVED

V-42-26
Photo Slide:
FLOOR GRATINGS REPLACED
BY WOOD DECK

V-42-27
Photo Slide:
WALKWAY SURFACE PROVIDED

V-42-28
Photo Slide:
LADDER SECTION REPLACED
WITH INADEQUATE LADDER

Lesson Plan

D. Bilges

1. If floor plates or gratings removed from bilge sections, guardrails required for these sections
 - o Exception: if guardrails interfere with work in progress.
2. If open sections are in walkway, safe walking surface to be provided
 - o At least two 10-inch planks placed side-by-side; or
 - o Equivalent walking surface.

E. Gratings, Walkways, and Catwalks

1. If sections or ladders have been removed, must be barricaded with adequate guardrails.

IV. ACCESS TO VESSELS (1915.44, 1916.44, 1917.44)

A. Access to Vessels Afloat

1. Following are required of employer before employees are permitted to board, leave any vessel except barge or river towboat:



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-29

Photo Slide:
GANGWAY TO FLOATING
DRY DOCK

V-42-30

Photo Slide:
GANGWAY

V-42-31

Photo Slide:
LADDER WAY TO VESSEL

V-42-32

Photo Slide:
JACOB'S LADDER

V-42-33

Photo Slide:
JACOB'S LADDER AND RUNGS

V-42-34

Photo Slide:
RAILINGS ON GANGWAY

Lesson Plan

- o Must provide gangway with at least 20-inch walking surface that is adequately strong and secure, well-maintained; or, if not practical,
- o Must provide substantial straight ladder for access
 - To extend 3 feet or more above upper landing surface
 - Adequately secured against shifting, slipping
- o Exception: if gangway and ladder both prohibited by conditions, appropriate Jacob's ladder may be used
 - Double rung or flat tread type
 - Well maintained and secured
 - Hung without slack from lashings or pulled up entirely.
- 2. Railing at least 33 inches high required on each side of gangway and turn table, if used
 - o Height of railing to be measured perpendicularly from rail to walking surface at stanchion
 - o Mid-rail required
 - o Railings to be made of wood, pipe, chain, rope
 - Kept taut at all times.



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-35
Photo Slide:
CLEATED DUCKBOARDS
NOT USED

V-42-36
Photo Slide:
NET UNDER GANGWAY

Lesson Plan

3. In ship repair operations, if vessel is inspected, certified by Coast Guard, gangway is deemed acceptable
 - o Exception: if vessel's regular gangway not used.
4. Gangway always to be properly trimmed
5. Cleated duckboards required to be laid over, secured to ladder if:
 - o Fixed tread accommodation ladder used; and
 - o Angle is so low that employees must walk on edges of treads.
6. Protection required if lower end of gangway overhangs water between vessel and dock and employees may fall into water
 - o Net or suitable protection to be rigged at foot of gangway to prevent employees from falling at gangway end.
7. Walkway required if foot of gangway more than one foot from apron's edge
 - o Firm walkway equipped with railings at least 33 inches high with mid-rails on both sides.
8. Unobstructed passage required for employees using gangway
 - o Supporting bridges to be kept clear
 - o No obstructions laid across gangway.



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-37

Photo Slide:

STEPS REQUIRED WHEN GANGWAY
RESTS ON BULWARK

V-42-38

Photo Slide:

ACCESS BETWEEN VESSELS

Lesson Plan

9. Substantial steps required if upper end of means of access rests on or flush with top of bulwark
 - o To be properly secured
 - o Equipped with one or more substantial handrails approximately 33 inches high
 - Rails to extend between top of bulwark and deck.
10. Full length of accessway to be lighted adequately
11. Accessway to be located so that cargo drafts do not pass over it
 - o Exception: if vessel construction makes impossible
 - o Loads never to be passed over while employees are on accessway.

B. Access to Vessels in Dry Dock or Between Vessels

1. Appropriate gangways required for:
 - o Access from wing wall to vessel;
or
 - o Access from one vessel to another
 - Applies to 2 or more vessels lying abreast
 - Does not apply to barges, river towboats.



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-39

Photo Slide:

UNSAFE WALKWAY BETWEEN
RAMP AND BARGE

Lesson Plan

C. Access to Barges and River Towboats

1. Requirements for vehicle ramps

- o Apply to access ramps for vehicles to or between barges
- o To be of adequate strength, well maintained and secured
- o Must have side boards.

2. Ramp or other safe walkway required unless employees can step safely to and from wharf, float, barge, river towboat

- o If walkway impractical, substantial straight ladder may be used
 - Must extend at least 3 feet above upper landing surface
 - Must be secured against shifting, slipping
- o If walkway and straight ladder both impractical, Jacob's ladder may be used
 - Double rung or flat tread type
 - Well maintained and secured
 - Either hung without slack from lashings or pulled up entirely.

3. Any means of access to meet applicable requirements for accessways to vessels afloat.



Lesson No.
42

Title
Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-40
Photo Slide:
ACCESS BETWEEN DRY DOCK
AND PIER

V-42-41
Photo Slide:
PERMANENT STAIRWAY
ON DRY DOCK

Lesson Plan

V. ACCESS TO AND GUARDING OF DRY DOCKS AND
MARINE RAILWAYS (1915.45, 1916.45, 1917.45)

A. Accessways Between Floating Dry Dock
and Pier or Bulkhead

1. Gangway, ramp or stairway with
minimum 20 inches of walking surface
2. Adequately strong, well maintained
3. Securely fastened.

B. Railing Requirements for Gangways,
Ramps and Permanent Stairways

1. Must have railing on each side
2. Includes those used for access to
and from dry dock floor, including
access to wing walls from floor
3. Railings to be approximately 42
inches high
 - o Railings on permanent stairways
to be 30 to 34 inches in height.
4. Must have mid-rail
5. To be made of wood, pipe, chain,
wire, rope
 - o Kept taut at all times.



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-42

Photo Slide:

RAILING ON DOCK EDGE

V-42-43

Photo Slide:

RAILINGS ON WING WALL

V-42-44

Photo Slide:

RAILINGS ON FLOATING
DRY DOCK

V-42-45

Photo Slide:

STANCHION ON DRY DOCK

V-42-46

Photo Slide:

ACCESS BETWEEN WING WALL
AND DRY DOCK FLOOR

Lesson Plan

C. Requirements for Railings on Floating
Dry Dock Wing Walls and Graving Dock
Edges

1. Railings to be approximately
42 inches in height
2. Must have mid-rail
3. Sections may be temporarily removed
if necessary
 - o Permits line handling while
vessel entering, leaving dock.

D. Requirements for Railings on Floating
Dry Docks

1. Required if employees on dry dock
floor may fall into water
2. End of dry dock to have portable
stanchions and 42-inch railing
with mid-rail
 - o Exception: if impractical, or
ineffective, other means to be
used to keep employees from
falling into water.

E. Access Between Wing Walls and Floors
of Dry Docks

1. Must be one of following types of
accessways:



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

Lesson Plan

V-42-47
Photo Slide:
LADDER TO CONFINED SPACE

- o Ramp
- o Permanent stairway
- o Appropriate ladder.

F. Requirements for Catwalks on Stiles of
Marine Railways

1. Must be at least 20 inches wide
2. To have appropriate guardrail and
mid-rail on at least one side.

VI. ACCESS TO CARGO SPACES AND CONFINED SPACES
(1915.46, 1916.46, 1917.46)

A. Cargo Spaces

1. At least one safe, accessible
ladder required in any cargo space
employees must enter
2. Employer to prohibit use of any
visibly unsafe fixed ladder
3. If adequate fixed ladder unavail-
able, straight ladder to be
provided
 - o Must have adequate strength
 - o Must be secured against slipping,
shifting
 - o Exception: if straight
ladder impractical, approp-
riate Jacob's ladder may
be used.



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-48
Photo Slide:
FIXED LADDER TO
CONFINED SPACES

V-42-49
Photo Slide:
VENTILATION TO
CONFINED SPACES

V-42-50
Photo Slide:
EMPLOYEE IN BOILER

Lesson Plan

4. Ladder is considered unsafe if cargo stowed 4 inches or less from back of ladder rungs (applies to ship repair only)
5. No use of fixed or straight ladders for access to cargo space while cargo drafts, other loads entering or leaving hold
 - o Before using ladders, employees to inform winchman or crane signalman.

B. Confined Spaces

1. More than one means of access required to confined space in which employees work and in which work may create hazardous atmosphere
 - o Exception: if impractical due to vessel structure or arrangement.
2. If ventilation ducts pass through means of access, must be of type and arranged so employee can freely pass through 2 or more accessways.

VII. WORKING SURFACES (1915.47, 1916.47, 1917.47)

A. Firebox Floors

1. May present tripping hazard if:



Lesson No.

42

Title

Scaffolds, Ladders, and Other Working
Surfaces (Continued)

Notes

V-42-51
Photo Slide:
EMPLOYEE ON SCAFFOLD

V-42-52
Photo Slide:
EMPLOYEE WITH RESTRICTED
VISION

V-42-53
Photo Slide:
WORK IN RESTRICTED AREA

Lesson Plan

- o Tubing is exposed
- o Refractory is missing or removed.
- 2. If hazardous, planking sufficient to afford safe footing to be laid while work underway inside boiler.

B. Work at Elevations More Than 5 Feet
Above Solid Surface

1. Scaffolds or sloping ladders required for safe footing; or
2. Employees to wear appropriate safety belts, life lines
3. Requirements for employees working with restricted vision:
 - o Apply to employees wearing blasting hoods, welding helmets, burning goggles
 - o Must work from scaffolds, not ladders
 - Exception: if performing initial or final welding to start or complete job
 - Exception applies to work such as erecting or dismantling hung scaffolding, other brief nonrepetitive jobs.
4. Requirements for work in restricted quarters



Lesson No. 42

Title Scaffolds, Ladders, and Other Working
Surfaces (Continued)

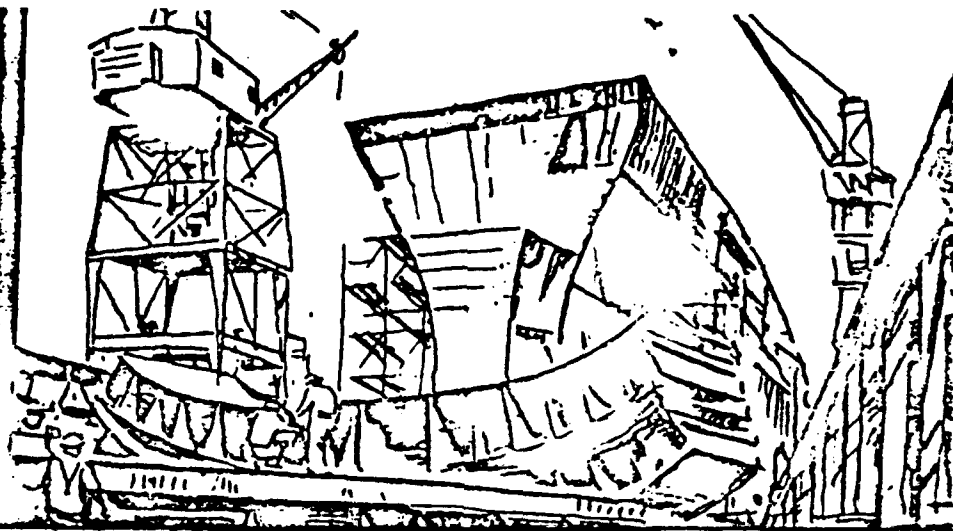
Notes

Lesson Plan

- o Apply to areas such as behind boilers, between congested machinery units and piping
- o Appropriate platforms at least 20 inches wide to be used
 - Backrails not required if bulkheading, boilers, machinery units, piping adequately protects against falls.
- 5. Appropriate buoyant work vests required when employees board, leave, or work from small boats or floats.

Maritime Safety Data

FOR SHIPYARDS



MSD LS-20

00S 3.66

The data in this presentation are devoted to promotion of safety in typical hazardous areas of ship repairing, shipbuilding, and ship-breaking operations.

41

FILE WITH

37 F

LADDERS AND OTHER MEANS OF ACCESS USED ON VESSELS IN SHIPYARDS

U. S. DEPARTMENT OF LABOR
Bureau of Labor Standards
Washington, D. C. 20210

> LESSON 42

HANDOUT 1

42-22

INTRODUCTION

Ladders, gangways, and other means of access are used in almost every type of ship repairing, shipbuilding, and shipbreaking operation. Their use is not only essential to these operations but can also contribute greatly to the safety of the operation. On the other hand, faulty construction, improper rigging and misuse of these means of access have been the cause of many accidents in the shipyards.

It is hoped that this publication will help to prevent some of these accidents by presenting and illustrating requirements for safe construction of ladders and access, indicating the safe methods of rigging these means of access, and by discussing the safe practices that should be observed in using them.

This data sheet was prepared by Roland J. Belanger of the Office of Occupational Safety.

Requirements for Safe Construction of Ladders

Ladder safety should begin with safe construction. The American Standard Safety Codes A 14.1 and A 14.2 give the nationally accepted standards for wood and metal ladders.

All ladders used by shipyards, whether constructed or purchased, must meet the constructional requirements of these standards to be in compliance with the Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking. Ladders made by reputable manufacturers usually meet the requirements of the ASA Code, but it is wise to stipulate such compliance on purchase orders.

The following general requirements of the safety regulations for construction of safe ladders deal mainly with portable wood cleated ladders, which are usually built by the shipyard. However, it will be noted that some of these requirements also apply to manufactured rung type ladders.

1. Cleats and side rails for a ladder should be made of clear lumber, straight grained and free from defects that would impair their strength. Lumber used should be Eastern Spruce, Sitka Spruce or wood of equivalent strength. The use of low density wood is prohibited.
2. Lumber for side rails and cleats should be dressed to remove all sharp edges and splinters. Knots should be sound and hard.
3. Use at least 2- x 4-inch side rails for ladders up to 30 feet long. Side rails of at least 2 x 6 inches should be used when the length is 30 to 60 feet.
4. Preferably, side rails should be continuous. If splicing is necessary, the splice must develop the full strength of a continuous side rail of the same length.
5. Cleats should be uniformly spaced not more than 12 inches apart and nailed to each rail with three 10-d wire nails. The cleats of ladders 30 to 60 feet in length should be secured with five 10-d wire nails. In either case, other fastenings of equal strength may be used.
6. Cleats should be housed into the edges of the side rails $\frac{1}{2}$ inch, or filler blocks should be used (Fig. 1). Cleats 20 inches or less in length should be at least $25/32$ x 3 inches in cross section. Cleats 20 to 30 inches in length should be at least $25/32$ x $3 \frac{3}{4}$ inches in cross section.

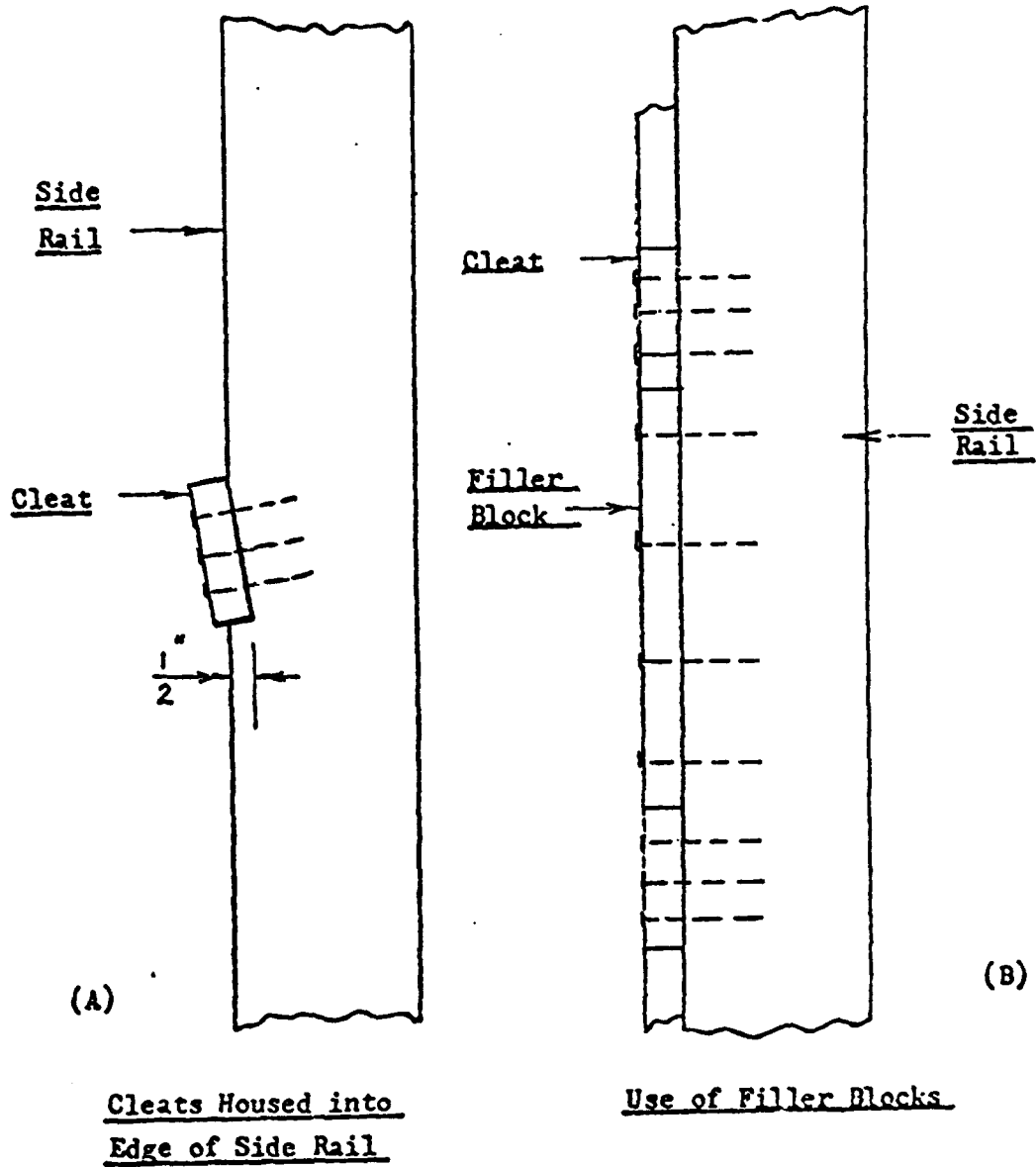


Fig. 1

7. Painting wood ladders with opaque paint is undesirable as this can hide defects. Instead of painting the ladder, it can be protected by using a transparent protective wood preservative.

Safe Installation of Ladders

Before any ladder is put into use, it should be carefully inspected for defects. Ladders with broken rungs, broken or split side rails, or other faulty construction should be withdrawn immediately from service. Inspection of metal ladders should include checking for corrosion of interiors of open-end hollow rungs. The inspection should be made by the supervisor, the worker installing the ladder, and by the worker who will be using it. If the ladder cannot be repaired, it should be destroyed. The fact that an obviously defective ladder was nearer at hand than a sound one has resulted in many accidents.

A sound, well-constructed ladder improperly installed or placed can prove to be as dangerous to the employee as if he had used a defective ladder. The following steps should be taken to ensure that a portable ladder is safely placed for use.

1. The rails of the ladder should be set on level, solid footing. Never set the ladder on boxes or other objects that are not strong and solidly placed. On soft ground, as around a marine railway, it may be necessary to use mud sills to ensure solid footing. Ladder safety shoes are always advisable to prevent sliding on smooth surfaces.
2. Place the ladder so that the horizontal distance from the base to the vertical plane of the top support is one-fourth of the working length of the ladder (Fig. 2). Ladders should not be placed in a horizontal or near horizontal position for use as a ramp, platform, or scaffold (Fig. 3). A ladder can support much less weight in a horizontal position than it can when in a vertical position.
3. Ladders in use should be lashed, blocked, or otherwise secured to prevent their being displaced. When ladders are to be used for a considerable length of time in one location, as may be the case in shipbuilding, it is customary to secure the ladders by welding retainer brackets or clips at the top and bottom landing levels (Fig. 4). When a portable straight ladder is to be used for a short time and it is not practical to secure it, someone should be assigned to hold the foot of the ladder while it is being used.

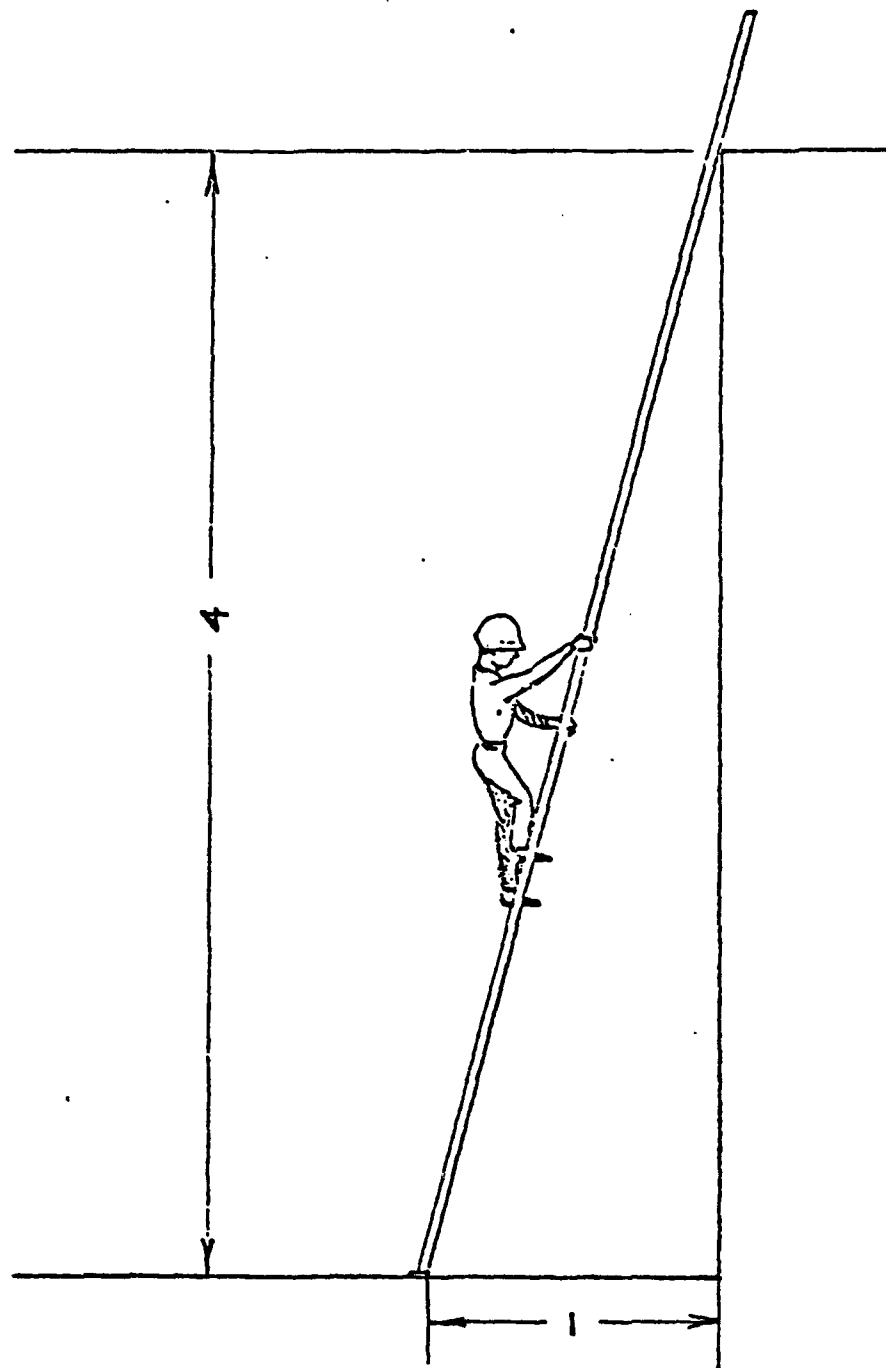


Fig. 2 . Safe Angle of Ladder

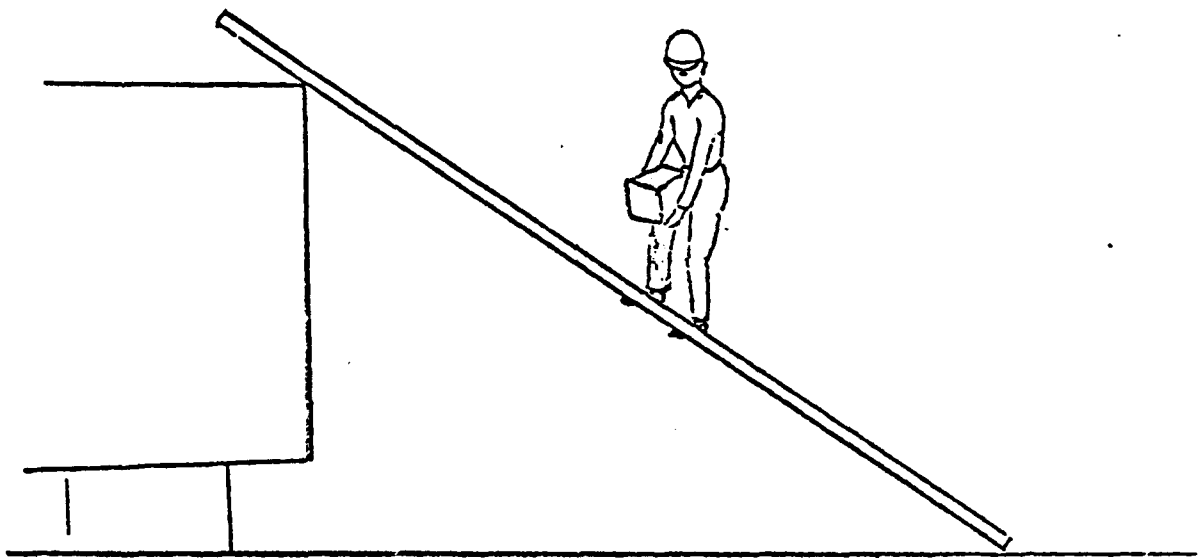


Fig. 3

Unsafe Use of Ladder
As Ramp

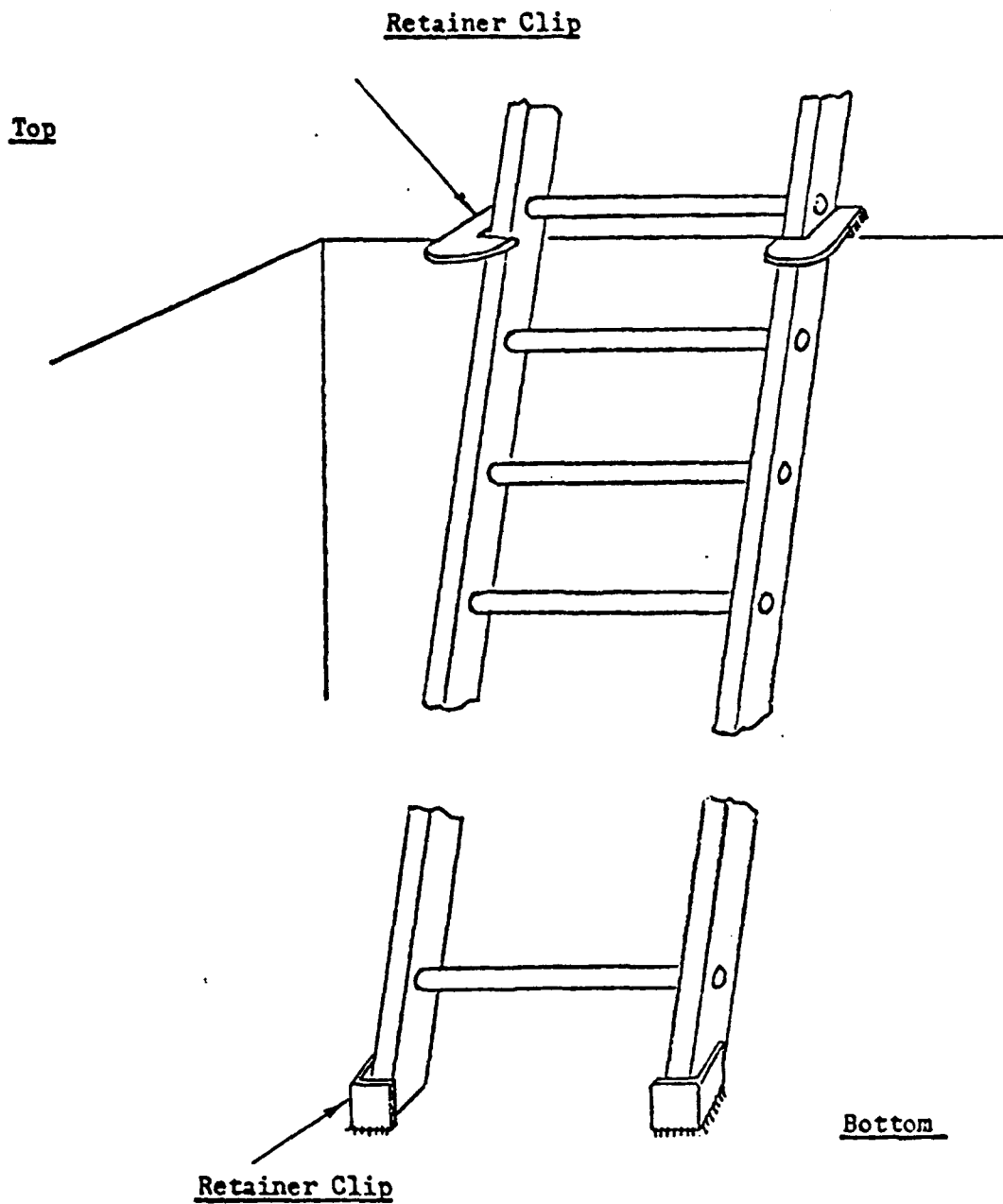


Fig. 4

Clips for Securing Ladder

4. When ladders are to be used as a means of access from a wharf or pier to vessels afloat, lashing used to secure the ladders should have enough slack to allow for minor movements of the vessel. Lashings should be adjusted as the tide changes.
5. Ladders used for access to any level should extend at least 36 inches above that level in order that employees getting on or off will have a solid handhold. When it is not practicable to provide a ladder that extends above the landing level, grab rails should be installed that will provide a secure grip for an employee moving to or from the ladder.
6. All metal ladders are electrical conductors. Their use in locations where they may come in contact with live circuits, electric arc welding operations, or any electrical conductor should be strictly forbidden.
7. Check to see that housekeeping conditions are good at both the foot and top of the ladder. Welding leads, hoses, ducts, or other lines should be removed if they are obstructing safe passage on the ladder.
8. Be sure that a ladder is used. Too often the supervisor assigns an employee to a job at an elevated worksite and assumes that he will obtain a ladder on his own. The supervisor should make sure the proper ladder is provided and set up correctly. Only jobs of short duration should be done from a ladder. A scaffold should be erected for jobs of long duration.
9. The legs of a stepladder should be fully spread and firmly locked open before being used.
10. If possible, don't place the ladder where it could be struck by moving vehicles. Rope off the area around the ladder if necessary.

Safe Practices for the Use of Ladders

Obtaining a sound, well constructed ladder and installing it properly are two essential steps to take in reducing ladder injuries. Of equal importance are the safe practices to observe in the use on this ladder. The unsafe use of a ladder can prove to be as dangerous as using one that is not safe. The following precautions should be taken to ensure the safe use of ladders.

1. Use both hands in climbing ladders.
2. Use a hand line to raise tools or equipment. Don't try to carry them while climbing.
3. Climb cautiously and always face the ladder.
4. Don't overreach while working from a ladder. Take time to climb down and move the ladder. A good rule is to keep your belt buckle inside the side rails.
5. Don't overload the ladder. Most straight ladders should be used by only one person at a time. An extra load could weaken a ladder so that it might break later under normal use.
6. Never stand on a rung higher than the second from the top while working from any portable ladder or stepladder.
7. Never leave tools on the top steps of a stepladder. They could easily be jarred off and hit someone below.
8. Don't use a stepladder as a straight ladder by leaning it against a bulkhead or hull.

Safe Constructional Requirements and Installation
of Gangways and Means of Access to Vessels

Many of the hazards encountered by employees when boarding and leaving vessels could be eliminated by first providing a means of access that would meet the requirements of the Safety and Health Regulations. There are several types of access to a vessel, including the ship's regular gangway, a brow ladder, a portable straight ladder, or a portable Jacob's ladder.

When the gangway is used, it should meet the following requirements:

1. The gangway should have a walking surface of at least 20 inches in width. It should be of adequate strength, maintained in safe repair, and safely secured.
2. Each side of the gangway should have a top rail with a minimum height of 33 inches and a midrail. The rails can be of wood, pipe, chain, wire, or rope. Wire, rope or chain used for railings should be kept taut; a slack rope rail will give little protection to a person falling against it.

3. The gangway should be kept properly trimmed at all times. It does no good to provide a sturdy gangway that meets all requirements and then fail to keep it trimmed consistent with changes in the tide and draft.
4. When a fixed, tread-type accommodation ladder is used and the angle is low enough to require employees to walk on the edge of the treads, cleated duckboards should be laid down and secured.
5. Where the lower end of the gangway overhangs the water between the ship and the dock, a net or other suitable protection should be rigged at the foot of the gangway to prevent employees from falling from the end.
6. Supporting bridles should be kept clear to permit unobstructed passage. Clean up any oil or grease on the gangway. Good housekeeping and adequate lighting on the gangway is essential to prevent accidents to employees boarding and leaving the vessel.
7. When it is necessary for the gangway to be secured on the top of the bulwark, employees should not have to jump down onto the deck to board the vessel. Substantial steps properly secured and equipped with at least one handrail should be installed to provide a safe passage from the top of the bulwark to the deck.
8. In many instances, an employee could safely step to a barge or towboat without a special means of access. However, wind and tide can quickly change what was previously an easy step to a hazardous gap of open water. A close check should be kept on these changing conditions and a safe means of access provided when needed. The access may consist of either a ramp with sideboards for use of vehicles and personnel, or a safe walkway equipped with railings at least 33 inches in height with midrails for use of personnel only. When there is a difference of height between the pier and the vessel, gangways or ladders must be used.
9. When it is necessary to use a straight ladder as a means of access to any type of vessel, the ladder should extend at least 36 inches above the landing surface and should be secured against shifting or slipping.
10. When there are many men working aboard a large vessel, more than one means of access should be provided. A straight ladder properly secured to the vessel at a distance from the

regular means of access could be used as an emergency exit in the event a fire or other mishap blocked access to the gangway.

11. When conditions are such that a gangway, walkway, or a straight ladder cannot be used as a means of access to the ship or barge, a Jacob's ladder should be used. Besides being properly secured and well maintained, the Jacob's ladder should be of the double rung or flat tread type. It is especially important that the ladder be hung without slack from its lashing.

12. Providing a safe means of access to the floors of drydocks, graving docks, building basins, and to the wingwalls of drydocks is also essential to prevent slipping, tripping, and falling accidents. The stairs, ladders, and ramps should meet the requirements of the regulations.

Safe Practices for Use of Gangways

Boarding or leaving a vessel should be a safe and simple operation when a safe means of access is provided. However, unsafe practices can lead to accidents even when conditions are reasonably safe. The following safe practices and precautions, which may seem obvious, must frequently be brought to employees' attention:

1. Use the railings for support when boarding or leaving the vessel.
2. Lack of attention has been the cause of many a trip, slip or fall in climbing or coming down a gangway. Always face in the direction you are going and watch your step.
3. Employees should be discouraged from carrying heavy equipment or material up or down the gangway. A fall on the gangway while carrying a heavy object could result in serious injury not only to the person falling, but to others as well. Only carry such equipment or materials as will allow you to keep one hand free for the rail.
4. Running, jumping, or horseplay has no place aboard the vessel, especially on the means of access to the vessel.
5. When a safe means of access has been provided, make certain that employees use it at all times. In situations where it appears to be fairly easy to step from the pier to the rail or deck, employees will be seen frequently taking this "shortcut," rather than using the gangway provided. Any sudden movement

of the vessel could change this "easy step" into a slip and fall between the vessel and the pier, which could result in a serious injury or fatality.

Fixed Ladders Aboard Ship

Vertical ladders found in ships' holds are inherently more dangerous than a sloping ladder. A man has to hold on at all times to prevent falling away from the ladder. A slip of his foot would cause his weight to drop parallel to the ladder. If a man slips on a sloping ladder, he has a chance to hold on or to grab again as he slides down the surface of it. For this reason, whenever heavy traffic is anticipated into and out of a ship's hold, a sloping portable ladder, such as shown in Fig. 5, should be set in the hatch for the use of employees.

When it is impractical to provide sloping ladders, the following precautions should be taken:

1. Before workers are allowed to enter any cargo space, at least one safe and accessible ladder should be provided.
2. Hold ladders should be inspected before being used to see that there are no bent, broken, or missing rungs. Any fixed ladder that is visibly unsafe should be blocked off or other means taken to ensure that it will not be used. A safe ladder should be provided.
3. It is vital that men have both hands free to aid their movement on vertical ladders. Be sure there is enough light so that men are not inclined to use flashlights. Place a line alongside with a bucket or basket attached so that they can easily avoid carrying tools or materials in their hands while on the ladder.
4. If their shoes are likely to be slippery from water or oil, mats should be placed at the head and foot of the ladder to wipe the feet.
5. Keep welding cables, hoses, and lines clear of ladders to prevent tripping hazards.
6. Be sure that cargo is stowed no closer than 4 inches from the back of the ladder. This would allow room for the feet to rest solidly on the rungs of the ladder.

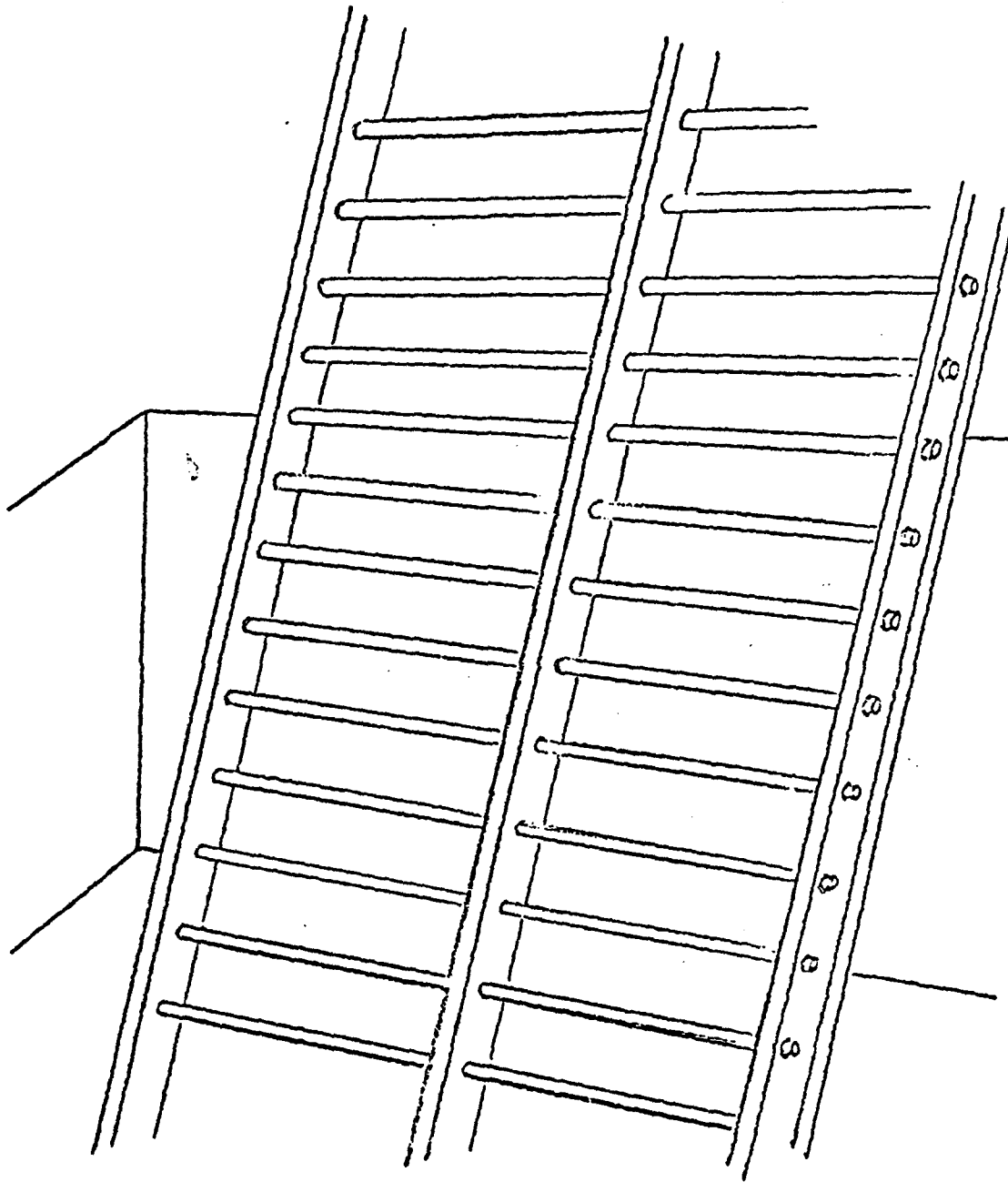


Fig. 5

Portable Gang Hatch Ladder

-15-

If a conscientious effort is made to use properly constructed and safely rigged ladders, gangways, and other means of access, without doubt a real improvement will be made in the reduction of the number of accidents in shipyards.



Lesson No 43

Time 50 minutes

Title General Working Conditions	
Objective	Upon completion of this lesson, the trainee will be able to discuss a variety of working conditions encountered by shipyard workers and will be able to identify unsafe conditions and recommend the appropriate abatement.
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Lesson No.

43

Title

General Working Conditions

Technique	Content	Time
Lecture and Slides	I. Housekeeping	15 minutes
	II. Illumination	10 minutes
	III. Utilities	10 minutes
	IV. Work in Lifeboats	5 minutes
	V. First Aid	10 minutes
		Total Time: 50 minutes
Materials		
38 Slides Slide Projector (35 mm)		
References		
U.S. Occupational Safety and Health Administration. "Safety and health standards for maritime employment." <u>Federal Register</u> , Volume 39, No. 119, June 19, 1974.		
43-2		



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VISUAL AIDS

V-43-1	Photo Slide	Work Area Around Vessel Site (*)
V-43-2	Photo Slide	Restricted Passageways in Vessel Construction Area (*)
V-43-3	Photo Slide	Clear Staging Platforms (*)
V-43-4	Photo Slide	Clear Platform in Overhead (*)
V-43-5	Photo Slide	Clear Ramp (*)
V-43-6	Photo Slide	Clear Stairway (*)
V-43-7	Photo Slide	Cluttered Stairway (*)
V-43-8	Photo Slide	Clear Walkways (*)
V-43-9	Photo Slide	Clear Aisles (*)
V-43-10	Photo Slide	Clear Passageway (*)
V-43-11	Photo Slide	Poor Housekeeping (*)
V-43-12	Photo Slide	Hoses and Cables on Deck (*)
V-43-13	Photo Slide	Obstructed Passageway (*)
V-43-14	Photo Slide	Cables Elevated on Bulkhead (*)
V-43-15	Photo Slide	Brackets Welded to Bulkhead (*)
V-43-16	Photo Slide	Brackets Bolted to Beam (*)
V-43-17	Photo Slide	Hoses and Cables Bridged (*)
V-43-18	Photo Slide	Material Stacked Neatly (*)
V-43-19	Photo Slide	Access Restricted by Hose Across Rail (*)
V-43-20	Photo Slide	Access to Fire Extinguisher
V-43-21	Photo Slide	Storage of Flammables Not in Use
V-43-22	Photo Slide	Adequate Lighting (*)

VISUAL AIDS (Continued)

V-43-23	Photo Slide	Guard on Temporary Light (*)
V-43-24	Photo Slide	Cables on Deck (*)
V-43-25	Photo Slide	Cables and Cords on Deck in Passageway (*)
V-43-26	Photo Slide	Portable Emergency Lighting (*)
V-43-27	Word Slide	Requirements for Utilities
V-43-28	Photo Slide	Ship's Steam System (*)
V-43-29	Photo Slide	Vessel Grounding Conductor (*)
V-43-30	Photo Slide	Circuits Tied in with Ship's Lighting (*)
V-43-31	Photo Slide	Circuit in Use with Overcurrent Protection (*)
V-43-32	Photo Slide	Infrared Lamp and Guard (*)
V-43-33	Photo Slide	Life Boats (*)
V-43-34	Photo Slide	Life Boat Davits (*)
V-43-35	Photo Slide	Life Boat Releasing Gear (*)
V-43-36	Photo Slide	First Aid Gondola (*)
V-43-37	Photo Slide	First Aid Kit
V-43-38	Photo Slide	Supervisor Checking Work in Confined Space (*)

(*) For internal Department of Labor training purposes only.



Lesson No

43

Title

General Working Conditions

Notes

V-43-1
Photo Slide:
WORK AREA AROUND
VESSEL CONSTRUCTION SITE

V-43-2
Photo Slide:
RESTRICTED PASSAGEWAYS IN
VESSEL CONSTRUCTION AREA

V-43-3
Photo Slide:
CLEAR STAGING PLATFORMS

V-43-4
Photo Slide:
CLEAR PLATFORM IN OVERHEAD

V-43-5
Photo Slide:
CLEAR RAMP

V-43-6
Photo Slide:
CLEAR STAIRWAY

V-43-7
Photo Slide:
CLUTTERED STAIRWAY

V-43-8
Photo Slide:
CLEAR WALKWAYS

V-43-9
Photo Slide:
CLEAR AISLES

Lesson Plan

I. HOUSEKEEPING (1915.51, 1916.51, 1917.51)

A. Requirements for Maintaining Good House-
keeping Conditions

1. Adequate aisles and passageways in
all work areas

2. Following areas on vessels, dry
docks to be kept clear of tools,
materials, equipment unless in use:

o Staging platforms

o Ramps

o Stairways

o Walkways

o Aisles



Lesson No.

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Title

General Working Conditions

Notes	Lesson Plan
V-43-10 Photo Slide: CLEAR PASSAGEWAY	o Passageways.
V-43-11 Photo Slide: POOR HOUSEKEEPING	3. Above areas also to be kept clear of debris, including:
V-43-12 Photo Slide: HOSES AND CABLES ON DECK	o Welding rod tips
V-43-13 Photo Slide: OBSTRUCTED PASSAGEWAY	o Bolts
	o Nuts
	o Similar materials.
V-43-14 Photo Slide: CABLES ELEVATED ON BULKHEAD	4. Requirements for placement of hoses, and electric conductors
V-43-15 Photo Slide: BRACKETS WELDED TO BULKHEAD	o Elevated over walkway; or
V-43-16 Photo Slide: BRACKETS BOLTED TO BEAM	o Placed under walkway or working surface; or
V-43-17 Photo Slide: HOSES AND CABLES BRIDGED	o Covered by adequate crossover planks.
V-43-18 Photo Slide: MATERIAL STACKED NEATLY	5. All working areas on vessels, dry docks to be reasonably free of debris
	o Construction material to be piled in safe fashion.
	43-5



Lesson No.

43

Title

General Working Conditions

Notes

V-43-19
Photo Slide:
ACCESS RESTRICTED BY
HOSE ACROSS RAIL

V-43-20
Photo Slide:
ACCESS TO FIRE EXTINGUISHER

V-43-21
Photo Slide:
STORAGE OF FLAMMABLES NOT
IN USE

V-43-22
Photo Slide:
ADEQUATE LIGHTING

Lesson Plan

6. Slippery conditions on walkways, working surfaces to be eliminated as they occur

7. Free access required at all times to:

- o All exits; and

- o All fire-alarm boxes or fire extinguishing equipment.

8. Storage in fire-resistant, covered containers required for following when not in use:

- o Oils

- o Paints

- o Thinners

- o Solvents waste

- o Rags

- o Other flammable substances.

II. ILLUMINATION (1915.52, 1916.52, 1917.52)

A. General Lighting Requirements

1. Adequate illumination required for:

- o All work areas

- o Means of access and walkways to work areas.



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Title

General Working Conditions

Notes

V-43-23
Photo Slide:
GUARD ON TEMPORARY LIGHT

V-43-24
Photo Slide:
CABLES ON DECK

V-43-25
Photo Slide:
CABLES AND CORDS ON DECK
IN PASSAGEWAY

Lesson Plan

B. Temporary Lighting Requirements

1. Must be equipped with guards to prevent accidental contact with bulb
 - o Exception: not required if bulb is deeply recessed.
2. Must be equipped with heavy duty electric cords
 - o Connections and insulation to be well-maintained
 - o Not to be suspended by electric cords unless cords and lights so designed
 - o Splices to have insulation equal to cord
 - o Cords to be kept clear of:
 - Working spaces
 - Walkways
 - Other locations where exposed to damage.
3. Exposed non-current-carrying metal parts of temporary lights provided by employer to be grounded
 - o Grounding must meet all applicable requirements
 - o May be grounded through third wire in cable containing circuit conductors; or
 - o Through separate wire grounded at current source.



Lesson No.

43

Title

General Working Conditions

Notes

V-43-26
Photo Slide:
PORTABLE EMERGENCY LIGHTING

V-43-27
Word Slide:
REQUIREMENTS FOR
UTILITIES

V-43-28
Photo Slide:
SHIP'S STEAM SYSTEM

Lesson Plan

4. If only lighting is provided by temporary lighting from source outside vessel, portable emergency lighting to be available
 - o Provides for safe movement of employees.
5. Employees prohibited from entering dark spaces without suitable portable light
 - o Matches, open flame lights prohibited
 - o If space is non-gas-free, approved portable lights required.
6. Temporary lighting on stringers, streamers to be arranged to prevent overloading branch circuits
 - o Each branch circuit to have over-current protection capacity no greater than current carrying capacity of cord.

III. UTILITIES (1915.53, 1916.53, 1917.53)

A. Steam Supply and Hoses

1. Before supplying steam to vessel from outside source, employer must:
 - o Ascertain safe working pressure of vessel's steam system



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Title

General Working Conditions

Notes

Lesson Plan

- To ask responsible representatives who know condition of plant
- o Install pressure gauge, relief valve of proper size and capacity at point where steam hose joins vessel's steam piping system(s)
- Relief valve to be set, capable of relieving at pressure no greater than safe working pressure of vessel's system in present condition
- Relief valve not to be isolatable from system
- Relief valve and pressure gauge to be visible, readily accessible.
- 2. Safety factor of at least 5 required for steam hose, fittings
- 3. If steam hose hung in bight or bights, weight to be relieved by appropriate lines
 - o Hose to be protected from chafing.
- 4. Steam hose to be protected from damage
- 5. Hose, temporary piping to be shielded when passing through normal work area to prevent accidental contact by employees.

B. Electric Power

1. Requirements if supplied from source outside vessel



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Title

General Working Conditions

Notes

V-43-29
Photo Slide:
VESSEL GROUNDING
CONDUCTOR

V-43-30
Photo Slide:
TEMPORARY CIRCUITS TIED
IN WITH SHIPS LIGHTING

V-43-31
Photo Slide:
CIRCUIT IN USE WITH
OVERCURRENT PROTECTION

V-43-32
Photo Slide:
INFRARED LAMP AND GUARD

V-43-33
Photo Slide:
LIFEBOATS

V-43-34
Photo Slide:
LIFEBOAT DAVITS

Lesson Plan

- o Vessel to be adequately grounded if in dry dock
- o Employer to ascertain all circuits to be used are in safe condition
 - To ask responsible vessel representatives who know condition of vessel's electrical system
- o Circuits that will be energized have overcurrent protection of capacity no greater than rated capacity of cord.

C. Infrared Electrical Heat Lamps

1. To have guards that surround all sides except face
 - o Minimize accidental contact with lamps.

IV. WORK IN OR ON LIFEBOATS (1915.56, 1916.56, 1917.56)

A. Requirements Before Entering Lifeboat

1. Applies whether lifeboat stowed or suspended
2. Employees not permitted to enter until:
 - o Employer ensures boat secured independent of releasing gear



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Title

General Working Conditions

Notes

V-43-35
Photo Slide:
LIFEBOAT RELEASING GEAR

V-43-36
Photo Slide:
FIRST AID GONDOLA

V-43-37
Photo Slide:
FIRST AID KIT

Lesson Plan

- Prevents boat from falling if releasing gear tripped accidentally
- Prevents movement of davits or boat's capsizing in chocks.

B. Requirements for Lifeboat Work

1. Employees not to remain in boats while boats hoisted for stowage
2. No work allowed on outboard side of lifeboat stowed on chocks
 - o Exception: if boats secured by gripes, other measures to prevent swinging outboard.

V. FIRST AID (1915.58, 1916.58, 1917.58)

A. First Aid Kits

1. Required for each vessel on which work is being performed
 - o Exception: if first aid room and attendant close by, ready to aid employees on employer's behalf
 - o Exception: only one kit required if work is done on one or more small vessels at one pier.
2. When kit is required to be kept near vessel, at least one employee nearby to be qualified to give first aid



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Title
General Working Conditions

Notes	Lesson Plan
	3. Kit must be weatherproof and contain sealed packages for each type of item 4. Minimum contents include: - o Gauze roller bandages, 1-inch and 2-inch - o Gauze compress bandages, 4-inch - o Adhesive bandages, 1-inch - o Triangular bandage, 40-inch - o Ammonia inhalents and ampules - o Burn dressing - o Eye dressing - o Wire or thin board splints - o Forceps and tourniquet. 5. Contents of kit to be checked: - o Before sent out on each job - o At least once weekly on each job to see that used items are replaced. 6. Stretcher and blanket requirements - o One Stokes basket stretcher or equivalent for each vessel on which 10 or more employees work - Permanently equipped with bridles to attach to hoisting gear - Exception: no more than 2 stretchers required at each job location - Exception: stretcher not required if ambulance is available that carries stretchers 43-12



Lesson No

43

Title

General Working Conditions

Notes

V-43-38
Photo Slide:
SUPERVISOR CHECKING
WORK IN CONFINED SPACE

Lesson Plan

- o Blanket, other suitable liner for transferring patient to, from stretcher required.

VI. OTHER REQUIREMENTS

A. Work in Confined or Isolated Spaces (1915.54, 1916.54, 1917.54)

1. Frequent checks required whenever work is performed in confined space

- o Exception: if employees wear air line respirators, attendant must be present at all times.

2. Frequent checks also required if employee works alone in isolated location.

B. Work On or In Vicinity of Radar and Radio (1915.55, 1916.55)

1. Only radar or radio repairmen allowed to work on masts, kingposts, other aloft areas

- o Exception: if radar and radio secured, made incapable of radiation.

2. Radio and radar to be appropriately tagged



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Title

General Working Conditions

Notes

Lesson Plan

3. Radar, radio not to be tested until employer schedules tests at time when:
 - o No work in progress aloft; or
 - o Personnel cleared from work area
 - Minimum clearance distance based on equipment type, model, power.



Lesson No. 44

Time 50 minutes

Title

Health and Sanitation

Objective

Upon completion of this lesson, the trainee will be able to discuss the more common health hazards and the requirements to protect the health of shipyard workers, including the Material Safety Data Sheet.

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Lesson No.

44

Title

Health and Sanitation

Technique	Content	Time
Lecture, Workshop, and Slides	I. Material Safety Data Sheet	15 minutes
	II. Workshop	35 minutes
		Total Time: 50 minutes

Materials

- 1 Slide
Slide Projector (35 mm)
- 2 Handouts

Provide multiple copies of the following suggested references or similar source materials:

- 1. NFPA Guide on Hazardous Materials
- 2. Sax's Dangerous Properties of Industrial Materials
- 3. Patty's Industrial Hygiene and Toxicology, Volume II.

References

- 1. U.S. Occupational Safety and Health Administration. Material safety data sheet: requirements for reporting hazardous materials. Washington, DC, U.S. Department of Labor, 1976.
- 2. U.S. Occupational Safety and Health Administration. "Safety and health standards for maritime employment." Federal Register, Vol. 39, No. 119, June 19, 1974.



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B. Contents of Material Safety Data Sheets	44-4
C. Review of Important Definitions	44-12
II. Workshop	44-13



VISUAL AID

V-44-1

Word Slide

Important Definitions for Material
Safety Data Sheets



HANDOUTS

1. Form OSHA-20
2. U.S. Occupational Safety and Health Administration. Material safety data sheet: requirements for reporting hazardous materials. Washington, DC, U.S. Department of Labor, 1976.



Lesson No.

44

Title

Health and Sanitation

Notes

Lesson Plan

I. MATERIAL SAFETY DATA SHEET--FORM OSHA 20
(1915.57, 1916.57, 1917.57)

A. General Requirements

1. Employer must ascertain potential fire, toxicity, reactivity hazards of using, handling, applying following types of hazardous substances before use:

- o Chemical products, such as:

- Solvents
- Preservatives

- o Structural materials, such as:

- Cadmium or zinc-coated steel
- Plastic

- o Process materials, such as:

- Welding filler metal, e.g., cadmium.

2. All required information about substance to be recorded on Material Safety Data Sheet, Form OSHA 20, or similar form approved by OSHA

- o Copies of Form OSHA 20 available at OSHA regional offices

- o Completed form to be available for inspection for 3 months from date job is completed.

B. Contents of Material Safety Data Sheet

1. Manufacturer's name and address

- o If data not provided by manufacturer, source of data to be given.

Handout 1
FORM OSHA 20

Handout 2
MATERIAL SAFETY DATA SHEET
(OSHA BOOKLET)



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44

Title

Health and Sanitation

Notes

Lesson Plan

2. Emergency telephone number

- o For further information in case of emergency involving material.

3. Chemical name and synonyms

- o Refers only to product consisting of one element or compound

- Examples: oxygen, methyl ethyl ketone (MEK).

4. Trade names and synonyms

- o Name(s) under which product is sold if different from chemical name.

5. Chemical family

- o Generic name of single element or compound

- Examples: acid, ketone.

6. Formula

- o Only chemical formula for single elements or compounds, not formulation of a mixture

- Examples: O_2 (oxygen), $C_2H_5COCH_3$ (methylethyl ketone).

7. Hazardous ingredient

- o Hazardous material in mixture in sufficient concentration to:

- Produce enough flammable vapor or gas to ignite; or

- Cause acute or chronic health effects in doses that result from normal use or predictable misuse of material



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Health and Sanitation

Notes

Lesson Plan

- o To be noted by chemical name in one of following three divisions:
 - Paints, preservatives, and solvents
 - Alloys and metallic coatings, such as plating, cladding, metallizing, and filler metal added in making brazed, soldered, or welded joint
 - Hazardous mixtures of other liquids, solids, or gases, such as abrasive blasting materials
 - o Approximate percentage of each hazardous ingredient to be shown to nearest 5 percent
 - Percentage of ingredient constituting less than 5% to be indicated as such
 - o If a mixture, such as filler metals and their coatings and cores, in which hazardous ingredients are small proportion of mixture, hazardous ingredients to be stated to nearest 0.5%
 - If ingredient is less than 0.5% of mixture, to be indicated as such
 - o Threshold limit value (TLV) to be provided.
8. Boiling point
- o Temperature at which liquid boils in degrees F at pressure of 760 mmHg
 - Boiling range acceptable for mixtures.



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Health and Sanitation

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Lesson Plan

9. Vapor pressure

- o Refers to pressure of saturated vapor above liquid in mmHg at 20°C.

10. Vapor density

- o Refers to relative density or weight of vapor or gas, with no air present, compared with equal volume of air
- o Values to be given in temperature range of 60°F to 90°F to facilitate field usage.

11. Solubility in water

- o Following terms used to describe product's solubility by weight in distilled water at 50°F:
 - Negligible -- less than 0.1%
 - Slight -- 0.1 - 1.0%
 - Moderate -- 1 - 10%
 - Appreciable -- more than 10%
 - Complete -- in all proportions.

12. Specific gravity

- o Ratio of weight of a volume of material to weight of equal volume of water at 39.2°F
- o Determines whether material floats or sinks in water.



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Title

Health and Sanitation

Notes

Lesson Plan

13. Percentage volatile by volume

- o Percentage of liquid or solid by volume that evaporates at 70°F
- o Applies to solids such as naphthalene.

14. Evaporation rate

- o Whether rate is greater, less than one
- o Either butyl acetate or ether used as unity (one)
 - Name of whichever one used to be inserted.

15. Appearance and odor

- Brief description, e.g., viscous, colorless liquid with aromatic odor.

16. Flash point

- o Temperature in degrees F at which liquid gives off enough flammable vapor to ignite
- o Closed cap values to be given
- o If multi-component paint systems are used and mixed in the field, flash point of individual ingredients to be noted.

17. Flammable or explosive limits

- o Range of gas or vapor concentrations (as percent by volume in air) which will burn, explode if ignition source present
 - LEL is lower explosive limit
 - UEL is upper explosive limit



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Health and Sanitation

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Lesson Plan

- o Aids in determining volume of ventilation needed to prevent fires, explosions in enclosed spaces.

18. Extinguishing media

- o List of firefighting material suitable for use on burning material
- o If special formulations available for extinguishing fires in addition to standard agents, they are to be listed by generic names
 - Standard firefighting agents are water fog, foam, alcohol foam, carbon dioxide, and dry chemicals.

19. Special firefighting procedures

- o Media to be specified if water unsuitable
- o Includes list of necessary personal protective equipment.

20. Unusual fire and explosion hazards

- o Hazards and/or any special conditions governing them.

21. Threshold limit value (TLV)

- o Refers to current figures of American Conference of Governmental Industrial Hygienists (ACGIH)
- o TLV for single elements and compounds to be noted
- o Values to be expressed as:
 - Millions of particles per cubic foot of air (mppcf) or milligrams of particulate per cubic meter of air (mg/m³) for dust



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Lesson Plan

- Milligrams of particulate per cubic meter of air (mg/m^3) or parts per million of air by volume (ppm) for all other contaminants.

22. Effects of overexposure

- o Most common sensations person will feel
- o Appearance of overexposed person.

23. Emergency and first aid procedures

- o Only inhalation and skin or eye contact to be considered in recommending first aid measures
- o Emergency procedures only
 - Victim to be examined by doctor as soon as possible.

24. Stability

- o Whether stable or unstable under reasonably foreseeable conditions of storage, use, misuse
- o If unstable, conditions that can cause dangerous reaction to be listed
 - Examples: shock from dropping; temperatures above 150°F .

25. Incompatibility

- o Information on common materials, contaminants with which product may reasonably come in contact and produce reaction that would release large amounts of energy
 - If none, should be noted.



Lesson No. 44

Title Health and Sanitation

Notes

Lesson Plan

26. Hazardous decomposition products

- o Hazardous materials produced in dangerous amounts by:
 - Burning
 - Oxidation
 - Heating in welding or other hot work
- o Examples of thermal decomposition products
 - Carbon monoxide
 - Carbon dioxide
 - Hydrochloric acid from vinyl chloride plastics.

27. Hazardous polymerization

- o Polymerization that takes place at rate which releases large amounts of energy
- o If it can occur, reasonably foreseeable storage conditions that would start polymerization to be listed
- o Expected time period in which inhibitors may be used up to be included.

28. Spill or leak procedures

- o Applicable precautions to be listed
 - Avoiding inhalation of vapors, gases
 - Avoiding contact with liquids, solids
 - Removing sources of ignition



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Health and Sanitation

Notes

Lesson Plan

- Special equipment used for cleanup, e.g., glass or plastic scoops
- Disposal of spilled liquids, solids, e.g., flushing with water, burning.

29. Special protection information

- o Type of personal protective equipment and ventilation to be used
- o Precautions when using product for intended purpose
 - Example: eliminate ignition sources.

30. Special precautions

- o Precautions necessary to avoid reaction hazards, e.g., in handling, storing
 - Also other general precautions
- o If applicable, safe storage life relative to reactivity to be indicated.

C. Review of Important Definitions

1. Trade name
2. Hazardous ingredients
3. Formulation
4. Threshold limit values
5. Boiling point
6. Vapor pressure
7. Vapor density

V-44-1

Word Slide:

IMPORTANT DEFINITIONS FOR
MATERIAL SAFETY DATA SHEETS



Lesson No

44

Title

Health and Sanitation

Notes

[Each student has a sample data sheet to review. After instructor has pointed out all points of information on the sheet, the students will fill out a blank sheet. References should be provided in adequate number for the entire class. Suggested references include the NFPA Guide on Hazardous Materials, Sax's Dangerous Properties of Industrial Materials, and Patty's Industrial Hygiene and Toxicology. Suggested substances include trichloroethylene, toluene, xylene, kerosene, and methyl ethyl ketone (MEK). Use the completed data sheets that accompany this lesson to check trainee's work.]

Lesson Plan

8. Solubility in water
9. Specific gravity
10. Reactivity.

II. WORKSHOP.

Form Approved
Budget Bureau No. 44-R1387
Approval Expires April 30, 1971

Form No. LSH-OOS-4
May 1969

U.S. DEPARTMENT OF LABOR
WORKPLACE STANDARDS ADMINISTRATION
Bureau of Labor Standards

MATERIAL SAFETY DATA SHEET

SECTION I

MANUFACTURER'S NAME		EMERGENCY TELEPHONE NO.
ADDRESS (Number, Street, City, State, and ZIP Code)		
CHEMICAL NAME AND SYNONYMS		TRADE NAME AND SYNONYMS
CHEMICAL FAMILY	FORMULA	

SECTION II HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS			BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS					
HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES				%	TLV (Units)

SECTION III PHYSICAL DATA

BOILING POINT (°F.)		SPECIFIC GRAVITY (H ₂ O=1)	
VAPOR PRESSURE (mm Hg.)		PERCENT VOLATILE BY VOLUME (%)	
VAPOR DENSITY (AIR=1)		EVAPORATION RATE (_____ = 1)	
SOLUBILITY IN WATER			
APPEARANCE AND ODOR			

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	FLAMMABLE LIMITS	LeI	UeI
EXTINGUISHING MEDIA			
SPECIAL FIRE FIGHTING PROCEDURES			
UNUSUAL FIRE AND EXPLOSION HAZARDS			

SECTION V HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE

EFFECTS OF OVEREXPOSURE

EMERGENCY AND FIRST AID PROCEDURES

SECTION VI REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE		

INCOMPATIBILITY (Materials to avoid)

HAZARDOUS DECOMPOSITION PRODUCTS

HAZARDOUS
POLYMERIZATION

MAY OCCUR

WILL NOT OCCUR

CONDITIONS TO AVOID

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

WASTE DISPOSAL METHOD

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)

VENTILATION

LOCAL EXHAUST

MECHANICAL (General)

SPECIAL

OTHER

PROTECTIVE GLOVES

EYE PROTECTION

OTHER PROTECTIVE EQUIPMENT

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

OTHER PRECAUTIONS

Form Approved
Budget Bureau No. 44-R1387
Approval Expires April 30, 1971

Form No. LSA-OOS-4
May 1969

U.S. DEPARTMENT OF LABOR
WORKPLACE STANDARDS ADMINISTRATION
Bureau of Labor Standards

MATERIAL SAFETY DATA SHEET

SECTION I

MANUFACTURER'S NAME		EMERGENCY TELEPHONE NO.
ADDRESS (Number, Street, City, State, and ZIP Code)		
CHEMICAL NAME AND SYNONYMS Kerosene (Fuel oil No.1)		TRADE NAME AND SYNONYMS
CHEMICAL FAMILY	FORMULA	

SECTION II HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS			BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS					
HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES				%	TLV (Units)

SECTION III PHYSICAL DATA

BOILING POINT (°F.)	304-574° F	SPECIFIC GRAVITY (H ₂ O=1)	<1
VAPOR PRESSURE (mm Hg.)		PERCENT VOLATILE BY VOLUME (%)	
VAPOR DENSITY (AIR=1)	4.5	EVAPORATION RATE (_____ = 1)	
SOLUBILITY IN WATER	NO		
APPEARANCE AND ODOR A pale yellow to water white oily liquid			

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	100° F (cc)	FLAMMABLE LIMITS	Lel	Uel
			0.7	5
EXTINGUISHING MEDIA Water spray, foam				
SPECIAL FIRE FIGHTING PROCEDURES Use water spray, dry chemical, foam or CO ₂				
Use water to keep fire-exposed container cool, if a leak or spill has not ignited,				
UNUSUAL FIRE AND EXPLOSION HAZARDS use water spray to disperse the vapors and to provide protection for person attempting to stop the leak. Water spray must be used to flush spills away from exposures.				

SECTION V HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE

None established

EFFECTS OF OVEREXPOSURE Inhalation of mists will cause mucous membrane irritation. Contact with lung tissue will cause chemical pneumonitis. Prolonged skin contact will cause

EMERGENCY AND FIRST AID PROCEDURES

drying dermatitis.

SECTION VI REACTIVITY DATA

STABILITY

UNSTABLE

CONDITIONS TO AVOID

STABLE

YES

INCOMPATIBILITY (Materials to avoid)

HAZARDOUS DECOMPOSITION PRODUCTS

HAZARDOUS
POLYMERIZATION

MAY OCCUR

CONDITIONS TO AVOID

WILL NOT OCCUR

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Clean up with absorbent material.

WASTE DISPOSAL METHOD

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)

Organic vapor cartridge respirator

VENTILATION

LOCAL EXHAUST

SPECIAL

MECHANICAL (General)

Ventilation control recommended

OTHER

PROTECTIVE GLOVES

EYE PROTECTION

Chemical goggles

OTHER PROTECTIVE EQUIPMENT

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

OTHER PRECAUTIONS

U.S. DEPARTMENT OF LABOR
WORKPLACE STANDARDS ADMINISTRATION
Bureau of Labor Standards

MATERIAL SAFETY DATA SHEET

SECTION I

MANUFACTURER'S NAME		EMERGENCY TELEPHONE NO.
ADDRESS (Number, Street, City, State, and ZIP Code)		
CHEMICAL NAME AND SYNONYMS Methyl Ethyl Ketone (2-Butanone)		TRADE NAME AND SYNONYMS MEK
CHEMICAL FAMILY Ketone	FORMULA C ₂ H ₅ COCH ₃	

SECTION II HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS			BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS					
HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES				%	TLV (Units)
Methyl Ethyl Ketone 200				100	PPM

SECTION III PHYSICAL DATA

BOILING POINT (°F.)	176°C	SPECIFIC GRAVITY (H ₂ O=1)	.805
VAPOR PRESSURE (mm Hg.)	71.2	PERCENT VOLATILE BY VOLUME (%)	
VAPOR DENSITY (AIR=1)	2.5	EVAPORATION RATE (Ether =1)	2.7
SOLUBILITY IN WATER	YES		
APPEARANCE AND ODOR Colorless liquid acetone-like odor			

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	21° (F) (cc)	FLAMMABLE LIMITS	LeI	UeI
			1.8	10
EXTINGUISHING MEDIA Alcohol Foam, CO ₂ , dry chemical				
SPECIAL FIRE FIGHTING PROCEDURES Water may be ineffective, use alcohol foam				
UNUSUAL FIRE AND EXPLOSION HAZARDS Can react with oxidizing agents				

SECTION V HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE 200 ppm

EFFECTS OF OVEREXPOSURE Produces local irritation and narcosis. Highly irritating to eyes.

EMERGENCY AND FIRST AID PROCEDURES
 Inhalation: Remove to fresh air, consult a physician.
 Eye contact: Flush with water, consult a physician.

SECTION VI REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	Yes	

INCOMPATIBILITY (Materials to avoid)

HAZARDOUS DECOMPOSITION PRODUCTS

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR		

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Clean up with absorbent material.

WASTE DISPOSAL METHOD

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type) Organic vapor cartridge type respirator

VENTILATION	LOCAL EXHAUST Not necessary if below TLV	SPECIAL
	MECHANICAL (General) Dilute to below TLV	OTHER

PROTECTIVE GLOVES Yes **EYE PROTECTION** Chemical goggles

OTHER PROTECTIVE EQUIPMENT

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING Outside storage recommended. Inside storage should be in approved flammable liquid storage cabinets.

OTHER PRECAUTIONS

U.S. DEPARTMENT OF LABOR
WORKPLACE STANDARDS ADMINISTRATION
Bureau of Labor Standards

MATERIAL SAFETY DATA SHEET

SECTION I

MANUFACTURER'S NAME		EMERGENCY TELEPHONE NO.
ADDRESS (Number, Street, City, State, and ZIP Code)		
CHEMICAL NAME AND SYNONYMS Toluene (Methylbenzene)		TRADE NAME AND SYNONYMS
CHEMICAL FAMILY Aromatic HydroCarbon	FORMULA C ₆ H ₅ CH ₃	

SECTION II HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS			BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS					
HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES				%	TLV (Units)
Toluene				200	100 PPM

SECTION III PHYSICAL DATA

BOILING POINT (°F.)	231° (F)	SPECIFIC GRAVITY (H ₂ O=1)	0.9
VAPOR PRESSURE (mm Hg.)		PERCENT VOLATILE BY VOLUME (%)	
VAPOR DENSITY (AIR=1)	3.1	EVAPORATION RATE (Ether = 1)	4.5
SOLUBILITY IN WATER	NO		
APPEARANCE AND ODOR Colorless liquid with aromatic benzene-like odor			

SECTION IV FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	40° F (cc)	FLAMMABLE LIMITS	LeI	UeI
			1.2	7.1
EXTINGUISHING MEDIA CO ₂ dry chemical, foam				
SPECIAL FIRE FIGHTING PROCEDURES Water may be ineffective				
UNUSUAL FIRE AND EXPLOSION HAZARDS Vapor heavier than air and may travel considerable distance to a source of ignition, and flashback.				

SECTION V HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE

200 ppm

EFFECTS OF OVEREXPOSURE

Eye and respiratory irritant. Extreme inhalation of vapors may cause death by paralysis of the respiratory center.

EMERGENCY AND FIRST AID PROCEDURES

Inhalation: Remove to fresh air, consult a physician.

Skin contact: Wash with water, consult a physician.

SECTION VI REACTIVITY DATA

STABILITY

UNSTABLE

CONDITIONS TO AVOID

STABLE

Yes

INCOMPATIBILITY (Materials to avoid)

HAZARDOUS DECOMPOSITION PRODUCTS

HAZARDOUS
POLYMERIZATION

MAY OCCUR

CONDITIONS TO AVOID

WILL NOT OCCUR

SECTION VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Clean up with absorbent material

WASTE DISPOSAL METHOD

SECTION VIII SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)

Use organic vapor cartridge respirator.

VENTILATION

LOCAL EXHAUST

Not necessary if below TLV

SPECIAL

MECHANICAL (General)

Dilute to below TLV

OTHER

PROTECTIVE GLOVES

Yes

EYE PROTECTION

Chemical goggles

OTHER PROTECTIVE EQUIPMENT

Wear self contained breathing apparatus under extreme conditions

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING

Protect against physical damage outside or

detached storage preferred. Inside storage should be in a standard flammable

OTHER PRECAUTIONS

liquid storage cabinet or room separate from oxidizing materials.

U.S. DEPARTMENT OF LABOR
WORKPLACE STANDARDS ADMINISTRATION
Bureau of Labor Standards

MATERIAL SAFETY DATA SHEET

SECTION I

MANUFACTURER'S NAME		EMERGENCY TELEPHONE NO.
ADDRESS (Number, Street, City, State, and ZIP Code)		
CHEMICAL NAME AND SYNONYMS Xylene (Dimethyl benzene) (Xylol)		TRADE NAME AND SYNONYMS
CHEMICAL FAMILY Aromatic Hydrocarbon	FORMULA $C_6H_4(CH_3)_2$	

SECTION II. HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS			BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS			FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS					
HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES				%	TLV (Units)
m - Xylene				200	PPM

SECTION III. PHYSICAL DATA

BOILING POINT (°F.)	282° (F)	SPECIFIC GRAVITY (H ₂ O=1)	0.9
VAPOR PRESSURE (mm Hg.) at 10mmHg	32.1° (C)	PERCENT VOLATILE BY VOLUME (%)	
VAPOR DENSITY (AIR=1)	3.7	EVAPORATION RATE ($\frac{Et_{net}}{Et_{net}}=1$)	9.2
SOLUBILITY IN WATER	NO		
APPEARANCE AND ODOR Clear colorless liquid			

SECTION IV. FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used)	81°F-90°F (cc)	FLAMMABLE LIMITS	LeI	UeI
			1.1	7.0
EXTINGUISHING MEDIA	CO ₂ , Foam, Dry Chemical			
SPECIAL FIRE FIGHTING PROCEDURES	Water may be ineffective			
UNUSUAL FIRE AND EXPLOSION HAZARDS				

SECTION V HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE 200 ppm

EFFECTS OF OVEREXPOSURE Toxic vapors in high concentration are anesthetic irritant to skin and upper respiratory system.

EMERGENCY AND FIRST AID PROCEDURES Wash with water and consult a physician.

SECTION VI REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	Yes	

INCOMPATIBILITY (Materials to avoid) Can react with oxidizing materials

HAZARDOUS DECOMPOSITION PRODUCTS

HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR		

SECTION VII SPILL OR LEAK PROCEDURES**STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED**

Clean up with absorbent material.

WASTE DISPOSAL METHOD**SECTION VIII SPECIAL PROTECTION INFORMATION**

RESPIRATORY PROTECTION (Specify type) Use organic vapor cartridge respirator.

VENTILATION	LOCAL EXHAUST	SPECIAL
	MECHANICAL (General)	OTHER

Not necessary if below TLV
Dilute to below TLV

PROTECTIVE GLOVES Yes **EYE PROTECTION** Chemical goggles recommended.

OTHER PROTECTIVE EQUIPMENT

SECTION IX SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING
Protect container against damage. Outside detached storage is preferable - inside storage should be in standard flammable handy storage cabinet. Separate from oxidizing materials. Electrical installation should conform to Class I hazardous location article 500 National Electrical Code.



Lesson No. 45

Time 50 minutes

Title

Health and Sanitation (Continued)

Objective

Upon completion of this lesson, the trainee will be able to discuss the more common health hazards and the requirements to protect the health of shipyard workers, including the Material Safety Data Sheet.

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Lesson No.

45

Title

Health and Sanitation (Continued)

Technique	Content	Time
Lecture, Workshop, and Slides	II. Workshop (Continued)	20 minutes
	III. General Health Protection Requirements	15 minutes
	IV. Asbestos	15 minutes
	Total Time: 50 minutes	
Materials		
14 Slides Slide Projector (35 mm)		
References		
1. U.S. Occupational Safety and Health Administration. "OSHA safety and health standards for general industry (29 CFR 1910). Section 1910.1001, asbestos." Washington DC, U.S. Department of Labor, 1978.		
2. U.S. Occupational Safety and Health Administration. "Safty and health standards for maritime employment." <u>Federal Register</u> , Vol. 39, No. 119, June 19, 1974.		

45-2



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VISUAL AIDS

V-45-1	Photo Slide	Personal Protection (*)
V-45-2	Photo Slide	Washing Facilities
V-45-3	Photo Slide	Good Personal Hygiene
V-45-4	Photo Slide	Washing Hands
V-45-5	Photo Slide	Washing Facilities
V-45-6	Photo Slide	Uncovered Trash Container
V-45-7	Photo Slide	Employees Working in Dry Dock (*)
V-45-8	Photo Slide	Asbestos
V-45-9	Photo Slide	Pipe Insulation
V-45-10	Photo Slide	Ship Engine Room with Insulation Removed from Pipes (*)
V-45-11	Photo Slide	Engine Space on New Ship Ready for Insulation with Asbestos Substitute (*)
V-45-12	Word Slide	Symptoms of Asbestosis
V-45-13	Photo Slide	Asbestos Fiber
V-45-14	Word Slide	Regulatory Requirements to Control Asbestos Exposure

(*) For internal Department of Labor training purposes only.



Lesson No.

45

Title

Health and Sanitation (Continued)

Notes

Lesson Plan

II. WORKSHOP (Continued)

III. GENERAL REQUIREMENTS FOR WORKER HEALTH
PROTECTION (1915.57, 1916.57, 1917.57)

A. Training

1. Employer to instruct employees
who risk exposure to hazardous
materials in:

- o Nature of hazards
- o Means of avoiding hazards.

B. Controls

1. Employer to provide all necessary
hazard controls
2. Employees to be protected by
suitable personal protective
equipment as specified for:

- o Hazardous materials for which
Material Safety Data Sheets
required
- o Hazards cited in following
standards
 - Explosive and other
dangerous atmospheres
(Subpart B)
 - Surface preparation and
preservation (Subpart C)
 - Welding, cutting, and
heating (Subpart D).

C. Washing Facilities

1. Employer to provide adequate
washing facilities for employees
engaged in following work:
 - o Application of paints, coatings

V-45-1
Photo Slide:
PERSONAL PROTECTION

V-45-2
Photo Slide:
WASHING FACILITIES



Lesson No.

45

Title

Health and Sanitation (Continued)

Notes

V-45-3
Photo Slide:
GOOD PERSONAL HYGIENE

V-45-4
Photo Slide:
WASHING HANDS

V-45-5
Photo Slide:
WASHING FACILITIES

V-45-6
Photo Slide:
UNCOVERED TRASH CONTAINER

V-45-7
Photo Slide:
EMPLOYEES WORKING IN DRY DOCK

V-45-8
Art Slide:
ASBESTOS

V-45-9
Photo Slide:
PIPE INSULATION

Lesson Plan

- o Other operations where harmful contaminants can be ingested or absorbed.
- 2. Employer to encourage good personal hygiene practices
 - o Inform employees of need to remove surface contaminants by washing hands, face before eating or smoking.
- D. Smoking and Eating
 - 1. Prohibited in areas of surface preparation or preservation.
- E. Uncovered Garbage
 - 1. Employer to prohibit work in immediate vicinity of uncovered garbage
 - 2. Must ensure employees working beneath or on outboard side of vessel not subject to contamination from drainage, waste from discharges.

IV. ASBESTOS

- A. Sources of Asbestos
 - 1. Asbestos may be contained in:
 - o Grout
 - o Plaster
 - o Coating
 - o Insulation.



Lesson No.

45

Title

Health and Sanitation (Continued)

Notes

V-45-10

Photo Slide:

SHIP ENGINE ROOM WITH
INSULATION REMOVED FROM
PIPES

V-45-11

Photo Slide:

ENGINE SPACE ON NEW SHIP
READY FOR INSULATION WITH
ASBESTOS SUBSTITUTE

V-45-12

Word Slide:

SYMPTOMS OF ASBESTOSIS

Lesson Plan

2. Particular hazard during rip-out operations on older vessels where insulation on pipes, boilers likely to contain asbestos.

B. Health Effects

1. Known carcinogen of the lungs, pleura, peritoneum
 - o May cause mesothelioma, a rare tumor of the cells that line body cavities.
2. Causes asbestosis
 - o A diffuse fibrosis of lung tissue that may result in death from lack of oxygen
 - o Characterized by shortness of breath of increasing intensity, dry cough, emphysematous changes in lungs.
3. Symptoms of asbestosis
 - o Coughing
 - o Shortness of breath
 - o Asbestos bodies discharged in sputum
 - o Abnormal sounds (rales) accompany breaths
 - o Clubbing of the fingers.



Lesson No.

45

Title

Health and Sanitation (Continued)

Notes

V-45-13
Photo Slide:
ASBESTOS FIBER

V-45-14
Word Slide:
REGULATORY REQUIREMENTS TO
CONTROL ASBESTOS EXPOSURE

[Review the asbestos regula-
tion on slide in conjunction
with the text material.]

Lesson Plan

C. Regulatory Requirements (1910.1001)

1. Exposure to 8-hour time-weighted airborne concentrations of asbestos fibers not to exceed 2 fibers longer than 5 micrometers per cubic centimeter of air
 - o To be measured by membrane filter method at 400'450 x (magnification) (4 millimeter objective) with phase contrast illumination.
2. Ceiling concentration exposure limit is airborne concentration of 10 fibers longer than 5 micrometers per cubic centimeter of air
 - o To be measured as described above.
3. Engineering control methods of compliance
 - o May include, but not limited to:
 - Isolation method (most likely in shipyards)
 - Enclosure
 - Exhaust ventilation
 - Dust collection
 - o Must be used to meet exposure limits described above
 - o Local exhaust ventilation and dust collection systems to be designed, constructed, installed, maintained according to American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems (ANSI Z9.2-1971)



Lesson No.

45

Title

Health and Sanitation (Continued)

Notes

Lesson Plan

- o Hand-operated and power-operated tools that may release asbestos fibers when operated must have appropriate local exhaust ventilation systems

- Saws
- Scorers
- Abrasive wheels
- Drills.

4. Work practice methods of compliance

- o Asbestos to be handled, mixed, used in wet state whenever practical

- Prevents excess emissions of airborne fibers

- o No material containing asbestos to be removed from shipping containers unless:

- Wetted, or
- Enclosed, or
- Ventilated

- o Respiratory protection and special clothing required for employees engaged in following:

- Spraying asbestos
- Removal or demolition of pipes, structures that contain asbestos
- Removal or demolition of asbestos insulation or coverings.



Lesson No.

45

Title

Health and Sanitation (Continued)

Notes

Lesson Plan

5. Personal protective equipment

- o Respirators and shift rotation of employees not acceptable means of achieving compliance with exposure limits except:
 - During time necessary for installation of engineering controls and institution of required work practices
 - In situations where required control methods technically infeasible or insufficient to meet exposure limits
 - In emergencies
- o Under above circumstances, employee rotation preferable to respiratory protection
- o If respirator used, must be Bureau of Mines or NIOSH approved
 - Air purifying respirator to be used to reduce concentrations of airborne fibers in respirator below exposure limits when 8-hour time-weighted average airborne concentration expected to exceed 10 times the limits or less
 - Powered air purifying respirator to be used if airborne concentration expected to exceed 10 times but not 100 times exposure limits
 - Type C supplied-air continuous flow or pressure-demand respirator to be used if airborne concentration expected to exceed 100 times exposure limit



Lesson No.

45

Title

Health and Sanitation (Continued)

Notes

Lesson Plan

- o Employer to establish respirator program according to requirements of ANSI Standard Z88.2-1969
 - Includes requirements for maintaining historic file
- o Employee prohibited from wearing respirator if:
 - Most recent physical exam shows employee will be unable to function normally with respirator; or
 - Safety and health of employee, other employees will be impaired by use of respirator
 - If employee cannot use respirator, is to be rotated to another job or given opportunity for transfer to different position if available.
- 6. Special clothing requirements
 - o Employer to provide, require use of special clothing for any employee exposed to concentration above limits, including:
 - Coveralls or similar whole body clothing
 - Head coverings
 - Gloves
 - Foot coverings.
- 7. Requirements for change rooms
 - o To be provided at any fixed place of employment where airborne asbestos concentration exceeds exposure limits



Lesson No.

45

Title

Health and Sanitation (Continued)

Notes

Lesson Plan

- o For employees who work regularly at the place
- o Two separate change lockers or containers required for each employee
 - Must be separate, isolated so that work clothes do not contaminate street clothes
- o Laundering to be done in way that prevents release of airborne fibers
 - If laundering done by person other than employer, must be informed that release of fibers in excess of exposure limits is to be prevented
- o Contaminated clothing to be transported in sealed or closed impermeable bags or containers
 - Must be labeled clearly to caution of presence of asbestos and hazards of dust inhalation.

8. Monitoring requirements

- o Personal monitoring samples to be collected within employee's breathing zone
 - On 0.8 micrometer porosity membrane filters mounted in open-face filter holder
 - Samples to be taken to determine 8-hour time-weighted average airborne and ceiling concentrations
 - Sampling to be frequent enough to ensure reasonably accurate readings



Lesson No.

45

Title

Health and Sanitation (Continued)

Notes

Lesson Plan

- Must sample at least every 6 months for employees reasonably expected to be exposed to concentrations greater than exposure limits
- o Environmental monitoring requires samples to be taken from air in work areas that is representative of employee's breathing zones
- On 0.8 micrometer porosity membrane filter mounted as above
- Taken to determine both 8-hour time-weighted average airborne and ceiling concentrations
- At least every 6 months for employees who can be expected to risk exposure above required limits
- o Affected employees or representatives must be given reasonable opportunity to observe monitoring and have access to records.
- 9. Requirements for cautions signs and labels
 - o Caution signs to be posted where airborne concentrations may exceed exposure limits
 - o To be posted so they can be read before entering marked area
 - Posting required at all entrances
 - o Signs must meet size and visibility requirements specified in the standard



Lesson No.

45

Title

Health and Sanitation (Continued)

Notes

Lesson Plan

- o Caution labels to be placed on all asbestos-containing materials or their containers
 - Exception: if asbestos fibers have been bonded, coated, or otherwise modified in way that prevents release of airborne fibers
- o Labels to be of sufficient size, contrast to be readily visible, legible.

10. Housekeeping

- o External surfaces to be kept free of excessive accumulations of fibers
- o Waste, debris, bags, other articles contaminated with asbestos to be disposed of in sealed or closed impermeable bags or containers.

11. Recordkeeping

- o Records to be maintained for any personal or environmental monitoring for 20 years
 - To be available to OSHA and NIOSH representatives
- o Every employee, former employee to be given reasonable access to records indicating own exposure
- o Employees found to have been exposed to excessive amounts of asbestos to be notified in writing within 5 days of the finding
 - Also to be notified of corrective action being taken.



Lesson No. 45

Title Health and Sanitation (Continued)

Notes

Lesson Plan

12. Medical examination requirements

- o Employer to provide exams relative to exposure at his cost
- o Comprehensive exam required for each employee within 30 days of first work that exposes him to asbestos fibers, including at minimum:
 - Chest roentgenogram
 - History to determine any symptoms of respiratory disease
 - Pulmonary function tests
- o Annual exams required for all exposed employees
 - To include same tests as above at minimum
- o Exam required within 30 days before or after termination of employment of any exposed employee
 - To include same tests as above at minimum
- o No exam required if employee has had adequate exam within past year
- o Medical records to be maintained and retained for 20 years
- o Contents of medical records to be available to:
 - OSHA
 - NIOSH



Lesson No.

45

Title

Health and Sanitation (Continued)

Notes

Lesson Plan

- Authorized physicians,
consultants of OSHA, NIOSH
- Employee's personal physician
- o Physician who conducts required
exams to tell employee about
record access, other information
on asbestos exposure.



Lesson No. 46

Time 50 minutes

Title

Gear and Equipment for Rigging and Materials Handling

Objective

Upon completion of this lesson, the trainee will be able to discuss the various gear, equipment and materials handling operations found in shipyard work, identify unsafe conditions and work practices, and recommend appropriate abatement methods.

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Lesson No.

46

Title

Gear and Equipment for Rigging and Materials
Handling

Technique	Content	Time
Lecture and Slides	I. Overview	25 minutes
	II. Applicable Standards	25 minutes
		Total Time: 50 minutes

Materials

51 Slides
Slide Projector (35 mm)
2 Handouts

References

1. Broderick and Bascom Rope Company. Rigger's handbook. St. Louis, MO, Broderick and Bascom, 1965.
2. National Safety Council. Accident prevention manual for industrial operations. 7th edition. Chicago, IL, National Safety Council, 1977.
3. U.S. Occupational Safety and Health Administration. "Safety and health standards for maritime employment." Federal Register, Vol. 39, No. 119, June 19, 1974.

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VISUAL AIDS

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VISUAL AIDS (Continued)

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V-46-30	Photo Slide	Barge Ways (*)
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V-46-33	Art Slide	Wire Rope Wear and Damage (1)
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V-46-45	Photo Slide	Marine Railway Carriage (*)
V-46-46	Photo Slide	Basket Being Rigged (*)
V-46-47	Photo Slide	Skip with Four Legs
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VISUAL AIDS (Continued)

V-46-49	Photo Slide	Signalmen Signaling to Hoist
V-46-50	Photo Slide	Damaged Pallets
V-46-51	Photo Slide	Open Hatch

(*) For internal Department of Labor training purposes only.

HANDOUTS

1. Wire Rope Wear and Damage.
2. Effectiveness of Attaching Wire Rope.



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes

V-46-1
Photo Slide:
HEAVY MANILA LASHING LINE

V-46-2
Photo Slide:
LASHING

V-46-3
Art Slide:
BLOCK AND TACKLE

Lesson Plan

I. OVERVIEW OF GEAR AND EQUIPMENT FOR RIGGING
AND MATERIALS HANDLING

A. Ropes, Chains, and Slings

1. Fiber rope

- o Used extensively in handling and moving materials
- o Generally made of manila, sisal, hemp, or nylon
 - Manila and nylon give best uniform strength, service
 - Commonly used in block and tackle
- o Safety factor variables for fiber ropes include:
 - Chafing
 - Cutting
 - Elasticity
 - Diameter-to-strength ratio
 - General anticipated mishandlings
- o Should be stored safe from:
 - Deleterious fumes
 - Heat
 - Chemicals
 - Moisture
 - Sunlight
 - Rodents
 - Biological attack.



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes

V-46-4
Photo Slide:
CRANES SHOWING WIRE ROPE IN
USE

V-46-5
Art Slide:
WIRE ROPE COMPONENTS

Lesson Plan

2. Wire rope

- o Used widely instead of fiber rope because:
 - Has greater strength for same diameter and weight
 - Strength constant whether wet or dry
 - Constant length regardless of weather conditions
 - Greater durability
- o Composed of wires, strands, and core
 - Size, number, arrangement of wires and strands, type of core determined by rope's intended use
- o Safety factor variables for wire rope include:
 - Type of load
 - Acceleration and deceleration
 - Rope speed
 - Rope attachments
 - Number, size, arrangement of sheaves and drums
 - Possible exposure to moisture, corrosives
- o Causes of deterioration include:
 - Wear
 - Corrosion
 - Kinks



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes

V-46-6
Photo Slide:
ROPE SLING IN USE

Lesson Plan

- Fatigue
- Drying out of lubrication
- Overloading
- Overwinding
- Mechanical abuse.

3. Rope slings

- o Fiber rope slings should be made of first grade manila rope
 - Has advantage of flexibility
 - Particularly suitable for loads that might be damaged by contact with metal slings
- o Wire rope slings preferably made with improved plow steel and preformed wire rope with independent core
- o Methods of attachment include:
 - Hook and ring
 - Socketing
 - Compression fittings
 - Swaged sleeve attachments
 - Hand-tucked splices
- o Factors that determine safety of rope slings include:
 - Use of rope and fittings suitable for weight of load
 - Methods of fastening rope to fittings



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes

Lesson Plan

V-46-7

Photo Slide:
CHAIN

V-46-8

Photo Slide:
CHAIN SLING

V-46-9

Photo Slide:
CHAIN SLING IN USE

V-46-10

Photo Slide:
SHACKLES

- Type of sling (single or 3-leg)
- Kind of hitch
- Regular inspection and maintenance.

4. Chains and chain slings

- o Alloy steel chain is standard because:
 - Twice as strong as wrought iron chain
 - High resistance to abrasion
 - Practically immune to failure from coldworking
- o Wrought iron chain has little commercial importance because of better qualities of alloy steel chain
- o Chain slings should preferably be purchased from manufacturer, returned there for repairs
- o In most cases, attachments are installed on chains by manufacturer who heat treats, tests the assembly.

B. Shackles and Hooks

1. Shackles

- o U-shaped fittings with pins
- o Used to secure chain fittings and other gear in a positive manner which requires the insertion of a drift pin, toggle, or bolt to make the connection.



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes

V-46-11
Photo Slide:
HOOK WITH SAFETY CLIP

V-46-12
Photo Slide:
CHAIN FALL

V-46-13
Photo Slide:
RATCHET COME-ALONG

V-46-14
Photo Slide:
CHAIN-TYPE PULL-LIFT

V-46-15
Art Slide:
WORKING LOAD LIMITS OF A
CHAIN SLING

V-46-16
Photo Slide:
LIFTING BEAM

Lesson Plan

2. Hooks

- o Curved fitting used to lift and pull
- o Usually a cast product and if bent or distorted will lose its original working strength.

C. Chain Falls and Pull-lifts

1. Chain falls

- o Chain-operated winch which is used to lift heavy objects in limited areas.

2. Pull-lifts and come-alongs

- o Chain or ratchet-turn buckle-type device used to hold steel sections in place
- o In shipfitting, come-alongs are used to hold units in place until the butt joint is tack-welded in place.

D. Sling Angles

1. Sling angles should be kept as small as possible to minimize tension on each sling leg
2. When the angle of a sling exceeds 60°, end pull on a load occurs and long slender objects will buckle

- o Lifting beam would be recommended for such objects
- o See Tables G-1 through G-8.



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes	Lesson Plan
V-46-17 Art Slide: STIFF LEG DERRICK V-46-18 Photo Slide: SLEW OF A DERRICK V-46-19 Art Slide: SKETCHES OF SHOP CRANES V-46-20 Photo Slide: JIB CRANE V-46-21 Photo Slide: OVERHEAD CRANE V-46-22 Photo Slide: TOWER CRANE V-46-23 Photo Slide: CANTILEVER PLATE-HANDLING CRANE V-46-24 Photo Slide: BARGE DERRICK V-46-25 Photo Slide: LOCOMOTIVE CRANE V-46-26 Photo Slide: CRAWLER AND TRUCK-MOUNTED CRANE	E. Hoisting and Hauling Equipment 1. Derricks - o Types of derricks used in ship-yards: - Stiff leg derrick - Guy derrick - "A" frame derrick - o Turning mechanism at the base of the derrick creates a pinch point hazard. 2. Shop cranes - o Types of cranes used in ship-yards: - Overhead crane - Cantilever crane - Gantry crane - Semi-gantry crane - Hammerhead crane - Wall crane. Mobile cranes - o Types of mobile cranes used in shipyards: - Barge derrick - Locomotive crane.



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes	Lesson Plan
V-46-27 Photo Slide: REVOLVING TRAVELING CRANES V-46-28 Photo Slide: REVOLVING CRANE ON WING WALL OF DRY DOCK V-46-29 Photo Slide: MARINE RAILWAY V-46-30 Photo Slide: BARGE WAYS V-46-31 Photo Slide: BARGE IN WAYS V-46-32 Photo Slide: BARGE READY FOR LAUNCH V-46-33 Art Slide: WIRE ROPE WEAR AND DAMAGE (1) Handout 1 WIRE ROPE WEAR AND DAMAGE V-46-34 Art Slide: WIRE ROPE WEAR AND DAMAGE (2)	4. Revolving cranes - o Types of revolving cranes used in shipyards: - Revolving traveling crane - Revolving crane on dry dock wing wall. 5. Marine railways - o Types of marine railways - Barge launching ways - Repair ways for tugs. II. REQUIREMENTS FOR GEAR AND EQUIPMENT USED IN RIGGING AND MATERIALS HANDLING (1915, 1916, 1917, SUBPART G) A. Inspection (1915.61, 1916.61, 1917.61) 1. All gear, equipment that employer provides for rigging, materials handling to be inspected as follows: - o Before each shift; and - o At intervals during use when necessary to ensure safety. 2. Defective gear to be removed and repaired or replaced before further use 3. Gear's safe working load not to be exceeded



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes

Lesson Plan

[Refer to Table G-1.]

[Refer to Tables G-2 through
G-6.]

4. Defects include:

- o Kinks
- o Wear
- o Wicking
- o "Birdcage"
- o High strands
- o Broken wires
- o Deformation
- o Fatigue
- o Crushing.

B. Ropes, Chains, and Slings (1915.62,
1916.62, 1917.62)

1. Manila rope and manila rope slings

- o Table G-1 to be used to deter-
mine safe working load of
different sizes of manila rope
and manila rope slings at
various angles
- Exception: higher loads
permissible if recommended
by manufacturer for specific
products and safety factor
of at least 5 maintained.

2. Wire rope and wire rope slings

- o Tables G-2 through G-5 to be
used to determine safe working
loads of different sizes,
classifications of improved
plow steel wire rope and wire
rope slings with various types
of terminals



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes

V-46-35
Art Slide:
EFFECTIVENESS OF ATTACHING
WIRE ROPE

Handout 2
EFFECTIVENESS OF ATTACHING
WIRE ROPE

[Refer to Tables G-7 and G-8.]

V-46-36
Photo Slide:
CHAIN SLING

Lesson Plan

- If size, classification, or grade not included in the tables, load recommended by manufacturer for specific product to be used and safety factor of at least 5 maintained

- o Protruding ends of spliced strands on slings, bridles to be covered or blunted
- o Table G-6 to be used to determine number, spacing of clips if U-bolt wire rope clips used to form eyes
- U-bolt to be applied so that U section contacts dead end of rope.

3. Chains and chain slings

- o Tables G-7, G-8 to be used to determine working load limit of various sizes of wrought iron and alloy steel chains, chain slings
- Exception: higher loads permitted when recommended by manufacturer for specific product
- o All sling chains, end fastenings to be visually inspected before use
- o Thorough inspection required every 3 months
- Each chain to be marked as to month of thorough inspection
- Inspection for wear, defective welds, deformation, increase in length or stretch



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes

[Refer to Table G-9.]

Lesson Plan

- o Table G-9 indicates maximum allowable wear at any point on link
 - Chain removed from service when maximum reached
 - Interlink wear when stretch does not exceed 5% to be noted
- o Chain to be removed from service when:
 - Stretch of measured section exceeds 5% of length; or
 - Link is bent, twisted, otherwise damaged; or
 - Raised scarfs, defective welds appear
- o Chain repairs to be made under qualified supervision
- o Defective links or chain portions to be replaced by links of proper size, similar material
 - To be proof tested to manufacturer's recommended proof test load before return to use
- o Wrought iron chains in constant use to be annealed or normalized at least every 6 months when recommended by manufacturer
 - Manufacturer to be consulted for proper annealing, normalizing procedures
- o Alloy chains never annealed



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Title Gear and Equipment for Rigging and
Materials Handling

Notes

V-46-37

Photo Slide:

SHACKLES (CLOSE-UP VIEW)

[Refer to Table G-10.]

V-46-38

Art Slide:

HOOK OPENING MEASUREMENT

[Point out that hook throat
opening measurement should
be made at its narrowest
point.]

V-46-39

Art Slide:

CRANE HOOK

Lesson Plan

- o Load not to be lifted by knotted or kinked chain
- o Bolting, wiring, knotting prohibited for shortening chain.

C. Shackles and Hooks (1915.63, 1916.63, 1917.63)

1. Shackles

- o Table G-10 to be used to determine safe working load of different sizes of shackles
 - Exception: higher loads permissible if recommended by manufacturer for specific product and safety factor of at least 5 maintained.

2. Hooks

- o Manufacturer's recommendations to be followed in determining safe working load for specific types of hooks
 - If no manufacturer's recommendations available, must be tested to at least twice safe working load before use
 - Employer must maintain record of dates, results of tests
- o Loads to be applied to throat of hook
 - Loading point overstresses and bends or springs hook
- o Hooks to be inspected periodically to see if bent by overloading
 - Bent or sprung hooks not to be used.



Lesson No.

46

Title

Gear and Equipment for Rigging and
Materials Handling

Notes

V-46-40

Photo Slide:

MARKINGS ON CHAIN FALLS

Lesson Plan

D. Chain Falls and Pull-lifts (1915.64,
1916.64, 1917.64)

1. Capacity to be clearly marked
and not exceeded
2. Regular inspections for distortion
and wear required
 - o On chain falls, particular
attention to:
 - Lift chains
 - Sheaves
 - Pinions
 - Hooks
 - o On pull-lifts, particular
attention to:
 - Ratchets
 - Pawls
 - Chains
 - Hooks.
3. Straps, shackles, and beam or over-
head structure to which chain fall
or pull-lift secured to be strong
enough to support load weight plus
gear
4. Upper hook to be moused, otherwise
secured against coming free of
support
5. Scaffolding not to be used as
point of attachment for lifting
devices unless specifically
designed for such.



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes

Lesson Plan

E. Hoisting and Hauling Equipment
(1915.65, 1916.65, 1917.65)

1. Derrick and crane certification

o Must be tested and approved
as required by accredited
persons if:

- Part of or regularly placed
on barges, other vessels,
wing walls of floating
dry docks; and

- Used regularly to move
materials, equipment to,
from vessel or dry dock.

2. Moving parts of hoisting, hauling
equipment to be guarded

3. Requirements for mobile crawler
and truck cranes used on vessel

o Following to be posted near
controls and visible to
operator:

- Manufacturer's maximum safe
working load for boom's
various radii

- Maximum and minimum safe boom
radii with and without out-
riggers

- Radius indicator

o Posted safe working loads not to
be exceeded.

V-46-41

Photo Slide:
MOBILE CRAWLER AND TRUCK-
MOUNTED CRANES

V-46-42

Photo Slide:
POSTED SAFE WORKING LOADS



Lesson No.

46

Title

Gear and Equipment for Rigging and
Materials Handling

Notes

V-46-43

Photo Slide:

SWING RADIUS OF SLEWING
CABLE NOT GUARDED

V-46-44

Photo Slide:

MOBILE TRUCK-MOUNTED CRANE

V-46-45

Photo Slide:

MARINE RAILWAY CARRIAGE

V-46-46

Photo Slide:

BASKET BEING RIGGED

Lesson Plan

4. Areas within swing radius of
of outermost part of revolving
derrick or crane body to be
guarded

- o Applies whether derrick or
crane is permanently or
temporarily mounted
- o Guard must prevent employee
from being in position where
he can be:
 - Struck by derrick or crane;
or
 - Caught between derrick or
crane and fixed parts of
vessel or crane.

5. Cradle or carriage on marine
railway to be blocked or secured
when in hauled position

- o Prevents accidental release.

F. Use of Gear (1915.66, 1916.66, 1917.66)

1. Loads to be safely rigged before
hoisting
2. Shackles preferred for handling
plates on and off hulls
 - o If there are no holes in plate,
adequately-sized clips or pads
to be welded to plate to receive
shackle pins
 - o If impossible to make holes in,
or weld pads to plate, following
may be used:
 - Alligator tongs
 - Grab hooks
 - Grab clamps
 - Screw clamps



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes

Lesson Plan

V-46-47
Photo Slide:
SKIP WITH FOUR LEGS

V-46-48
Photo Slide:
EMPLOYEE ON HOOK

- o In cases where holes or welds impossible, special precautions required to keep employees from under lifts.
- 3. Tag lines required if loads likely to swing, need guidance
- 4. If slings secured to eyebolts, to be arranged so that pull is within 20 degrees of bolt axis
 - o Spreaders to be used if necessary.
- 5. If slings pass over sharp edges or corners of load, must be padded with wood blocks, other suitable material
 - o Prevents cutting, kinking.
- 6. Skips to be rigged to be handled by bridles with at least 3 legs
 - o All legs to always be used
 - o Means to be taken to prevent contents from falling if open-end skips used.
- 7. Loose ends of idle sling legs to be hung on hook
- 8. Employees prohibited from riding hook or load
- 9. Loads not be swung, suspended over employees' heads
- 10. Pieces of equipment, structure that may fall or dislodge to be secured or removed as early as possible



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes	Lesson Plan
V-46-49 Photo Slide: SIGNALMEN SIGNALING TO HOIST	11. Signalman who knows signal code to be used when hoist operator cannot see load
	- o Must maintain clear, distinct visual or verbal communication - Verbal signals prohibited.
V-46-50 Photo Slide: DAMAGED PALLETS	12. Pallets to be constructed, maintained to safely support, carry loads
V-46-51 Photo Slide: OPEN HATCH	13. Section of hatch to be completely opened if:
	- o Materials or equipment raised, lowered, moved or shifted through hatch - Applies if moved manually, by crane, winch, hoist, or derrick - Beam or pontoon left in place adjacent to opening to be secured against accidental displacement.
	14. When employees below in square of hatch, hatch not to be opened or closed
	15. Clear and sufficient warning to nearby employees required before loads, empty lifting gear are raised, lowered, or swung
	16. Employees always prohibited from being in hazardous position between swinging load and fixed object.



Lesson No. 46

Title Gear and Equipment for Rigging and
Materials Handling

Notes

Lesson Plan

G. Qualifications of Operators (1915.67,
1916.67 1917.67)

1. When ship's gear used to hoist materials aboard, competent person to determine that gear:
 - o Is rigged properly
 - o Is in safe condition
 - o Will not be overloaded by size, weight of lift.
2. Before operating crane, winch, or other power hoisting apparatus, employees must:
 - o Understand signs, notices, and operating instructions
 - o Be familiar with signal code used.
3. Employees with following conditions prohibited from operating power hoisting devices:
 - o Uncorrected defective eyesight or hearing
 - o Heart disease
 - o Epilepsy
 - o Similar ailments that may incapacitate them.
4. Minors under 18 prohibited from employment involving:
 - o Operation of power-driven hoisting devices
 - o Assistance in such operations, such as hooking on, loading slings, or rigging gear.

Wire Rope Wear and Damage

The evidence in these illustrations will aid the inspector in determining the actual cause of wear or damage that he may find in any wire rope.



A wire rope which has been kinked. A kink is caused by pulling down a loop in a slack line during improper handling, installation, or operation. Note the distortion of the strands and individual wires. Early rope failure will undoubtedly occur at this point.



Localized wear over an equalizing sheave. The danger of this type wear is that it is not visible during operation of the rope. This emphasizes the need of regular inspection of this portion of an operating rope.



A typical failure of a rotary drill line with a poor cut-off practice. These wires have been subjected to excessive peening causing fatigue type failures. A predetermined, regularly scheduled, cut-off practice will go far toward eliminating this type of break.



A single strand removed from a wire rope subjected to "strand nicking". This condition is the result of adjacent strands rubbing against one another and is usually caused by core failure due to continued operation of a rope under high tensile load. The ultimate result will be individual wire breaks in the valleys of the strands.



A "bird cage". Caused by sudden release of tension and resultant rebound of rope from overloaded condition. These strands and wires will not return to their original positions.



A



B

An example of a wire rope with a high strand—a condition in which one or two strands are worn before adjoining strands. This is caused by improper socketing or seizing, kinks or dog legs. Picture A is a close-up of the concentration of wear and B shows how it recurs in every sixth strand (in a six strand rope).

Wire Rope Wear and Damage (Continued)



An illustration of a wire which has broken under tensile load in excess of its strength. It is typically recognized by the "cup and cone" appearance at the point of fracture. The necking down of the wire at the point of failure to form the cup and cone indicates that failure occurred while the wire retained its ductility.



A wire rope which has jumped a sheave. The rope itself is deformed into a "curl" as if bent around a round shaft. Close examination of the wires show two types of breaks—normal tensile "cup and cone" breaks and shear breaks which give the appearance of having been cut on an angle with a cold chisel.



A wire rope which has been subjected to repeated bending over sheaves under normal loads. This results in "fatigue" breaks in individual wires—these breaks are square and usually in the crown of the strands.



An illustration of a wire which shows a fatigue break. It is recognized by the squared off ends perpendicular to the wire. This break was produced by a torsion machine, which is used to measure the ductility. This break is similar to wire failures in the field caused by excessive bending.



An example of "fatigue" failure of a wire rope which has been subjected to heavy loads over small sheaves. The usual crown breaks are accompanied by breaks in the valleys of the strands—these breaks are caused by "strand nicking" resulting from the heavy loads.



An example of a wire rope that has provided maximum service and is ready for replacement.



A close-up of a rope subjected to drum crushing. Note the distortion of the individual wires and displacement from their normal position. This is usually caused by the rope scrubbing on itself.



A fatigue break in a cable tool drill line caused by a tight kink developed in the rope during operation.

Typical characteristics and causes of broken wires in wire ropes.

Effectiveness of Attaching Wire Rope

Open Type

Closed Type



SWAGED SOCKET 100%



WEDGE SOCKETS (depending on design) 75-80%



WIRE ROPE SOCKET-SPALTER ATTACHMENT 100%



CLIPS (number of clips varies with size of rope) 75-80%



PRESSED SLEEVE LOOP BACK THIMBLE ATTACHMENT
1 in. diameter and smaller 95%
1 1/2 in. diameter and larger 92.5%



THIMBLE SPICE - HAND TUCKED
1/4 in. 90% 1/2 in. 84%
5/16 in. 89% 5/8 in. 84%
3/8 in. 88% 7/8 in. 85%
7/16 in. 87% 1 in. and larger 80%



FLEMISH LOOP WITH MECHANICAL SLEEVE ATTACHMENT
1 in. diameter and smaller 95%
1 1/2 in. diameter and larger 92.5%



LOOP SPICE - HAND TUCKED
Efficiencies of loop splices are the same as those given for thimble splices.

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Lesson No. 47

Time 50 minutes

Title

Tools and Related Equipment

Objective

Upon completion of this lesson, the trainee will be able to discuss the safe use of various tools and related equipment used in shipyard activities. The trainee will be able to identify unsafe tools or work practices and recommend the appropriate abatement method.

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Lesson No.

47

Title

Tools and Related Equipment

Technique	Content	Time
Lecture and Slides	I. Types of Tools Used in Shipyards	35 minutes
	II. Applicable Standards	15 minutes
		Total Time: 50 minutes
Materials 38 Slides Slide Projector (35 mm) 1 Handout		
References 1. National Safety Council. <u>Accident prevention manual for industrial operations.</u> 7th edition. Chicago, IL, National Safety Council, 1977. 2. U.S. Occupational Safety and Health Administration. "Safety and health standards for maritime employment." <u>Federal Register</u> , Vol. 39, No. 119, June 19, 1974. 3. <u>Hand Tools Institute. Proper use and care of hand tools, pliers, screwdrivers, wrenches, striking and struck tools.</u> Chicago, IL, Klein Tools, Inc. 1977.		

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F. Internal Combustion Engines Other Than Ship's Equipment	47-19

VISUAL AIDS

V-47-1	Photo Slide	Metal Forming Hand Tools Used in Shipyards
V-47-2	Photo Slide	Woodworking Hand Tools (*)
V-47-3	Photo Slide	Electric Power Tools
V-47-4	Photo Slide	Air Hoses
V-47-5	Photo Slide	Air Powered Hand Tools (*)
V-47-6	Photo Slide	Close-up of Trigger of Air Powered Tool
V-47-7	Photo Slide	Loading Powder-actuated Tools
V-47-8	Photo Slide	Abrasive Disks (*)
V-47-9	Photo Slide	Abrasive Cutoff Saw (*)
V-47-10	Photo Slide	Pedestal Grinder
V-47-11	Photo Slide	Shaft Lathe (*)
V-47-12	Photo Slide	Bench Lathe
V-47-13	Photo Slide	Drillers
V-47-14	Photo Slide	Pipe Threader
V-47-15	Photo Slide	Bending Pipe (*)
V-47-16	Photo Slide	Boring Machine (*)
V-47-17	Photo Slide	Polishing Journal (*)
V-47-18	Photo Slide	Hydraulic Press
V-47-19	Photo Slide	Hydraulic Forge Press
V-47-20	Photo Slide	Iron Worker
V-47-21	Photo Slide	Roll Press
V-47-22	Photo Slide	Bending Press

VISUAL AIDS (Continued)

V-47-23	Photo Slide	Nibbler
V-47-24	Photo Slide	Engine Lathe
V-47-25	Photo Slide	Horizontal Miller
V-47-26	Photo Slide	Power Hack Saw
V-47-27	Photo Slide	Hydraulic Band Saw
V-47-28	Photo Slide	Electric Power Band Saw
V-47-29	Photo Slide	Table-mounted Drill Press
V-47-30	Photo Slide	Cutoff Saw
V-47-31	Photo Slide	Portable Compressor
V-47-32	Word Slide	General Precautions for Using Tools
V-47-33	Word Slide	Requirements for Portable Electric Tools
V-47-34	Word Slide	Requirements for Hand Tools
V-47-35	Word Slide	Requirements for Abrasive Wheels
V-47-36	Photo Slide	Tongue and Work Rest Properly Adjusted
V-47-37	Photo Slide	Abrasive Wheel Attachment
V-47-38	Word Slide	Requirements for Powder-actuated Fastening Tools

(*) For internal Department of Labor training purposes only.



HANDOUT

1. National Institute for Occupational Safety and Health. Powder-actuated fastening tools (No. 78-198A). Cincinnati, OH, NIOSH, 1978.



Lesson No.

47

Title

Tools and Related Equipment

Notes

V-47-1

Photo Slide:

METAL FORMING HAND TOOLS
USED IN SHIPYARDS

V-47-2

Photo Slide:

WOODWORKING HAND TOOLS

Lesson Plan

I. TYPES OF TOOLS USED IN SHIPYARDS

A. Hand Tools

1. Metal-cutting and forming tools

- o Chisels
- o Stamping and markings tools
- o Hack saws.

2. Wood-cutting tools

- o Wood chisels
- o Saws
- o Axes
- o Hatchets.

3. Miscellaneous cutting tools

- o Planes
- o Scrapers
- o Knives.

4. Materials handling tools

- o Crowbars
- o Hooks.

5. Torsion tools

- o Open-end wrenches
- o Socket wrenches
- o Torque wrenches
- o Pipe wrenches and tongs
- o Pliers



Lesson No.

47

Title

Tools and Related Equipment

Notes

Lesson Plan

- o Wire cutters

- o Nail band crimpers

- o Screwdrivers.

6. Shock and striking tools

- o Hammers

- o Sledge hammers

- o Riveting hammers.

7. Hazards and health effects
associated with the use of
hand tools

- o Loss of eyes or vision from
misuse of tools or use of
defective tools

- o Puncture wounds from flying
chips

- o Tendons and arteries severed
by cutting tools

- o Contusions from tools that
slip

- o Injuries from tools that fall
due to improper carrying.

B. Portable Power Tools

1. Electric power tools

- o Types include:

- Electric drills

- Chain saws

- Sabre saws

- Circular saws

V-47-3

Photo Slide:

ELECTRIC POWER TOOLS



Lesson No.

47

13

Tools and Related Equipment

Notes

Lesson Plan

- Grinding wheels
- Buffers and scratch brushes
- Sanders
- Soldering irons
- o Hazards associated with electric power tools include:
 - Electric shock
 - Particles in the eyes
 - Fires from faulty wiring
 - Tools falling from heights if tool's electric cord accidentally pulled or tool is not tethered
 - Lines on ground or floor that create tripping hazard
 - Burns from hot tools
 - Injuries from improper guarding.

2. Air power tools

- o Air hoses
 - Present stumbling and tripping hazard
 - If hose is hit accidentally, may unbalance operator or cause tool to fall
 - Disconnection may cause hose to whip about and cause accidents

V-47-4

Photo Slide:
AIR HOSES



Lesson No.

47

Title

Tools and Related Equipment

Notes

V-47-5

Photo Slide:

AIR POWERED HAND TOOLS

V-47-6

Photo Slide:

CLOSEUP OF TRIGGER OF AIR
POWERED TOOL

V-47-7

Photo Slide:

LOADING POWDER-ACTUATED
TOOLS

[Review the hazards
associated with powder-
actuated tools.]

Handout 1

POWDER-ACTUATED FASTENING
TOOLS--SAFE PRACTICES FOR
EMPLOYEES

Lesson Plan

- o Air powered grinders
 - Require adequate guarding to prevent injury
 - Speed regulator or governor important to avoid over-speeding wheel
- o Pneumatic impact tools
 - Includes riveting guns, jackhammers
 - Trigger should be located inside handle to prevent accidental operation
 - Tool should be secured in place by device so that it cannot be accidentally shot from barrel
 - Trigger never to be squeezed until tool is on work.
- 3. Powder-actuated tools
 - o Used for fastening fixtures materials to metal, concrete, block, brick, and stone
 - Explosive cartridges provide energy
 - o Hazards similar to those of hand gun
 - Accidental discharge
 - Ricochets
 - Ignition of explosive or combustible atmosphere
 - Projectiles penetrating the work
 - Flying particulates.



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Title

Tools and Related Equipment

Notes

V-46-8
Photo Slide:
ABRASIVE DISKS

V-47-9
Photo Slide:
ABRASIVE CUTOFF SAW

V-47-10
Photo Slide:
PEDESTAL GRINDER

V-47-11
Photo Slide:
SHAFT LATHE

V-47-12
Photo Slide:
BENCH LATHE

V-47-13
Photo Slide:
DRILLERS

V-47-14
Photo Slide:
PIPE THREADER

Lesson Plan

C. Machine Tools

1. Grinding machines

- o Abrasive disks and wheels
 - Hand-held disks and wheels
- o Abrasive cutoff saws
- o Grinding wheels
 - Bench grinder
 - Pedestal grinder.

2. Metal working tools

- o Lathes
 - Shaft lathes
 - Bench lathes
- o Drills
 - Drill press
 - Drillers
- o Pipe working machines
 - Pipe threader



Lesson No. 47

Title Tools and Related Equipment

Notes

V-47-15

Photo Slide:
BENDING PIPE

V-47-16

Photo Slide:
BORING MACHINE

V-47-17

Photo Slide:
POLISHING JOURNAL

V-47-18

Photo Slide:
HAND-OPERATED HYDRAULIC PRESS

V-47-19

Photo Slide:
HYDRAULIC FORGE PRESS

V-47-20

Photo Slide:
IRON WORKER

V-47-21

Photo Slide:
ROLL PRESS

V-47-22

Photo Slide:
BENDING PRESS

V-47-23

Photo Slide:
NIBBLER

V-47-24

Photo Slide:
ENGINE LATHE

Lesson Plan

- Pipe Bender

o Boring and turning devices

- Boring machine

- Polishing journal

o Presses

- Hand-operated hydraulic press

- Hydraulic power press.

3. Other machine tools used in ship-yards

o Iron worker

o Roll press (former)

o Bending press

o Sheet metal nibbler

o Engine lathe



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Title

Tools and Related Equipment

Notes

V-47-25

Photo Slide:

HORIZONTAL MILLER

V-47-26

Photo Slide:

POWER HACK SAW

V-47-27

Photo Slide:

HYDRAULIC BAND SAW

V-47-28

Photo Slide:

ELECTRIC POWER BAND SAW

V-47-29

Photo Slide:

TABLE-MOUNTED DRILL PRESS

[Note exposed belt drives.]

V-47-30

Photo Slide:

CUTOFF SAW

[Note that guard is missing.]

Lesson Plan

- o Milling machine

- o Power hack saw

- o Hydraulic band saw

- o Metal working band saw.

4. Woodworking tools

- o Planer

- o Power rip saw

- o Joiner

- o Table saw

- o Drill press

- o Cutoff saw

- o Jig saw.



Lesson No.

47

Title

Tools and Related Equipment

Notes

Lesson Plan

D. Internal Combustion Powered Equipment

1. Pumps

- o Portable pumps used to pump dry vaults, bilges, and other enclosed spaces.

2. Generators

- o Used for emergency or remote electrical power
- o Either fixed or portable.

3. Compressors

- o Used to produce compressed air
- o Types include:
 - Central yard systems
 - Small shop units
 - Portable or mobile compressors.

V-47-31
Photo Slide:
PORTABLE COMPRESSOR

II. REQUIREMENTS FOR USING TOOLS AND RELATED EQUIPMENT (1915, 1916, 1917, SUBPART H)

A. General Precautions (1915.71, 1916.71, 1917.71)

- 1. Device to be provided and used to handle tools, equipment and materials
 - o Types of devices include:
 - Hand lines
 - Slings
 - Tackles of adequate strength
 - Tool bags with shoulder straps

V-47-32
Word Slide:
GENERAL PRECAUTIONS FOR
USING TOOLS



Lesson No. 47

Title Tools and Related Equipment

Notes

Lesson Plan

- o Intended to keep employees' hands free for climbing ship ladders and access ladders
- o Hose and electric cord prohibited for this use.
- 2. Dies, tools to be removed when reciprocating-type air tools not in use
- 3. Guards required on portable power-driven circular saws
 - o Both above and below base plate or shoe
 - o Upper guard to cover saw to depth of teeth except for minimum arc needed to tilt base for bevel cuts
 - o Lower guard to cover saw to depth of teeth except for minimum arc needed for proper retraction, contact with work
 - o Lower guard to return to covering position automatically and instantly when withdrawn from work.
- 4. Moving parts of machinery on dry docks to be guarded
- 5. Positive means of securing pneumatic tools to extension hose or whip required before use
 - o Prevents tool from becoming accidentally disconnected from whip.
- 6. Moving parts of drive mechanisms to be adequately guarded



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Title

Tools and Related Equipment

Notes

Lesson Plan

V-47-33
Word Slide:
REQUIREMENTS FOR PORTABLE
ELECTRIC TOOLS

7. Headers, manifolds, widely spaced hose connections on compressed air lines to be labelled "air"
 - o Letters at least one inch high
 - o To be painted on manifold or separate hose connections; or
 - o Signs to be permanently attached to manifolds or connections
 - Grouped air connections require label in only one location.

8. Compressed air hose to be examined before use
 - o To be removed from service if visibly damaged, unsafe.

B. Portable Electric Tools (1915.72, 1916.72, 1917.72)

1. Frames to be grounded
 - o Through third wire in cable containing circuit connectors; or
 - o Through separate wire grounded at source of current
 - o Exception: no frame grounding required for double insulated tools approved by Underwriters' Laboratories.
2. Grounding circuits to be checked to ensure circuit between ground and grounded power conductor has resistance low enough to permit sufficient current flow to cause fuse or breaker to interrupt circuit
 - o Exception: grounding circuits by means of vessel on which tool is used.



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Title

Tools and Related Equipment

Notes

V-47-34

Word Slide:

REQUIREMENTS FOR HAND TOOLS

V-47-35

Word Slide:

REQUIREMENTS FOR ABRASIVE
WHEELS

Lesson Plan

3. Switches that must be manually held closed required on hand-held portable electric tools
4. Worn or frayed electric cables prohibited from use
5. Before operating tools with vessel's current, employer to notify vessel's officer in charge.

C. Hand Tools (1915.73, 1916.73, 1917.73)

1. Employer not to issue, permit use of unsafe hand tools
2. Wrenches prohibited from use if jaws sprung to point that slippage occurs
3. Impact tools to be kept free of mushroomed heads
 - o Includes tools such as chisels, wedges, drift pins.
4. Wooden tool handles must be:
 - o Free of splinters, cracks
 - o Kept tight in tool.

D. Abrasive Wheels (1915.74, 1916.74, 1917.74)

1. Safety guards (protective hoods) required for abrasive wheels used for external grinding
 - o Applies to both floor stand and bench-mounted wheels.
2. Maximum angular exposure of wheel periphery not to exceed 90 degrees
 - o Exception: when work requires contact with wheel below horizontal plane of spindle, angle not to exceed 125 degrees



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Title

Tools and Related Equipment

Notes

Lesson Plan

- o In both cases, exposure not to begin more than 65 degrees above horizontal plane of spindle.
- 3. Safety guards to be strong enough to withstand effects of bursting wheel
- 4. Floor and bench mounted grinders to have rigidly supported, readily adjustable work rests
 - o Rests to be kept 1/8-inch or less from wheel surface.
- 5. Cup type wheels used for external grinding to be protected by:
 - o Revolving cup guard; or
 - o Band-type guard
 - o Must conform to U.S. Standard Safety Code for Abrasive Wheels B7.1.
- 6. Other types of wheels used for external grinding to have protection as above except when:
 - o Work location makes it impossible
 - Then wheel must be equipped with safety flanges
 - o Wheels 2 inches or less in diameter securely mounted on end of steel mandrel are used.
- 7. Portable abrasive wheels used for internal grinding to have safety flanges designed for wheels that will retain pieces of wheel if it breaks



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Tools and Related Equipment

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Lesson Plan

- o Exceptions: if wheels 2 inches or less in diameter securely mounted to end of steel mandrel are used; or
- o If wheel is entirely in work being ground while used.
- 8. Safety guards, if required, to meet following requirements:
 - o Mounted so that proper alignment with wheel maintained
 - o Guard and fastenings to be strong enough to retain fragments if wheel breaks
 - o Maximum allowable angular exposure of grinding wheel periphery and sides is 180 degrees.
- 9. Abrasive wheels to be inspected for cracks, defects and ring tested before use
- 10. Grinding wheels to fit on spindle without being forced
 - o Spindle nut to be tightened only enough to hold wheel in place.
- 11. Power supply to be adequate to maintain rate spindle speed under normal conditions
 - o Maximum rated wheel speed not to be exceeded.
- 12. Appropriate eye protection equipment required for all employees using abrasive wheels
 - o Exception: when eye shields permanently attached to bench or floor give adequate protection.



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Title

Tools and Related Equipment

Notes

V-47-36

Photo Slide:

TONGUE AND WORK REST PROPERLY
ADJUSTED

V-47-37

Photo Slide:

ABRASIVE WHEEL ATTACHMENT

V-47-38

Word Slide:

REQUIREMENTS FOR POWDER-
ACTUATED FASTENING TOOLS

Handout 1

POWDER-ACTUATED FASTENING
TOOLS--SAFE PRACTICES FOR
EMPLOYEES

Lesson Plan

E. Powder-actuated Fastening Tools
(1915.75, 1916.75)

1. General precautions

- o Tested each day before loading
 - Ensures proper working condition
 - If not in good working order, to be removed from service until repaired
- o Prohibited from use in flammable or explosive atmosphere
- o To be guarded with appropriate shield or muzzle guard
- o Fasteners not to be driven into hard or brittle materials such as:
 - Cast iron
 - Glazed tile
 - Surface hardened steel
 - Glass block
 - Live rock
 - Face brick
 - Hollow tile



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Title

Tools and Related Equipment

Notes

Lesson Plan

- o Fasteners not to be driven into soft materials unless backed to prevent pin from passing through
 - o Fasteners not to be driven into brick, concrete within 3 inches of unsupported edge or corner unless special guard, fixture used
 - Not to be driven within 1/2-inch of unsupported edge, corner of steel surface unless specially guarded
 - o Requirements when fastening other material, e.g., lumber, to concrete:
 - Fasteners to have diameter of 7/32-inch or less
 - Not to be driven closer than 2 inches to unsupported edge, corner
 - o Positive guide to secure alignment required if driving fasteners through existing holes
 - o Driving fastener into spalled area prohibited
 - o Appropriate eye protection equipment required for employees using powder-actuated fastening tools.
2. Operators' instructions
- o Competent person must instruct employees before tool operation as follows:
 - Tool to be inspected for safe operation before use



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Tools and Related Equipment

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Lesson Plan

- If defect develops, employee to stop using tool and notify supervisor immediately
- Tool not to be loaded until just before firing
- Tool not to be unattended while loaded
- Not to be pointed at anyone whether loaded or empty
- Hands to be kept clear of open barrel end
- Tool to be held in operating position for 15 seconds or longer in case of misfire and while tool is disassembled, opened, and powder is removed
- Tools, charges to be stored in place not available to unauthorized persons.

F. Internal Combustion Engines Other Than Ship's Equipment (1915.76, 1916.76, 1917.76)

1. Exhaust from internal combustion equipment provided by employer that is used in fixed position below deck to be led to open air clear of ventilation intakes
2. Exhaust line joints, connections to be checked as soon as engine starts
 - o Leaks to be corrected immediately.



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Title

Tools and Related Equipment

Notes

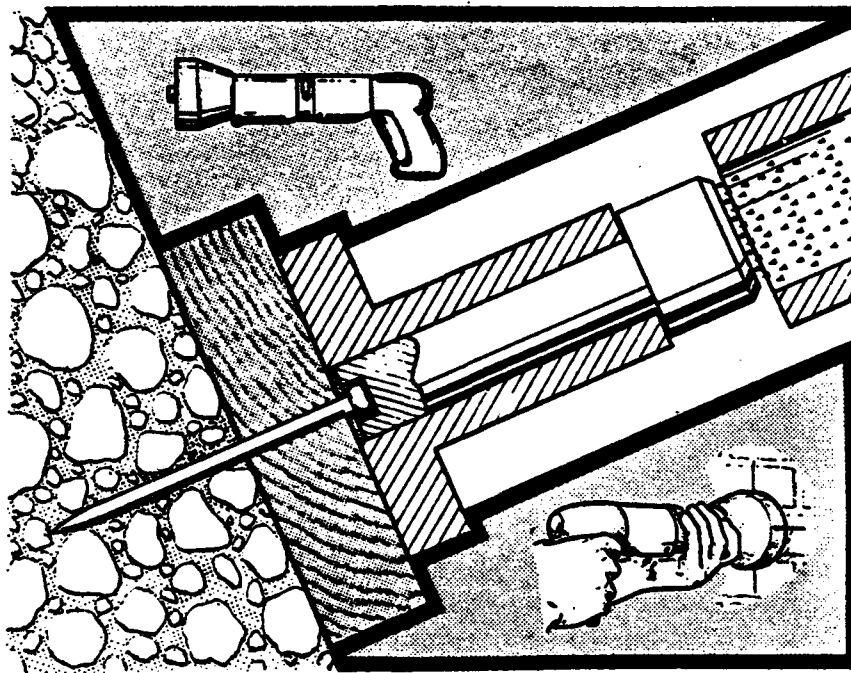
Lesson Plan

3. If exhaust is blown into air below decks, competent person must make frequent tests for carbon monoxide concentrations
 - o If concentration exceeds 50 ppm (0.005%), employees to be removed from compartment
 - o Employer to use sufficient blowers arranged to maintain concentration below limit before work resumes.

NIOSH

Powder Actuated Fastening Tools

SAFE PRACTICES for EMPLOYEES



U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health



Lesson No. 48

Time 50 minutes

Title

Personal Protective Equipment

Objective

Upon completion of this lesson, the trainee will be able to discuss the use of personal protective equipment in shipyard work.

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Lesson No.

48

Title

Personal Protective Equipment

Technique	Content	Time
Lecture and Slides	I. Eye Protection	10 minutes
	II. Respiratory Protection	20 minutes
	III. Head, Foot, and Body Protection	10 minutes
	IV. Lifesaving Equipment	10 minutes
		Total Time: 50 minutes
Materials		
13 Slides Slide Projector (35 mm)		
References		
U.S. Occupational Safety and Health Administration. "Safety and health standards for maritime employment." <u>Federal Register</u> , Vol. 39, No. 119, June 19, 1974.		
48-2		



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VISUAL AIDS

V-48-1	Photo Slide	A Variety of Personal Protective Equipment
V-48-2	Photo Slide	Flying Chips
V-48-3	Photo Slide	Welder's Flash (*)
V-48-4	Photo Slide	Chemical Eye Protection
V-48-5	Word Slide	Eye Protection Requirements
V-48-6	Photo Slide	Chemical Cartridge Respirator
V-48-7	Photo Slide	Filter-type Respirator with Welder's Hood
V-48-8	Photo Slide	Filter-type Respirator
V-48-9	Word Slide	Respiratory Protection Requirements
V-48-10	Photo Slide	Protective Hard Hats (*)
V-48-11	Photo Slide	Metatarsal Guard
V-48-12	Photo Slide	Work Vest (*)
V-48-13	Photo Slide	Life Rings

(*) For internal Department of Labor training purposes only.



Lesson No.

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Title

Personal Protective Equipment

Notes

V-48-1

Photo Slide:
A VARIETY OF PERSONAL
PROTECTIVE EQUIPMENT

V-48-2

Photo Slide:
FLYING CHIPS

V-48-3

Photo Slide:
WELDER'S FLASH

V-48-4

Photo Slide:
CHEMICAL EYE PROTECTION

V-48-5

Word Slide:
EYE PROTECTION REQUIREMENTS

Lesson Plan

I. EYE PROTECTION (1915.81, 1916.81, 1917.81)

A. Causes of Eye Injuries

1. Impact from flying objects

2. Flash produced by welding

3. Chemicals, oils, molten metals
splashing into eyes.

B. Eye Protection Requirements

1. General precautions

o Eye protection equipment to meet
specifications in American
Standard Safety Code Z2.1

o Equipment to be well-maintained

o To be cleaned, disinfected after
use before employer issues to
another employee

o Special type of protective
equipment required for employees
who wear glasses

- Exception: if employees have
prescription ground safety
glasses that provide suitable
protection from hazard
involved.

2. Protection against impact

o Suitable face shields or goggles
required for operations where
flying particles, molten metal,
liquid chemicals are eye hazard,
such as:



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Personal Protective Equipment

Notes

Lesson Plan

- Chipping
- Caulking
- Drilling
- Riveting
- Grinding
- Pouring babbitt metal.

3. Protection against radiant energy

- o If hazard of light rays or other radiant energy exists, employees to be protected according to intensity of radiation by one of following equipped with filter lenses:
 - Spectacles
 - Cup goggles
 - Helmets
 - Hand shields
 - Face shields
- o Filter lenses to be shaded appropriately for type of work as shown in Table I-1
 - Exception: shade numbers may vary by one or two to suit individual preference
- o If filter lenses used in goggles worn under helmet, lens shade number may be reduced so that total shade numbers of 2 lenses will equal value in Table I-1.



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Personal Protective Equipment

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Lesson Plan

II. RESPIRATORY PROTECTION (1915.82, 1916.82, 1917.82)

A. Types of Respiratory Hazards

1. Oxygen deficiency
2. Gaseous atmospheres immediately dangerous to life
3. Gaseous and/or particulate atmospheres not immediately dangerous to life
4. Particular hazards of working in confined or enclosed spaces.

B. Types of Respiratory Protection

1. Self-contained breathing apparatus
2. Hose mask or air line respirator
3. Cannister used with mask
 - o Must be approved for use with a specific contaminant.
4. Approved cartridge-type respirator
 - o Must be approved for use with a specific contaminant.
5. Approved filter-type respirator
 - o Must be approved for use with a specific contaminant.

V-48-6

Photo Slide:

CHEMICAL CARTRIDGE RESPIRATOR

V-48-7

Photo Slide:

FILTER-TYPE RESPIRATOR WITH
WELDER'S HOOD

V-48-8

Photo Slide:

FILTER-TYPE RESPIRATOR



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Title Personal Protective Equipment

Notes

Lesson Plan

C. Requirements for Respiratory Protective Equipment

1. General requirements

- o Equipment must be approved by Bureau of Mines for intended use
 - Only used for intended purposes
 - Modifications of equipment prohibited
- o To be inspected regularly and well-maintained
 - Gas mask cannisters, chemical cartridges to be replaced when necessary to give complete protection
 - Mechanical filters to be cleaned, replaced when necessary to avoid undue breathing resistance
 - If previously used, to be cleaned, disinfected before employer issues to another employee
 - Emergency rescue equipment to be cleaned, disinfected immediately after use
- o Employees to be instructed in use, limitations of equipment regardless of type used
- o Air line respirators required to have:
 - Pressure regulation valve
 - Filter to remove oil, water, rust particles



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Title

Personal Protective Equipment

Notes

Lesson Plan

V-48-4

Word Slide:

RESPIRATORY PROTECTION
REQUIREMENTS

- Air intake free of all
contaminants

- o Attendant stationed outside when
employees working in space where
atmosphere is immediately
dangerous to life to have emer-
gency equipment immediately
available

- Must be equivalent to that
required for employees inside
space

- o When attendant is stationed
outside space where air is not
immediately dangerous to life,
to have protective equipment
equivalent to employees inside
if he risks prolonged exposure
to same contaminant concen-
tration.

2. Protection in atmospheres immedi-
ately dangerous to life

- o Air is considered immediately
dangerous if:

- Oxygen content less than
16.5%
- Atmosphere is highly toxic
- Atmosphere has contaminant
concentration high enough
to endanger life even if
breathed for a short time

- o Following types of respiratory
protection are approved:

- Self-contained breathing
apparatus in which wearer
carries oxygen or air
supply or oxygen-generating
material



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Title

Personal Protective Equipment

Notes

Lesson Plan

- Hose mask with blower where blower supplies air at high volume, low pressure through hose large enough so wearer can draw air if blower fails
- Gas mask and cannister approved for particular gas if oxygen content greater than 16% and gas less than 2% by volume
- o Work to be performed only in emergency, e.g., rescuing man overcome or shutting off contamination source
- Employee entering to have, use adequate attended life line
- o Employer to provide approved equipment in vicinity of each vessel where exposure to immediately dangerous atmosphere is potential
- When such equipment required, at least one employee to be trained in use.
- 3. Protection against gaseous contaminants not immediately dangerous to life
- o Such contaminants include gases that can be breathed for short period without endangering life but that would be harmful if exposure is prolonged or over numerous short exposures
- o Following types of approved respiratory equipment are approved:



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Title Personal Protective Equipment

Notes

Lesson Plan

- Hose mask or air line respirator in high or unknown concentrations; also acceptable for lower concentrations
 - Cannister type gas mask with cannister appropriate for gas; in concentrations of ammonia less than 3%, concentrations of other gases less than 2% by volume
 - Chemical cartridge respirator with appropriate cartridge in gas concentration less than 0.1% by volume
 - Gases for which specific cannisters are approved include acid gases, hydrocyanic acid gas, chlorine gas, organic vapors, ammonia, carbon monoxide, and combinations of these.
4. Protection against particulate contaminants not immediately dangerous to life
- o Air line or filter respirators required unless otherwise provided for in the regulations
 - o Filter respirators to be equipped with filters approved for following contaminants:
 - Pneumonconiosis-producing dust and nuisance dusts such as aluminum, cellulose, cement, charcoal, coal, iron ore, limestone, wood
 - Toxic dusts not significantly more toxic than lead, such as arsenic, cadmium, chromium, manganese, selenium, vanadium, compounds of these



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Title

Personal Protective Equipment

Notes

Lesson Plan

- Mists, including pneumoconiosis-producing mists, chronic acid mists, nuisance mists
 - Fumes, i.e., solid dispersoids or particulate matter formed by concentration of vapors, such as those from heated metals
 - Combinations of 2 or more of above-described contaminants.
5. Protection against combinations of gaseous and particulate contaminants not immediately dangerous to life
- o When exposed to such contaminants, such as during spray painting, employees required to wear equipment approved for type, concentration of contaminants
 - o In high or unknown concentrations, hose mask or air line respirator required
 - Use of either permitted in lower concentrations
 - o In concentrations less than 2% by volume, cannister type gas mask with combination cannister approved for particular contaminant and filter for particular type of particulate to be worn
 - o If concentration of gaseous contaminant is low, e.g., less than 0.1% by volume, employees required to wear respirators equipped with appropriate cartridges and filters.



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48

Title

Personal Protective Equipment

Notes

V-48-10
Photo Slide:
PROTECTIVE HARD HATS

V-49-11
Photo Slide:
METATARSAL GUARD

Lesson Plan

III. HEAD, FOOT AND BODY PROTECTION (1915.83,
1916.83, 1917.83)

A. Requirements for Protective Hats

1. To be worn by employees when working in area where there is danger of falling objects
2. Must meet specifications in U.S. Standard Safety Code Z2.1
3. Hats without dielectric strength prohibited if there is possibility of contact with electric conductors
4. If previously worn, must be cleaned, disinfected before employer issues to another employee.

B. Requirements for Safety Shoes

1. Employer to arrange through vendor, local store, or other means for safety shoes to be readily available to all employees
2. Employer to encourage use
3. If covering has worn off of metal toe caps, caps to be insulated if employees work on exposed energized circuits of vessel's electrical system.

C. Clothing Requirements

1. Excessively greasy clothing prohibited on employees engaged in hot work
2. Suitable gloves to be worn by employees engaged in work hazardous to hands.



Lesson No.

48

Title

Personal Protective Equipment

Notes

V-48-12

Photo Slide:
WORK VEST

[Employee is riding the
load, which is very
hazardous.]

Lesson Plan

IV. LIFESAVING EQUIPMENT (1915.84, 1916.84,
1917.84)

A. Buoyant Work Vests

1. Must be Coast Guard approved
2. To be inspected before each use
for:
 - o Dry rot
 - o Chemical damage
 - o Other defects in strength,
buoyancy.
3. Use of defective vests prohibited.

B. Safety Belts and Lifelines

1. Belts to have lifelines secured
to fixed structure with minimum
slack
2. To be inspected for defects prior
to each use
 - o Use of defective belts or life-
lines prohibited.
3. When lifeline is worn, care to
be taken not to cut, pinch, or lead
lifeline over sharp edge
4. During hot work or operations using
acids, solvents, or caustics, line
to be kept clear
 - o Avoid burning or weakening line.
5. Attachment point of lifeline to
be changed as work progresses
 - o Keep lifeline continuously
attached with minimum slack.



Lesson No.

48

Title

Personal Protective Equipment

Notes

V-48-13
Photo Slide:
LIFE RINGS

Lesson Plan

C. Life Rings and Ladders

1. At least three 30-inch life rings with line attached to be kept easily visible, accessible aboard each vessel afloat where work is performed
 - o Must be Coast Guard approved
 - o One to be located forward, one aft, one on gangway
 - Exception: if vessel is less than 200 feet long, one at gangway sufficient.
2. At least one life ring with attached line to be located on each staging float alongside vessel on which work is done
3. Line attached to life ring to be at least 90 feet long
4. Life rings and lines to be well maintained
5. At least one portable or permanent ladder of sufficient length for employees to reach safety if they fall in water required in vicinity of each vessel afloat where work is performed.



Lesson No. 49

Time 50 minutes

Title

Ship's Machinery and Piping Systems and Other Topics (Subparts K and L)

Objective

Upon completion of this lesson, the trainee will be able to discuss the ship's machinery and piping systems, identify unsafe conditions, and recommend appropriate abatement procedures. The trainee will also be able to discuss the use of portable unfired pressure vessels, drums and containers found in shipyard work, recognize unsafe conditions, and recommend appropriate abatement procedures. The trainee will be able to discuss the requirements for working on electrical circuits and distribution boards.

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Lesson No.

49

Title

Ship's Machinery and Piping Systems and
Other Topics (Subparts K and L)

Technique	Content	Time
Lecture and Slides	I. Overview of Vessel Systems	5 minutes
	II. Requirements for Boilers	5 minutes
	III. Requirements for Piping Systems	5 minutes
	IV. Requirements for Propulsion Machinery	5 minutes
	V. Requirements for Deck Machinery	5 minutes
	VI. Portable Unfired Pressure Vessels	15 minutes
	VII. Electrical Machinery	10 minutes
		Total Time: 50 minutes

Materials

20 Slides
Slide Projector (35 mm)

References

1. Arnott, David (ed). Design and construction of steel merchant ships. New York, The Society of Naval Architects and Marine Engineers, 1955.
2. U.S. Occupational Safety and Health Administration, "Safety and health standards for maritime employment." Federal Register, Vol. 39, No. 119, June 19, 1974.



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B. Other Machinery Systems	49-5
C. Deck Machinery	49-5
II. Requirements for Work on Ship's Boilers	49-6
A. Safety Precautions Required of Employer	49-6
III. Requirements for Ship's Piping Systems	49-7
A. Precautions Required of Employers	49-7
IV. Requirements for Work on Ship's Propulsion Machinery	49-8
A. Precautions Required of Employer	49-8
B. Precautions Before Operating Jacking Engine	49-9
C. Precautions Before Working in Immediate Vicinity of Propeller	49-10
D. Precautions Before Main Engine is Turned Over	49-10
V. Requirements for Work on Ship's Deck Machinery	49-10
A. Precautions Required of Employer	49-10
VI. Portable Unfired Pressure Vessels, Drums and Containers, Other Than Ship's Equipment	49-11
VII. Electrical Machinery	49-14

VISUAL AIDS

V-49-1	Photo Slide	Turbines
V-49-2	Photo Slide	Auxiliary Turbine Generator
V-49-3	Photo Slide	Tail Shaft
V-49-4	Photo Slide	Diesel Propulsion System (*)
V-49-5	Photo Slide	Switchboards and Control Panels
V-49-6	Photo Slide	Lubrication Oil System
V-49-7	Photo Slide	Steering Gear
V-49-8	Photo Slide	Piping System on a Tanker (*)
V-49-9	Photo Slide	Anchor Windlass (*)
V-49-10	Photo Slide	Mooring Machinery (*)
V-49-11	Word Slide	Safety Precautions for Work on Ship's Machinery
V-49-12	Photo Slide	Devil Claws
V-49-13	Photo Slide	Riding Pawls
V-49-14	Photo Slide	Air Receiver
V-49-15	Word Slide	Requirements for the Use of Portable Unfired Pressure Vessels
V-49-16	Word Slide	Requirements for the Use of Drums and Containers
V-49-17	Photo Slide	Circuit Distribution Board
V-49-18	Photo Slide	Insulated Mat at Switchboard
V-49-19	Photo Slide	Main Circuit Breaker
V-49-20	Photo Slide	Open-front Switchboards

(*) For internal Department of Labor training purposes only.



Lesson No. 49

Title Ship's Machinery and Piping Systems
and Other Topics (Subparts K and L)

Notes

V-49-1
Photo Slide:
TURBINES

V-49-2
Photo Slide:
AUXILIARY TURBINE GENERATOR

V-49-3
Photo Slide:
TAIL SHAFT

V-49-4
Photo Slide:
DIESEL PROPULSION SYSTEM

Lesson Plan

I. OVERVIEW OF VESSEL MACHINERY AND PIPING SYSTEMS

A. A Ship's Steam Propulsion System

1. Steam supply system
 - o Boilers
 - o High pressure turbines
 - o Low pressure turbines
 - o Condensers
 - o Feed water pumps.
2. Auxiliary steam systems
 - o Turbine generators
 - o Turbine pumps.
3. Propulsion system
 - o Reduction gear
 - o Tail shaft
 - o Bearings
 - Thrust bearings
 - Steadying bearings
 - o Propeller.
4. Other types of propulsion systems
 - o Diesel
 - o Nuclear (Naval warships)
 - o Gasoline
 - o Sail.



Lesson No. 49

Title Ship's Machinery and Piping Systems
and Other Topics (Subparts K and L)

Notes

V-49-5

Photo Slide:
SWITCHBOARDS AND CONTROL
PANELS

V-49-6

Photo Slide:
LUBRICATION OIL SYSTEMS

V-49-7

Photo Slide:
STEERING GEAR

V-49-8

Photo Slide:
PIPING SYSTEM ON A TANKER

V-49-9

Photo Slide:
ANCHOR WINDLASS

V-49-10

Photo Slide:
MOORING MACHINERY

Lesson Plan

B. Other Machinery Systems

1. Switchboards and control panels
2. Lubrication oil systems
 - o Pumps
 - o Filters and strainers.
3. Electro-hydraulic steering gear
4. Fuel oil transfer systems
5. Bulk cargo systems
 - o Transfer systems
 - o Vent systems
 - o Tank cleaning systems.
6. Fire protection systems
7. Refrigeration systems
8. HVAC (Heating, Ventilation and
and Air Conditioning of quarters
and work spaces).

C. Deck Machinery

1. Anchor windlass
2. Mooring machinery.



Lesson No. 49

Title Ship's Machinery and Piping Systems
and Other Topics (Subparts K and L)

Notes

V-49-11

Word Slide:

SAFETY PRECAUTIONS FOR
WORK ON SHIP'S MACHINERY

Lesson Plan

II. REQUIREMENTS FOR WORK ON SHIP'S BOILERS
(1915.91, 1916.91)

A. Safety Precautions Required of Employer

1. Employer must take precautions before work is performed in:
 - o Fire, steam, water spaces of boiler
 - o These and other spaces where employees may risk injury from direct escape of high temperature medium entering from interconnecting system
 - Steam
 - High temperature water, oil, or other medium.
2. Isolation and shutoff valves that connect dead boiler with live system or systems to be:
 - o Secured,
 - o Blanked, and
 - o Tagged indicating employees are in boiler
 - Tag not to be removed until such can be done without creating hazard to employees in boiler; or
 - Work in boiler is completed.
3. If valves are welded instead of bolted, at least 2 isolation and shutoff valves connecting dead boiler with live system(s) to be secured, locked, tagged



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Title Ship's Machinery and Piping Systems
and Other Topics (Subparts K and L)

Notes

Lesson Plan

4. Drain connections to atmosphere on all dead interconnecting systems to be opened
 - o Allows for visual observation of drainage.
5. Warning sign to be hung conspicuously in engine room
 - o To call attention to fact that employees are in boilers
 - o Not to be removed until:
 - Work is complete
 - All employees are out of boilers.

III. REQUIREMENTS FOR SHIP'S PIPING SYSTEMS (1915.92, 1916.92)

A. Precautions Required of Employers

1. Precautions apply before any work takes place where employees risk injury from direct escape of steam, hot water, oil, other medium at high temperature
 - o Includes work on the following:
 - Valves
 - Fittings
 - Sections of piping in piping systems.
2. Isolation and shut-off valves connecting dead boiler to live system(s) to be secured, blanked, and tagged
 - o Tag to indicate employees are working on system(s).



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and Other Topics (Subparts K and L)

Notes

Lesson Plan

3. Tags and blanks to remain in place until:
 - o To remove them would not endanger employees working on system; or
 - o Work on system is complete.
4. If valves are welded instead of bolted, at least 2 isolation and shutoff valves connecting dead system with live system(s) must be secured, locked, and tagged
5. Drain connections to atmosphere on all dead interconnecting systems to be opened so that drainage can be observed visually.

IV. REQUIREMENTS FOR WORK ON SHIP'S PROPULSION MACHINERY (1915.93, 1916.93)

A. Precautions Required of Employer

1. Apply before any work is performed on:
 - o Main engine
 - o Reduction gear
 - o Connecting accessories.
2. Jacking gear to be engaged
 - o Prevents main engine from turning over.
3. Sign to be posted at throttle indicating jacking gear engaged
 - o Not to be removed until safe to disengage jacking gear.



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Title Ship's Machinery and Piping Systems
and Other Topics (Subparts K and L)

Notes

Lesson Plan

4. If jacking gear is steam driven:

- o Stop valves to be secured, locked, and tagged
- Tag to indicate employees working on main engine.

5. If jacking gear electrically driven:

- o Circuit controlling jacking gear to be deenergized by following means:
 - Tripping circuit breaker; or
 - Opening switch; or
 - Removing fuse, whichever is appropriate
- o Breaker, switch, or fuse location to be tagged indicating that employees are working on main engine.

B. Precautions Before Operating Jacking Engine

1. Check to be made to ensure employees, equipment, and tools are clear of:
 - o Engine
 - o Reduction gear
 - o Connecting accessories
 - o Propeller.

C. Precautions Before Working in Immediate Vicinity of Propeller

1. Warning sign to be hung in immediate vicinity of propeller



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Title Ship's Machinery and Piping Systems
and Other Topics (Subparts K and L)

Notes

Lesson Plan

- o To call attention to fact that employees are working in area
- o To be hung in conspicuous location in engine room.
- 2. Sign to remain until:
 - o Work is complete
 - o All employees are free of propeller.

D. Precautions Before Main Engine is Turned Over

1. Applies whether engine is warmed up before departure or for testing after overhaul
2. Check to be made to ensure employees, equipment, and tools are free of propeller.

V. REQUIREMENTS FOR WORK ON SHIP'S DECK MACHINERY (1915.94, 1916.94)

A. Precautions Required of Employer

1. Apply to work on anchor windlass or attached accessories
2. Devil claws to be made fast to anchor chains
3. Riding pawls to be in engaged position
4. In absence of devil claws and riding pawls:
 - o Anchor chains to be secured to suitable fixed structure of vessel.

V-49-12
Photo Slide:
DEVIL CLAWS

V-48-13
Photo Slide:
RIDING PAWLS



Lesson No.

49

Title

Ship's Machinery and Piping Systems
and Other Topics (Subparts K and L)

Notes

V-49-14

Photo Slide:
AIR RECEIVER

V-49-15

Word Slide:
REQUIREMENTS FOR THE USE OF
PORTABLE UNFIRED PRESSURE
VESSELS

Lesson Plan

VI. PORTABLE, UNFIRED PRESSURE VESSELS, DRUMS
AND CONTAINERS, OTHER THAN SHIP'S EQUIPMENT
(1915, 1916, SUBPART K)

A. Portable Air Receivers and Other
Unfired Pressure Vessels (1915.101,
1916.101)

1. Types of vessels

o Air receivers

- Compressed air tank serves
as a receiver of pressure
that accumulates within
a system

o Other types

- Steam jacketed kettles
- Digesters
- Vulcanizers.

2. Requirements for use

- o Portable, unfired pressure
vessels to be marked and
reported indicating they were
designed, constructed according
to standards
- Applicable standards to be
met are those in American
Society of Mechanical Engi-
neers Boiler and Pressure
Vessel Code, Section XIII,
Rules for Construction of
Unfired Pressure Vessels,
1963
- Are to be subjected to
hydrostatic pressure test
1.5 times working pressure
of vessels



Lesson No. 49

Title Ship's Machinery and Piping Systems
and Other Topics (Subparts K and L)

Notes

Lesson Plan

- o If not built to Code requirements and built before the OSHA regulations took effect, must be examined quarterly by competent person
 - To be subjected to annual hydrostatic pressure test 1.5 times working pressure of vessels
- o Relief valves to be set to:
 - Safe working pressure of vessel; or
 - Lowest safe working pressure of systems, whichever is lower
- o Record of all examinations and tests to be maintained.

B. Drums and Containers (1915.102, 1916.102)

1. Types and uses

- o Shipping drums containing oil, paints, solvents, and a variety of other substances used in shipyards.

2. Requirements for use

- o Shipping drums, containers not to be pressurized to remove contents
- o Temporarily assembled pressurized piping systems conveying hazardous liquids, gases to have relief valves and by-passes
 - Prevent rupture of system
 - Prevent escape of hazardous liquids, gases

V-49-16

Word Slide:

REQUIREMENTS FOR THE USE
OF DRUMS AND CONTAINERS



Lesson No. 49

Title Ship's Machinery and Piping Systems
and Other Topics (Subparts K and L)

Notes

Lesson Plan

- o Storage and use of following prohibited in way of open flame, hot metal, other sources of artificial heat:
 - Pressure vessels,
 - Drums, and
 - Other containers containing toxic or flammable liquids or gases
- o Barriers and guards to be erected to protect pressure vessels, drums, and containers of 30 gallon or greater capacity containing flammable or toxic gases
 - Exception: if stored in out-of-the-way area where they are not subject to physical injury from outside source
- o Dikes or pans to be erected around containers of 55 gallon or greater capacity that contain flammable or toxic liquids
 - Must enclose volume equal to at least 25% of total volume of containers
- o Adequate number of suitable fire extinguishers to be provided
 - To be located in immediate area where pressure vessels, drums, or containers containing flammable liquids or gases are stored or used
 - To be ready for use at all times.



Lesson No. 49

Title Ship's Machinery and Piping Systems
and Other Topics (Subparts K and L)

Notes

V-49-17
Photo Slide:
CIRCUIT DISTRIBUTION BOARD

V-49-18
Photo Slide:
INSULATED MAT AT
SWITCHBOARD

V-49-19
Photo Slide:
MAIN CIRCUIT BREAKER

Lesson Plan

VII. ELECTRICAL MACHINERY (1915, 1916,
SUBPART L)

A. Electrical Circuits and Distribution
Boards (1915.111, 1916.111)

1. Circuit to be deenergized and
checked before employees are per-
mitted to work on electrical
circuit
 - o To be checked at point where
work is done to ensure it is
actually deenergized
 - o Exception: when circuit must
remain energized for testing
or adjusting.
2. When testing or adjusting circuit,
insulation required under foot
if there is no insulated deck
 - o Rubber mat, or
 - o Duck board, or
 - o Other suitable insulation.
3. Appropriate method to be used to
deenergize circuit
 - o Opening switch, or
 - o Opening circuit breaker, or
 - o Removing fuse.
4. Circuit breaker, switch, or fuse
to be tagged
 - o Tag to indicate employee working
on circuit.



Lesson No. 49

Title Ship's Machinery and Piping Systems
and Other Topics (Subparts K and L)

Notes

V-49-20
Photo Slide:
OPEN-FRONT SWITCHBOARDS

Lesson Plan

5. Work must be definitely completed before:
 - o Tag is removed
 - o Circuit is reenergized.
6. If work is performed immediately adjacent to open-front energized board or in back of energized board, board to be covered or other equally safe means taken to prevent contact with energized parts.



Lesson No. 50

Time 50 minutes

Title

Course Review and Post-test

Objective

Upon completion of this lesson, the trainee will be able to measure his understanding and knowledge of the material presented.

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Lesson No.

50

Title

Course Review and Post-test

Technique	Content	Time
Lecture and Post-test	I. General Review of Course	25 minutes
	II. Administration of Post-test	25 minutes
		Total Time: 50 minutes
Materials		
Post-test		
References		

50-2



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I. General Review of Course	50-4
II. Administration of Post-test	50-5



Lesson No.

50

Title

Course Review and Post-test

Notes

[Instructor should name the topics listed in this outline, make any final remarks he wishes to about the subjects, and answer any questions that students have prior to taking the post-test. The review should be conducted as quickly as possible to give adequate time for students to complete the post-test in the allotted period.]

Lesson Plan

I. GENERAL REVIEW OF COURSE

- A. Background of Maritime Safety Laws
- B. Maritime Nomenclature
- C. Longshoring
- D. Ship Repair
- E. Shipbuilding
- F. Shipbreaking
- G. Explosive and Other Dangerous Atmospheres
- H. Competent Person
- I. Instrumentation
- J. Gas-freeing
- K. Surface Preparation and Preservation
- L. Welding, Cutting, and Heating
- M. Scaffolds, Ladders and Other Working Surfaces
- N. General Working Conditions
- O. Health and Sanitation
- P. Gear, Rigging and Materials Handling Equipment
- Q. Tools and Related Equipment
- R. Personal Protective Equipment
- S. Machinery and Piping Systems
- T. Subparts K and L



Lesson No.

50

Title

Course Review and Post-test

Notes

[Instructor will choose 50 questions from the test questions developed for the course (two questions for each lesson). He should explain to the students that they are to choose as many answers for each question as are appropriate. He should also emphasize that the post-test is designed to test the effectiveness of the training material and instruction, not to judge the student's performance.]

Lesson Plan

II. ADMINISTRATION OF POST-TEST



GLOSSARY

ABEAM

At right angles to the keel.

ACCOMODATION LADDER

A portable ladder fastened to a platform attached to the side of a ship which can be positioned to provide ready access to the ship from water or shore.

AMIDSHIPS

In the vicinity of the mid-length of a ship, as distinguished from the ends. Technically, it is exactly halfway between the forward and after perpendiculars.

ANCHOR

A heavy iron or steel implement attached to a vessel by means of a rope or chain cable for holding it at rest in the water. When an anchor is lowered to the bottom, the drag on the cables causes one or more of the prongs, called flukes, to sink into or engage the ground and provide holding power.

ANNEAL

To heat a metal and then cool it in such a fashion so that it toughens and softens. Brass or copper is annealed to cherry red and dipped suddenly into water while hot. Iron or steel is slowly cooled from the heated state to anneal.

APRON

Portion of a wharf or pier lying between the waterfront of the wharf or pier and the shed.

ASTERN

Signifying position in the rear or abaft the stern. In regard to motion, moving astern means moving backwards.



GLOSSARY (CONTINUED)

ATHWARTSHIPS

Across the vessel, from side to side, at right angle to the keel.

ATLANTIC INTRACOASTAL WATERWAY

The waterway system that extends from Norfolk, Virginia to Miami, Florida. It is 1,120 miles in length, with an average depth of 12 feet and project width of 90 feet.

AUXILIARIES

The various winches, pumps, motors, engines, etc., required on a ship, as distinguished from the main propulsive machinery.

BALE

1. Triangular plate of steel used as a connection between the bull chain, bull line, and single topping lift.
2. A large, closely-pressed package of merchandise, as in a bale of cotton.

BALE CUBIC CAPACITY

Cargo space available in a ship, measured in cubic feet, to the inside of the cargo battens, on the frames, and to the underside of the beams.

BALLAST

Heavy material placed low in ships, used to maintain proper stability and draft.

BALLAST TANKS

Tanks provided in various parts of a ship for introduction of water ballast when it is necessary to add weight to the ship to change its stability or draft. They are capable of being flooded or pumped out whenever required.



GLOSSARY (CONTINUED)

BARGE

An unpowered, flat bottom, shallow draft vessel, including scows, car-floats, and lighters.

BATTENS, CARGO

The planks that are fitted to the inside of the frames in a hold to keep cargo away from the shellplating; the strips of wood or steel used to prevent shifting of cargo. As a verb, **BATTEN** means to secure with battens, as in "batten down the hatches".

BAY

An area in a transit shed or warehouse between posts and columns, or the area between lateral ceiling beams or trusses projected down to the floor of the pier or warehouse.

BEAM

The maximum width of a ship. Also an athwartship or longitudinal member of the ship's structure supporting the deck.

BENDING ROLLS

Parts of a large machine used to give curvature to plates by passing them in contact with three rollers.

BENDING SLAB

Heavy cast-iron blocks with square or round holes for holding in place, arranged to form a large solid floor (slab) on which a ship's frames and structural members are bent and formed.

BIGHT

The bend, loop, or slack part of a rope.



GLOSSARY (CONTINUED)

BILGE BLOCKS

Short heavy pieces of timber, similar to keel blocks, placed at intervals on both sides of the keel as support for the bottom of a ship during building or when in dry dock.

BINNACLE

A stand or case for housing a ship's compass. It consists essentially of a pedestal topped by a bowl-shaped receptacle that accomodates the gimbals which in turn support the compass.

BITTS

Heavy steel castings with base plates fitted to a vessel's weather deck and with vertical cylindrical capped projections for securing mooring or towing lines, or hawsers.

BLOCK

The name given to a pulley or sheave, or a system of pulleys or sheaves mounted in a wood or metal frame and used for moving objects by means of ropes run over the pulleys or sheaves. The prefixes single, double, triple, etc., indicate the number of pulleys or sheaves in the block. Principle parts of a block are:

- a) the shell, or outside frame
- b) the sheave, on which the rope runs
- c) the pin, on which the sheave turns
- d) the strap, which provides a bearing for the pin
- e) the hook.

The opening between the sheave and the shell is called the breech, and the vise attached to the bottom of the block opposite the hook for securing the standing part of the fall to the block is called the beckett.

A block also may be a self-supporting regular stack of supplies, two or more units in width, two or more in depth, and two or more in height. It may be either rectangular or pyramidal in shape.



GLOSSARY (CONTINUED)

BOLLARD

A cast steel cylindrical capped head extending up from a base plate for fastening a ship to a wharf.

BOOBY HATCH

An access hatch from a weather deck protected from sea and weather by a hood. The hood often is fitted with a sliding cover to facilitate access.

BOOM

A long round spar hinged at its lower end, usually to a mast, and supported by a wire rope or tackle from aloft to the upper end of the boom. Cargo, stores, etc., are lifted by tackle leading from the upper end of the boom.

BOW

The forward end of a ship.

BOW LINES

Curves representing vertical sections parallel to the central longitudinal vertical plane of the bow end of a ship. Similar curves in the aft part of a ship are called buttock lines.

BREAK DOWN

To put cargo in a step formation. Also called a stepdown.

BRIDGE

A high transverse platform, often forming the top of a bridge house extending from side to side of a ship, and from which there is a good view of the weather deck.

BRIDGE PLATE

A plate, usually metal, used to span the distance between a freight car or truck and the loading platform.



GLOSSARY (CONTINUED)

BRIDLE

A span of line or chain so fastened at the ends that another line or chain may be fastened at its middle. Also may refer to an assembly of wire rope or chain used as sling.

BROKEN STOWAGE

Lost or unfilled space in a vessel's hold caused by irregularity in the size and shape of packages or the incidence of hold pillars, frames, deck beams and other obstructions, and the failure to utilize available space.

BROW

1. A runway with wooden cleats to facilitate entry and exit between ship and shore. It is usually fitted with rollers at the shore end to allow for the movement of the vessel. Also called a gangplank.
2. A small curved or flanged plate fitted to the shell plating over an air port to prevent water trickling down the ship's side from entering the port when opened.
3. A plate forming a riser on the sides of a 'tween-deck hatch coaming. It enables the stevedore to truck cargo on the hatch covers so that it can be hoisted from the square of the hatchway. Also called a brow plate.

BULKHEAD

A term applied to the vertical partition walls which subdivide the interior of a ship into compartments or rooms. The various types of bulkheads are distinguished by their location, use, kind of material or method of fabrication, such as aft, peak, longitudinal, transverse, watertight, wire mesh, etc. Bulkheads which contribute to the strength of a vessel are called strength bulkheads; those which are essential to watertight subdivision are watertight or oiltight bulkheads; and gastight bulkheads serve to prevent the passage of gas or fumes. A longitudinal bulkhead is a partition wall of planking or plating running in a fore and aft direction. Transverse bulkheads run athwartships across a portion or the whole breadth of a ship. Their principal function is to divide a ship into a series of watertight compartments so that any rupture of the shell will not cause the loss of the vessel. The bulkhead deck is the highest deck to which the transverse watertight bulkheads extend and provide subdivision.



GLOSSARY (CONTINUED)

BULL LINE

A line used to lower or top a boom that is rigged with a single topping lift.

BULL WIRE OR CHAIN

A heavy wire on a single topping lift used to hold the boom in a vertical working position. Also used to heave, haul, or lift a load without the multiplying power of tackle blocks.

BULLING CARGO

The practice of removing cargo from a vessel's wings or other such difficult to reach place by way of a bull line led directly from the heel block.

BULWARK

The raised woodwork or plating that runs along each side of a vessel above the weather deck to help keep decks dry, serving also as a fence to guard against losing men or deck cargo overboard.

BUNKER

A compartment used for the stowage of oil, coal, or other fuel.

BURTON

The tackle used for various purposes, such as hoisting rigging aloft. Used with single or double pulley blocks to set up or tighten rigging, or move heavy objects. Also used in reference to the outboard boom and fall.

BUTT, BUTT WELD

A butt is the joint formed when two parts are placed edge to edge, i.e., the end joint between two plates. A butt weld is made along a seam that is butted and not scarfed or lapped.



GLOSSARY (CONTINUED)

CABOTAGE

Trade or transport in coastal waters or between two ports within a country. The term is used especially to such trade by other than domestic carriers, although cabotage may be restricted to domestic carriers only.

CANT HOOKS

Hooks used in hoisting steel drums by hooking into the chime, which is the part of the drum at the end of the staves.

CARGO NET

A square net made in various series of manila or wire rope or chain and used with the necessary tackle to hoist cargo aboard a ship.

CHAIN SLING

An arrangement of chains used to suspend a cargo draft. Chain slings are used to handle heavy objects, such as large timbers.

CHAIN STOPPER

A device used to secure the chain cable when riding at anchor, thereby relieving the strain on the windlass. It is also used to secure the anchor in the housed position.

CHIPPING

Removing paint or other material from vessel decks. Longshoring operations are prohibited during this procedure.

CHOCKS

A heavy smooth-surfaced fitting usually located near the edge of the weather deck through which wire ropes or manila hawsers may be led, usually to piers.



GLOSSARY (CONTINUED)

CLASSIFICATION SOCIETY

An organization created for the initial and continuing inspection of ships so that their classification may be assessed and maintained. Classification societies publish rules and regulations principally concerned with the strength of a ship, the provision of adequate equipment, and the reliability of the machinery. Ships may be built in any country to a particular society's rules. Although classification is not mandatory, the owner of an unclassified ship must satisfy government authorities that it has sufficient strength for assignment of a load line and issuance of a safety construction certificate.

CLEAT

A metal or wood fitting with arms or horns on which lines are secured. Wedge cleats are fittings on the hatch coaming; wedges are placed between these cleats and the battens in place.

CLEATED DUCKBOARD

A boardwalk or slatted flooring laid on a wet, muddy, or cold surface, equipped with metal or wood fittings that have arms or horns to which lines may be secured.

CLIP

A four- to six-inch angle bar welded temporarily to floors, plates, etc., and used as a hold-fast, which, with the aid of a bolt, pulls objects up close in fitting. It also refers to short lengths of bar, generally angle, used to attach and connect various members of a ship's structure.

COAMING

The side wall of a hatch that projects above the deck around the hatch perimeter. Coaming forms a support for hatch covers, prevents water from running off the deck into the hold, and provides safety to personnel working near the hatch opening.

COFFERDAM

A void or empty space separating two or more compartments for the purpose of insulation, or to prevent the liquid contents of one compartment from entering another if the walls of one fail to retain their tightness.



GLOSSARY (CONTINUED)

COLD WORK

Any work, such as painting, cleaning, and carpentry, which does not involve spark or fire producing operations.

COMPETENT PERSON

A person, designated by the employer, who is capable of recognizing and evaluating employee exposure to hazardous substances and other unsafe conditions. The competent person must know and be able to specify protections and precautions to ensure employee safety as required by particular regulations.

CONFINED SPACE

A compartment, usually of small size, with limited access and egress. Its size and confined nature can create or aggravate a hazardous exposure. Examples of confined spaces are tanks, cofferdams, vats, and bins.

CORROSIVE LIQUIDS

Liquids such as hydrochloric, nitric, and sulphuric acids, that have strong oxidizing action. The corrosive effects of these liquids present difficulties in fire fighting.

CRADLE

A temporary external wood and steel structure used during construction of a ship where necessary to present a supporting surface conforming to the shape of the hull. For launching, such a structure including its necessary lashings is built between the top of the sliding ways and the shell of the ship for optimum distribution of launching stress to the ship's hull.

CRANE (FLOATING AND GANTRY)

A mechanical device for hoisting or moving heavy lifts. A floating crane is mounted on a nonpropelled barge, with a capacity ranging up to 100 tons. It can be towed to the off-shore side of a vessel to load or unload heavy lifts to or from other craft. A gantry crane is revolving, with a long boom that is mounted on a high bridge or platform, and moves on tracks along the length of a pier.



GLOSSARY (CONTINUED)

CRIBBING

Timbers used to support the bottom of a ship while it is under construction. Cribbing also refers to the manner in which dunnage is placed to secure cargo.

CROSS BEAMS

Beams that support hatch covers. They are also called hatch beams and strongbacks. Cross beams which support the center of the hatch covers are referred to as blind, she, or queen beams, while those with vertical flanges to retain the ends of the covers in place are called king beams.

DAVIT

A crane arm for handling lifeboats, anchors, stores, etc.

DEADWEIGHT TONNAGE

The total weight in long tons (2240 lb.) that a vessel carries on a specified draft including cargo, fuel, water in tanks, stores, baggage, passengers, crew and their effects but excluding water in the boilers.

DECK

The platform in a ship corresponding to the floor in a building. It is the plating, planking, or covering of any tier of beams either in the hull or superstructure of a ship. Decks are usually designated by their location--bridge deck, upper deck, main deck--but are sometimes designated by letters, such as "A" deck, "B" deck, etc.

DEEP TANKS

Tanks located in a vessel's lower holds. These tanks take up only a portion of a hold and are used to carry water ballast or dry or liquid cargo.

DERRICK

Common abbreviation of derrick crane. A derrick crane consists of a long beam pivoted at the base of a vertical, stationery beam, moved by ropes running on pulleys and used to hoist and move large, heavy objects.



GLOSSARY (CONTINUED)

DISPLACEMENT TONNAGE

The light displacement is the weight in long tons (2240 lb.) of a vessel complete with all items of outfit, equipment, and machinery on board but excluding all cargo, fuel, water in tanks, stores, passengers, dunnage, and the crew and their effects. A vessel's loaded displacement is its displacement when floating to its greatest allowable draft. Loaded displacement is equal to the weight of the water displaced and is the sum of the vessel's light displacement and its deadweight. A cubic foot of sea water weighs 64 pounds and one of fresh water weighs 62.5 pounds. Consequently, one long ton is equal to 35 cubic feet of sea water or 35.9 feet of fresh water.

DOCK

A basin for the reception of vessels. Wet docks are used for loading and unloading ships. Dry docks are used for construction and repair.

DOLPHIN

A buoy or spar used for mooring a vessel.

DOUBLE BOTTOM

A term that applies to the space between the inner and outer bottom shells of a vessel. Also used to indicate that a ship has complete inner or extra envelope of watertight bottom plating, a double bottom is usually fitted in large ships extending from bilge to bilge and nearly the whole length of the vessel fore and aft.

DRAFT

1. The depth of a vessel below the waterline measured vertically to the lowest part of the hull, propellers, or other reference points.
2. A single load of cargo.

DRUM, WINCH

The cylinder or barrel on a winch around which cable or rope is used in raising loads or drafts or other hoisting and hauling is wound.



GLOSSARY (CONTINUED)

DUNNAGE

A term applied to loose wood or other material used to protect cargo in a ship's hold. Dunnage serves the following purposes according to the nature of the cargo carried:

- a) protects cargo from contact with water from bilges, or leakage from other cargo, the ship's side, or the double bottom tank
- b) protects cargo from moisture and the sweat that condenses on the ship's sides, frames, stringers, brackets, bulkhead, etc., and falls down on cement caps and into the bilges
- c) provides air passages for heated, moisture-laden air to travel to the ship's sides and bulkheads and up toward the uptaker
- d) prevents chafing as well as chocks off and secures cargo by filling in broken stowage, i.e., spaces not filled by cargo
- e) distributes weight.

EMPLOYEE

For the purposes of OSHA's maritime standards, an employee is any person engaged in longshoring ship repair, shipbuilding, shipbreaking, or related employments on navigable U.S. waters. Dry docks, graving docks, and marine railways are included. Vessel masters, officers, and crew are excluded, as are persons performing repair on or loading or unloading any vessel under 18 net tons.

EMPLOYER

For the purposes of OSHA's maritime standards, an employer is anyone whose workforce is in some way involved in longshoring, ship repair, shipbuilding, shipbreaking, or related employments on navigable U.S. waters.

ENCLOSED SPACE

Any space other than a confined space that is enclosed by bulkheads and overheads, such as cargo holds and machinery and boiler spaces.

EYE BOLT

A bolt formed with an eye in the head. When a ring is fitted into the eye, it is known as a ring bolt.



GLOSSARY (CONTINUED)

EYE SPLICE

A loop formed in the end of a rope and spliced to join the end to the rope.

FAIRING THE LINES

Consists of making lines smooth and harmoniously grouped and curved. Rivet holes are fair when they agree with one another in joining members.

FAIRWATER

A term applied to plating fitted to form a conical shape around the ends of shafts and struts to prevent an abrupt change in their form.

FALL

In common usage, the entire length of rope used in a tackle. A strict interpretation of the term would limit its application to the end of the rope to which power is applied. The end secured to the block is called the standing part; the opposite end, the hauling part. Also called a runner or a whip.

FIBER ROPE

A rope formed wholly or chiefly of fibers.

FLANGE

A rib, rim, or turned edge of a shape or girder which acts to resist bending strain, or is used for guiding or attachment to another object.

FRAME

A term generally used to designate one of the transverse ribs that make up the skeleton of a ship. The frames act as stiffeners, holding the outside plating in shape and maintaining the transverse form of the ship.

FREEBOARD

The vertical distance from a vessel's waterline to the top of the weather deck at the side.



GLOSSARY (CONTINUED)

GANGWAY

A narrow, portable platform used as a passageway by persons boarding or leaving a vessel moored alongside a quay or pier. It has a minimum width of 22 inches and is fenced on each side to a height of about 33 inches by means of taut rope or chain railings. Also called a gangplank.

GANTLINE

A purchase consisting of a rope passing through a single block on the head of a mast, to hoist up rigging, staying, or hatch tents or send aloft gear or men having to do work aloft. It is usually made of two-inch manila rope, 60 feet or more in length. Also called a girtline.

GEAR CERTIFICATION

Cargo handling gear, such as chains, rings, hooks, shackles, blocks, etc., are to be tested and must meet certain minimum requirements for strength, load bearing capacity, etc., before use. Small pieces of loose gear usually bear a mark that indicates they are certified. For large pieces of handling gear, records are kept that indicate the gear has been tested and certified at prescribed intervals.

GIRDER

On ships this term is used to designate large single or compound beams that provide rigidity and support to smaller and more closely spaced beams. Girders are set in a horizontal position to support vertical loads with their ends bearing vertically upon supports. In the case of long girders, there may be several intermediate supports in addition to the end supports.

GRATING

A structure of metal bars arranged to give support or footing over an opening, while still providing for the passage of light and circulation of air.

GRAVING DOCK

A dry dock in which a vessel is floated in and the entrance gates are closed when the tide is at ebb. The remaining water is then pumped out and the vessel is graved, or cleaned.



GLOSSARY (CONTINUED)

GROSS TONNAGE

A measure of the internal volume of spaces within a vessel in which 100 cubic feet equals one ton. Gross tonnage includes a ship's internal volume excluding such space as the double bottom, tanks used only for water ballast, anchor and steering-gear spaces, toilets, and certain passenger spaces.

GROUNDWAYS

Timbers fixed to the ground fore and aft under the hull on each side of the keel to form a broad-surfaced track on which a ship is end-launched. Groundways for side-launching are basically similar.

GULF INTRACOASTAL WATERWAY

The waterway system extending from St. Marks, Florida to Brownsville and Harlingen, Texas. It is 1,113 miles long with a depth of 12 feet and a project width of 125 feet.

GUY

A line or cable used to steady or swing a boom or spar, or to steady or swing an object when it is hoisted or lowered.

GUY PENDANT

A single wire with eyes in both ends, one of which is attached to the tackle, the other to a fitting on a boom, deck, or vessel side.

GYPSY HEAD

The outside spool or drum end of a winch or windlass, usually fitted with ridges, used for heaving in or other handling of mooring lines.

HATCH, HATCHWAY

One of the large square openings in the deck of a ship through which cargo or machinery is hoisted in or out, and which provides access to the hold or machinery spaces. There may be forward, main, and after cargo hatchways on a vessel, according to its size and type.



GLOSSARY (CONTINUED)

HATCH BEAMS

Steel or wooden beams that support hatch covers. Also called strongbacks.

HATCH BOARDS

Boards that form a cover for an opening in a vessel deck (hatch), fitted into recesses in the hatch coaming and resting on the hatch beams. Hatch boards are usually about 4.5 feet in length, 2.5 feet wide, and 2 to 3 inches thick. The ends of the boards are normally reinforced with metal. Also called hatch cover.

HATCH TENDER

Person belonging to a dock gang of longshoremen who is stationed at the hatchway opening to give necessary signals to the winchman, supervise the raising of sling loads, and attend to falls when necessary. Also called a hatchman, hatchminder, or hatch signal man.

HAWSER

A large rope or cable used in warping, towing, and mooring.

HAZARDOUS CARGOES

May be any of the following:

- a) Corrosive Liquids: liquids that have strong oxidizing action and impose difficulties in fire fighting action by their corrosive effects. Examples: hydrochloric, nitric, and sulphuric acids.
- b) Flammable Liquids: liquids having flash points below 80°F. Examples: acetone, alcohol, benzol, ether, gasoline, naphtha.
- c) Flammable Gases: liquefied petroleum and other compressed gases that will ignite when exposed to a flame, spark, or other source of heat above a certain temperature. Examples: acetylene, butane, propane, hydrogen, and ethylene.
- d) Flammable Solids: substances that are likely to produce fire spontaneously if exposed to air, moisture, friction, or moderate heat. Examples: iodine, pyroxyline plastics, and calcium carbide.



GLOSSARY (CONTINUED)

HAZARDOUS CARGOES (Continued)

- e) Miscellaneous: materials other than the above which, because of their characteristics under fire conditions, create abnormal difficulties in fire extinguishment. Examples: crude rubber and cordage fibers.
- f) Oxidizing Materials: materials which may start a fire if they come in contact with other materials because of their strong oxidizing action. Examples: chlorates, permangates, peroxides, nitrates, and other corrosive liquids such as sulphuric acid.

The above categories do not include incendiary and explosive materials defined by and stored in accordance with specific regulations governing their handling and storage.

HEAT TREATMENT

The tempering of metal with heat to increase its strength.

HEEL

The lower end of a boom.

HOIST

A mechanism or machine, the function of which is to raise or elevate heavy objects from above by means of tackle or other gear, often including such gear.

HOLD

A space below deck where cargo is stowed.

HOT WORK

All work that may produce fire or sparks, including such operations as riveting, welding, and burning.

HULL

The framework of a vessel, including all decks, deck houses, and inside and outside plating planking, but excluding masts, rigging, and all other outfit and equipment.



GLOSSARY (CONTINUED)

ILO

The International Labor Office of the United Nations charged with carrying out the requirements of the International Labor Organization Convention which sets international standards regarding testing, examining, and annealing cargo gear, handling equipment, etc.

INNER BOTTOM

The plating that forms the top of the double bottom. It is also called the tank top.

IMPROVED PLOW STEEL

A grade of wire rope. Classified by breaking strength in order of increasing breaking strength, the grades are iron, traction, mild plow steel, plow steel, improved plow steel ("yellow strand"), and extra improved plow steel ("powersteel").

JACOB'S LADDER

A marine ladder of rope or chain with wooden or metal rungs.

JOGGLING

The term applied to offsetting one plate edge of a lapped plate joint to give a continuous flush surface on the side opposite the offset. It is also the term applied to offsetting a frame in the way of outside strakes of plating to make both inside and outside strakes fit snugly against the frame. Jogging is employed to eliminate the use of liners.

JOINT, BUTT AND LAPPED

Butt joint is the term applied to a connection made between two pieces of material by bringing their ends or edges together with no overlap and fastening by welding along, or by welding, riveting, or bolting each to a strip or strap that overlaps both pieces. A lapped joint is a connection made between two pieces of material by lapping the end or edge of one over the end or edge of the other and fastening them together with bolts, rivets, or welds.



GLOSSARY (CONTINUED)

JOURNAL

The portion of a shaft or other revolving member that transmits weight directly to and is in immediate contact with the bearing in which it turns.

KEEL

A center-line strength member running fore and aft along the bottom of a ship and often referred to as a ship's backbone. It is composed either of long bars scarfed at the ends or by flat plates riveted or welded together.

KEEL BLOCKS

Heavy timber blocks piled one above the other on which the keel of a vessel is supported when being built or when in dry dock. They are placed under the keel from bow to stern at sufficient distances apart to allow work to be done between them.

KINGPOST

A vertical spar, usually steel, stepped in pair, one on each side of the ship's center line and used to support cargo booms. Also called pairmast or Samson post.

LANYARD

Any rope used to make something fast.

LASHINGS

Rope, wire, chain, or steel strapping usually used with turnbuckles to secure cargo or gear.

LAUNCHING

A term applied to the operation of sliding a ship into the water. It may be accomplished by end-launching or side-launching. End-launching is used when it is desired to slide a vessel into the water stern first and where the vessel is built at an angle, usually 90 degrees, to the water. Side-launching is used when the vessel is built parallel to the water. A track of heavy timbers is constructed on the ground or other foundation, running under the ship and for a distance out into the water.



GLOSSARY (CONTINUED)

LAUNCHING (Continued)

Sliding timbers, or ways, are placed on the track under the vessel and temporarily fastened to it. A cradle is then built up on these ways to support the vessel. The cradle is wedged up and the keel and building blocks are removed. Because the ways are laid on an inclination and launching grease is placed between them, the force of gravity is usually sufficient to launch the vessel when the sliding timbers are released from the track. If necessary, starting rams may be used to start the vessel's move along the track.

LIGHTER

A barge or flat-bottomed vessel used to carry cargo from one point to another in a harbor. Lighters are usually decked over, either roofed or unroofed, and are usually not self-propelled.

LINKBOARD

A band fitted around the head of a cargo boom to which are shackled the topping lift, headblock, and boom guys.

LOG BOOM

A barrier around an area of water used to keep floating logs from dispersing; the area in which logs are thus confined.

LONG TON

Weight measurement unit equal to 2240 pounds.

LONGITUDINALS

The structural shape or plate members that run fore and aft below decks, flats, or the inner bottom, or along the inboard side of the shell plating.

LONGSHORING

The loading or discharging of vessels either aboard ship or on the wharf or quay. Longshore workers may be divided into two categories: those who work on the ship (stevedores) and those who belong to the shore gang (dock workers). In a generic sense, the term longshore usually refers to the laborers who do the actual physical work, while the stevedore is the contractor who employs longshoremen.



GLOSSARY (CONTINUED)

MANIFEST, SHIP'S

A document listing the types and amounts of the various cargo a vessel is carrying; the number of crew members; the number of passengers, if any; the name(s) of the person(s) or agent(s) to whom the cargoes will be delivered; the destination(s) of all cargoes; and the gross cargo weight. It is used to compute tariffs and other charges that are levied on the vessel and its cargo at the various ports where it calls.

MARRY

To join two ropes' ends so that the joint will run through a block; also to place two ropes alongside each other so that both may be hauled on at the same time.

MAST

A solid or tubular steel or wood structure tapered and stepped on the centerline of a vessel. A mast supports the yards, gaffs, booms, lights, and radio antenna. On a cargo vessel, it supports the cargo booms.

MISSISSIPPI RIVER SYSTEM

The system includes the entire Mississippi River from its head of navigation to its mouth, and also the following navigable tributaries: Illinois Waterway, Missouri River, Ohio River, Tennessee River, Allegheny River, Cumberland River, Green River, Kanawha River, Monongahela River, and others where barge operations extend. The system is 2,360 miles in length with an average depth of from 9 to 40 feet and a project width from 300 to 1,100 feet.

MOLD LOFT

A space used for laying down the lines of a vessel to actual size and making templates for the structural work of the hull.

MOUSING

A small rope or yarn seized across the mouth of a hook to prevent slings or lines from slipping off of the hook and to aid in preventing stretching of the hook.



GLOSSARY (CONTINUED)

NET TONNAGE

A vessel's gross tonnage minus certain additional spaces such as officer and crew quarters, the chart room, and a percentage of the propelling machinery spaces.

NORMALIZED

In reference to wrought iron chains, chains that have been annealed or heat treated to increase their strength and prevent stretching.

PADEYE

A metal eye attached to a deck or bulkhead to or through which a shackle, hook, line, or ring may be secured or passed.

PALLET

A wooden platform on which material can be stacked then moved about by use of a fork truck.

PATENT EYE

A metal eye secured to the end of a wire rope in place of a spliced eye.

PEAK TANKS

Compartments at the extreme fore and aft ends of a ship used as void spaces or trimming tanks. When used for the latter purpose, water is introduced to change the trim of the vessel.

PERPENDICULARS, LENGTH BETWEEN

The length of a ship between the forward and after perpendiculars. The forward perpendicular is a vertical line at the intersection of the fore side of the stern and the summer load waterline. The after perpendicular is a vertical line at the intersection of the summer load line and the after side of the rudder post or stern post, or the centerline of the rudder stock if there is no rudder post or stern post.



GLOSSARY (CONTINUED)

PIER

A projecting quay or wharf running at an angle to the shoreline and providing a landing place on each side for vessels to receive and discharge cargo or passengers.

PLATE HOOK

A quick releasing hook device.

PLATING, TYPES OF

Shell plating forms the outer skin of a vessel, constituting a watertight envelope around the hull and contributing largely to the strength of the vessel. With flush plating, the edges of the plates form butt joints so that a continuous surface is achieved; they are attached by straps or welds. Clunker plating is arranged so that the plates form lap joints with one edge of a plate inside and the opposite edge outside of the adjacent strokes. Jogged plating has offset edges to avoid the use of liners between the plating and the framing. With in and out plating, the edges of the outside plating form lap joints so that both edges of the strake are either inside or outside of the adjacent strokes.

PONTOON COVER

A hollow, oblong structure made of mild steel which spans a hatch opening. It eliminates the need for hatch boards and beams and is sturdy enough to hold deck cargo and withstand water washing over the deck.

PORTABLE UNFIRED PRESSURE VESSEL

A container or vessel used aboard a ship that contains liquids or gases under pressure, such as oxyacetylene fuel tanks used for welding.

POWDER-ACTUATED FASTENING TOOL

A machine or tool which drives a stud, pin, or other fastener by means of an explosive charge, including both hammer-driven and trigger-activated tools.



GLOSSARY (CONTINUED)

PREVENTER

An auxiliary rope or wire fitted with tackle and attached to or placed alongside a heavily laden rope, brace, or backstay to relieve unusual strain and provide additional security.

PROPELLOR

A propulsive device consisting of a boss or hub carrying radial blades, from two to four in number. The near or driving faces of the blades form portions of an approximately helical surface, the axis of which is the centerline of the propellor shaft.

PUBLIC VESSEL

Any vessel owned and operated by a government and not regularly employed in merchant service, including Coast Guard vessels.

PURCHASE

Tackle or a system of blocks and tackle offering a mechanical advantage.

QUAY

A landing place at which vessels receive or discharge cargo. It is also called a wharf. A quay is usually a solid masonry wall filled in behind, as distinguished from an open pile structure.

REEFER

A ship on which all cargo compartments are refrigerated.

RIG

To fit the shrouds, stays, etc., of a vessel to their respective masts or other fittings.

RIGGING

A term used to collectively for all ropes and chains used to support the masts, yards, and booms of a vessel, and to operate moving parts of the same.



GLOSSARY (CONTINUED)

RIVER TOWBOAT

A shallow draft, low freeboard, self-propelled vessel used to tow river barges by pushing ahead.

RUDDER

A device used in steering and maneuvering a vessel. The most common type consists of a flat slab of metal or wood, hinged at the forward end to the stern or rudder post. When made of metal, it may be built up from plates, shapes, and castings, with or without wood filling, or it may be a casting. The rudder is attached to a vertical shaft called the rudder stock, by which it is turned from side to side.

SAFE WORKING LOAD

The maximum load a rope, chain, or other equipment or gear may carry safely and efficiently. The safe working load of gear or equipment is specified by the manufacturer.

SCALING

Removing paint from vessel decks. Longshoring operations are prohibited during this procedure.

SCANTLINGS

A term applied to the dimensions of the frames, girders, plating, etc., that enter into a ship's structure.

SCARFS

Joints made by matching, grooving, or otherwise cutting the ends of two pieces of material and fastening them so that they lap over and join firmly into one continuous piece.

SCOW

A large flat-bottomed boat with square ends, used for carrying coal, sand, etc., and often towed by a tug.



GLOSSARY (CONTINUED)

SEIZING

A light strand tied about the loose end of a cable or rope to prevent ravelling. Three seizings are usually required on an end.

SHACKLE

A bow-shaped, D-shaped, saddle-shaped, or U-shaped wrought iron or steel fitting with a pin across the throat, used as a connection between lengths of chain or to attach other fittings. Shackles used in rigging have a threaded pin; those used for joining lengths of anchor chains have a smooth, heavy pin held in place by a small cotter.

SHACKLE BLOCK

An iron-shaped block fitted with a shackle and bolt attachment. If the shackle bolt passes through the eye of the strap, the block is called a regular or standard shackle block. If the "U" passes through the eye, it is known as an upset shackle block. When the shackle is made fast in the direction of the pin, it is a side shackle block.

SHEAVE

A grooved wheel in a block, mast, yard, etc., over which a rope passes and which rotates on a pin. Sheaves are made of wood, bronze, or galvanized cast iron or steel for running rigging. When severe or heavy intermittent strains are expected, brass sheaves are used.

SHELL

The outside of a ship from stem to stern. The plates forming the shell are called strokes, and are lettered starting at the keel, A-B-C, etc. Strakes are classified inner skin, outer or cover, clinker or in and out, forefoot, shoe, boss, sheer, and garboard.

SHORT TON

A unit of weight equal to 2000 pounds avoirdupois.

SHROUD

One of the principal members of standing rigging, consisting of wire rope which extends from the mast head to the vessel's side, affording lateral support for the mast.



GLOSSARY (CONTINUED)

SKEG

A deep, vertical, fin-like projection on the bottom of a vessel near the stern to support the lower edge of the rudder and the propellor shaft, and to support a vessel in dry dock. It also serves to minimize erratic steering.

SKIDS

A skeleton framework used to hold a vessel's structural assemblies above ground to facilitate welding or riveting during building.

SLIDERS

The timbers attached to the hull, which carry the ship down the ways when the vessel is launched.

SLING

An arrangement of ropes, cables, or canvas used to suspend a cargo draft. A belt sling is a long narrow canvas sling. A cargo sling is made of manila rope, wire, canvas, wood, or steel, and is used for hoisting cargo by the cargo runner. A chain sling is a length of chain with a large link ring or shackle in one end and a hook in the other, used to handle structural steel or rails. A platform sling is a wooden platform equipped with a four-legged sling with spreaders.

SNATCH BLOCK

A single block so fitted that the bight of a rope may be passed through it, without the delay of reeving or unreeving. The iron strap is hinged on one side and the shell is divided to allow the rope to be shipped into the sheave. A snatch block is often used as a lead block for wires and moorings, in which case it is hooked into a ring bolt in the hatch coaming or on deck near a winch.

SPLICE

A method of joining rope by interweaving the strands. A splice is a more intimate junction of parts than a knot. The lay of the rope is opened and the ends tucked in so that the size and character of the rope at the place where the splice is made are not greatly changed.



GLOSSARY (CONTINUED)

SPLICED EYE

A loop spliced in the end of a rope.

SPREADER

A pipe or shape made and used to hold two objects at a fixed distance apart.

STANCHION

An upright pillar of wood or steel supporting railings.

STANDING RIGGING

Fixed rigging supporting the masts, such as shrouds and stays. It does not include running rigging, e.g., topping lifts and cargo falls.

STAYS

Fixed wire ropes leading forward from aloft on a mast to the deck to prevent the mast from bending aft. Backstays lead from aloft to the deck edge well abaft the position of the mast. Preventer stays lead to any point on the deck to provide additional mast support when handling very heavy loads with boom tackle.

STEVEDORE

A person or firm employed in loading and unloading vessels. The private stevedore, in return for a fixed rate of remuneration, usually charged per ton of cargo, provides the men, gear, and all other necessary equipment for working the cargo in or out of a vessel. Some shipowning firms do their own stevedoring and maintain a special staff for this purpose.

STOPPER

A short length of rope or chain or a steel fitting used on board ship for checking the running of a rope, chain, or cable, or for holding it firmly while it is being played. A rope stopper is made up of a short length of manila secured at one end of the structure of a ship, the other end being passed around the rope to be stopped with a jamming hitch.



GLOSSARY (CONTINUED)

STOWAGE

Method of placing cargo in a hold; the careful and compact arrangement of cargo aboard a vessel.

STOWAGE FACTOR

The figure which expresses the number of cubic feet occupied by one long ton (2240 lbs.) of a commodity when stowed and dunnaged in the usual manner. It is computed by dividing 2240 pounds by the weight, in pounds, of a cubic foot of the particular commodity.

STRAKE

A continuous row or range of plates. The strakes of shell plating are usually lettered, beginning with "A" at the bottom row. This bottom row is called the garboard strake and is adjacent to the keel. These plates are made heavier than the other bottom plates.

STRONGBACK

A heavy girder usually as deep as the hatch itself, extending fore and aft of the exact center of the hatch, fitted into slots or slides in the end coaming and secured by bolts. Also called a hatch beam.

SUPERSTRUCTURE

A structure built above the uppermost complete deck, such as a pilot house or galley house.

TACKLE

Any combination of ropes and blocks that multiplies power.

TAG LINE

A length of small line used as a guide or to steady drafts of cargo.

TARPAULIN

A painted or treated canvas used as covering for hatches.



GLOSSARY (CONTINUED)

TOGGLES

- a) Pins inserted into nautical knots to make them more secure or easier to slip.
- b) Crosspieces attached to the end or loop of a chain, rope, line, strap, belt, etc., to prevent slipping.

TOPPING LIFT

A wire rope extending from the head of a boom to a mast for the purpose of supporting weight and permitting the boom to be raised or lowered.

TRANSVERSE BULKHEAD

A bulkhead placed at right angles to the vessel's centerline.

TRIM

The difference in feet between a vessel's draft forward and draft aft. If the draft forward is greater, the vessel is said to "trim by the head". If the draft aft is greater, the vessel is "trimming by the stern". To trim a vessel is to adjust the location of fuel, cargo, etc., to result in the desired draft fore and aft.

TRIMMING HATCH

A hatch, usually small in size and located in an intermediate deck, often used for stowing ballast.

'TWEEN DECK

Any deck below the upper deck and above the lowest deck, an abbreviation of "between deck".

VESSEL

Any watercraft or other device used for transportation on water. The term also applies to special purpose floating structures, such as offshore drilling platforms, not primarily used for water transportation.



GLOSSARY (CONTINUED)

WEATHER DECK

The uppermost continuous exposed deck.

WELDING BEAD

A seam made by closing a joint with molten metal applied by a welding tool.

WHARF

A structure for loading or discharging vessels, particularly a platform made of timber, stone, or concrete against which vessels may be secured to load or discharge.

WINCH

A hoisting or pulling machine fitted with a horizontal single or double drum. A small drum, called a gypsy head or winch head, is usually fitted on one or both ends of the shaft supporting the hoisting drum. The hoisting drums are either fitted with a friction brake or are directly keyed to the shaft. The driving power is usually steam or electric, but the winch may be operated manually. Winches are used principally for handling, hoisting, and lowering cargo from a dock to the hold of a ship and vice versa.

WINDLASS

An apparatus with horizontal or vertical drums operated by a steam engine or motor and used to handle heavy anchor chains, hawsers, etc.

WING TANK

Tanks located outboard adjacent to the side shell plating, often consisting of a continuation of the double bottom up the sides to a deck or flat.

YARD BOOM

A derrick or cargo boom swung over a ship's side and guyed there. It takes the load off of the hatch boom and lowers it clear of the ship's side.



SELF-STUDY GUIDE
ON-THE-JOB TRAINING GUIDE
FOR
MARITIME STANDARDS FOR CSHO'S

Prepared For:
Occupational Safety and Health Administration
U.S. Department of Labor

Prepared By:
JRB Associates, Inc.
8400 Westpark Drive
McLean, Virginia 22102

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SELF-STUDY GUIDE

INTRODUCTION

You will soon be attending a 50-hour course entitled "Maritime Standards for CSHOs." This course (number 100-24) will be given at the OSHA Training Institute, as part of the third year of your compliance training.

Purposes and Objectives

The purpose of the OSHA training program is to prepare you for your work in enforcing the Occupational Safety and Health Act of 1970. The overall purpose of this course is to build technical and professional competence in the recognition and evaluation of occupational safety and health hazards in the maritime industry.

Completion of this course will enable you to:

- o Identify maritime safety and health hazards and appropriate abatement procedures.
- o Demonstrate a knowledge of maritime operations and apply 29 CFR 1915, 1916, 1917, and 1918 to those operations.
- o Use current maritime nomenclature and terminology included in 29 CFR 1915, 1916, 1917, and 1918.

Specific, measurable, performance objectives will be included in each of the 50 lessons in the course. These objectives will be the basis for criterion tests to be administered before and after the instruction.



Course Content

This 50-hour course is designed to enable the safety engineer or other safety specialist in CSHO training to understand basic processes in the maritime industry, as well as recognize and evaluate their associated occupational hazards. The lessons combine illustrated lecture, demonstration, and laboratory exercise. Lesson 1 includes a pretest to determine your level of knowledge about the subject matter prior to taking the course.

Following is a list of the lessons:

- Lesson 1: Introduction and Background of Maritime Safety
- Lesson 2: Introduction and Background of Maritime Safety (Continued)
- Lesson 3: Maritime Nomenclature
- Lesson 4: Maritime Nomenclature (Continued)
- Lesson 5: Longshoring--Introduction
- Lesson 6: Walkthrough Overview
- Lesson 7: Gangways and Other Means of Access
- Lesson 8: Working Surfaces
- Lesson 9: Opening and Closing Hatches
- Lesson 10: Ship's Cargo Handling Gear, Part I
- Lesson 11: Ship's Cargo Handling Gear, Part II
- Lesson 12: Gear Certification
- Lesson 13: Cargo Handling Gear Other Than Ship's Gear, Section 1
- Lesson 14: Cargo Handling Gear Other Than Ship's Gear, Section 2
- Lesson 15: Cargo Handling Gear Other Than Ship's Gear, Section 3



- Lesson 16: Handling Cargo, Section 1**
- Lesson 17: Handling Cargo, Section 2**
- Lesson 18: General Working Conditions, Section 1**
- Lesson 19: General Working Conditions, Section 2**
- Lesson 20: Personal Protective Equipment and Health Hazards**
- Lesson 21: Longshoring Documentation**
- Lesson 22: Shipyard Section--Introduction**
- Lesson 23: Walkthrough Overview, Ship Repair**
- Lesson 24: Walkthrough Overview, Ship Repair (Continued)**
- Lesson 25: Walkthrough Overview, Shipbuilding**
- Lesson 26: Walkthrough Overview, Shipbuilding (Continued)**
- Lesson 27: Walkthrough Overview, Shipbreaking**
- Lesson 28: Explosive and Other Dangerous Atmospheres**
- Lesson 29: Explosive and Other Dangerous Atmospheres (Continued)**
- Lesson 30: Explosive and Other Dangerous Atmospheres (Continued)**
- Lesson 31: Explosive and Other Dangerous Atmospheres (Continued)**
- Lesson 32: Competent Person**
- Lesson 33: Competent Person (Continued)**
- Lesson 34: Instrument Workshop**
- Lesson 35: Instrument Workshop (Continued)**
- Lesson 36: Gas-freeing**
- Lesson 37: Surface Preparation**
- Lesson 38: Surface Painting and Preservation**
- Lesson 39: Welding, Cutting and Heating**
- Lesson 40: Welding, Cutting and Heating (Continued)**



- Lesson 41: Scaffolds, Ladders, and Other Working Surfaces
- Lesson 42: Scaffolds, Ladders, and Other Working Surfaces (Continued)
- Lesson 43: General Working Conditions
- Lesson 44: Health and Sanitation
- Lesson 45: Health and Sanitation (Continued)
- Lesson 46: Gear and Equipment for Rigging and Materials Handling
- Lesson 47: Tools and Related Equipment
- Lesson 48: Personal Protective Equipment
- Lesson 49: Ship's Machinery and Piping Systems and Other Topics (Subparts K and L)
- Lesson 50: Course Review and Post-test

Course Materials

Your course package consists of this Self-Study Guide and a class manual with lecture notes and supplementary material. Your supervisor will receive an On-the-Job Training Guide to assist you in planning 5 weeks of practical applications of course content.

The Self-Study Guide will serve both to prepare you for the formal training period and to extend the coverage of subject areas presented in class. The activities are designed to relate principles and theories to actual problems encountered on the job.



CLASS PREPARATION

We want you to spend about 2 days on background reading in the following basic references on the course subject matter areas:

1. 29 CFR 1915 -- Safety and Health Regulations for Ship Repairing
2. 29 CFR 1916 -- Safety and Health Regulations for Shipbuilding
3. 29 CFR 1917 -- Safety and Health Regulations for Shipbreaking
4. 29 CFR 1918 -- Safety and Health Regulations for Longshoring
5. 29 CFR 1919 -- Gear Certification.

CLASS FOLLOWUP

OSHA doesn't expect you to even try to keep up all the literature in the field. However, you should be familiar with the most frequently used sources of information. Following is a list of references used in developing this course. You may want to do some "tree-searching" of additional related references in these standard works.

Your lesson materials contain a glossary of special terms used in the maritime industry. We suggest that you expand this glossary with additional terms you encounter in your reading. This is a good practice to follow in all of your work.



References

American Conference of Governmental Industrial Hygienists. Air sampling instruments for evaluation of atmospheric contaminants. 5th edition. Cincinnati, OH, ACGIH, 1978.

American Conference of Governmental Industrial Hygienists. Recommended threshold limit values. Cincinnati, OH, ACGIH, 1980.

American Mutual Insurance Alliance. Handbook of organic industrial solvents. 4th edition. Chicago, AMIA, 1972.

American Waterways Operators. Big load afloat. Arlington, VA, American Waterways Operators, 1973.

Eyres, D.J. Ship construction. London, Heinemann, 1972.

Factory Mutual Engineering Corporation. Handbook of industrial loss prevention. 2nd edition. New York, McGraw-Hill, 1967.

Heine, Irwin M. The United States merchant marine, a national asset. Washington, D.C., National Maritime Council, 1976.

Hilti Fastening Systems. "High velocity powder-actuated tools" (advertising brochure). Stamford, CT, Hilti, Inc., 1960.

Hobart Brothers Company. Hobart vest pocket guide: a guide to better welding. Troy, OH, Hobart Brothers Company, 1967.

International Labour Office. Encyclopedia of occupational health and safety. Vol. II, pp. 1033-5, Shipbuilding. New York, McGraw-Hill, 1972.

Kreig, A.H. The problems with welding fume and how to solve them. Naugatuck, CT, Widder Corporation, 1979.

Lewis, Edward V. and Robert O'Brien. Ships. New York, Time Incorporated, 1965.

National Fire Protection Association. "NFPA 306, 1975. Control of gas hazards on vessels to be repaired." Boston, MA, NFPA, 1975.

National Fire Protection Association. "NFPA 312, 1976. Fire protection of vessels during construction, repair, and lay-up." Boston, MA, NFPA, 1976.

National Safety Council. Accident prevention manual for industrial operations. 7th edition. Chicago, National Safety Council, 1977.

Olishifski and McElroy (eds.). Fundamentals of industrial hygiene. Chicago, National Safety Council, 1971.



Sax, N.I. Dangerous properties of industrial materials. 4th edition. New York, Litton Educational Publishing, Inc., and Van Nostrand Reinhold Company, 1975.

Seatrains Shipbuilding Corporation. Shipfitter's handbook. New York, Seatrain Shipbuilding Corporation, [n.d.].

Tube-Turn. Pipefitter's manual. Louisville, KY, Tube-Turn, Division of Chemetron Corporation [n.d.].

U.S. Bureau of Labor Statistics. Occupational injuries and illnesses in the United States by industry, 1976. Washington, D.C., U.S. Bureau of Labor Statistics, 1979.

U.S. Department of the Army. Transportation corps military stevedoring. Technical Manual No. 55-513. Washington, D.C., U.S. Department of the Army, 1961.

U.S. Occupational Safety and Health Administration. All about OSHA. Washington, D.C., U.S. Occupational Safety and Health Administration, 1980.

U.S. Occupational Safety and Health Administration. Industrial hygiene field operations manual. Washington, D.C., U.S. Department of Labor, 1977.

U.S. Occupational Safety and Health Administration. An OSHA operation safety analysis for the longshore industry: break-bulk operation, the container operation, the barge operation, the lash operation, the roll-on, roll-off operation. U.S. Department of Labor, Washington, D.C., U.S. Occupational Safety and Health Administration, 1976.

U.S. Occupational Safety and Health Administration. An OSHA job safety analysis for the longshore industry: the straddle truck operator. Washington, D.C., U.S. Occupational Safety and Health Administration, 1976.

U.S. Occupational Safety and Health Administration. Longshoring accident summary for two month period in 1977. Washington, D.C., U.S. Occupational Safety and Health Administration, 1977.

U.S. Occupational Safety and Health Administration. "Memorandum of understanding between the U.S. Coast Guard, the Department of Transportation and the Occupational Safety and Health Administration, the Department of Labor concerning occupational safety and health on artificial islands, installations and other devices on the outer continental shelf of the United States." Washington, D.C., U.S. Occupational Safety and Health Administration, December 1979.

Villiers, Alan, et al. Mens, ships, and the sea. Washington, D.C., National Geographic Society, 1973.



ON-THE-JOB TRAINING GUIDE

INTRODUCTION

This guide to on-the-job training in maritime activities for CSHO's is divided into five sets of tasks that correspond to the various parts of the safety and health regulations. The sequence of assignments may be adapted to the needs of the trainee and other work requirements. However, it is suggested that all tasks for a given topic be completed before beginning another set.

The supervisor or instructor may elect to use prepared checklists or standard formats for the written evidence of task completion. On the other hand, practice in developing job aids for compliance inspections also can be built into the written part of the tasks.

All written material should be considered as important practice in preparing inspection reports. These materials should be carefully reviewed by the instructor for grammar, punctuation, spelling, and other elements of style. They should be redone until the trainee demonstrates adequate mastery of the essentials of report writing. If additional assistance appears to be needed, the instructor and the supervisor should recommend the most appropriate training available.



Topic: Ship Repairing

Length: 1 Week

- Tasks:
1. Walk through a ship repair yard and observe the hazards associated with the following:
 - o Dry dock facilities
 - o Fabrication facilities
 - o Intermediate staging areas.
 2. Review activities of the employer's competent person. Specifically check:
 - o OSHA 73 and OSHA 74
 - o Procedures for maintaining gas-free conditions
 - o Posting inspections and tests of areas certified by a Marine Chemist.
 3. Test a work area for combustible gas concentrations and oxygen content.

Expectation: Completion of the tasks will enable the trainee to:

1. Recognize hazards in dry dock, fabrication, and intermediate staging areas.
2. Assess compliance of employer with respect to competent person activities.
3. Perform workplace tests for combustible gas concentration and oxygen.

Instructor: Designated on-the-job trainer.

Validation: Completion memo signed by Area Director, trainer, and trainee.

- Evaluation:
1. Written evaluation by trainer.
 2. Review by Area Director.

Note: Training techniques and task assignments should be appropriate to the experience and education profile of the trainee.



Topic: Shipbuilding

Length: 1 Week

Tasks:

1. Observe a surface preparation operation and record safety and health hazards. Use the following as a guide:
 - o Use of electric or pneumatic tools
 - o Use of toxic solvents
 - o Use of respiratory protection.
2. Examine employee personal protection for welding, cutting, and burning operations. Assess whether employees are protected against:
 - o Ultraviolet radiation
 - o Impact from chips and flying objects
 - o Falls from heights.
3. Audit the employer's records with respect to Material Safety Data Sheets.
 - o During a walkthrough, note the names of chemicals known to be hazardous (xylene, toluene, kerosene, etc.).
 - o Request appropriate Material Safety Data Sheet from the employer.

Expectation: Completion of the tasks will enable the trainee to:

1. Recognize hazards associated with electric or pneumatic tools, toxic solvents, and conditions requiring respiratory protection.
2. Evaluate hazard control by personal protection in welding, cutting, and burning operations.
3. Assess compliance of employer with respect to Material Safety Data Sheets on hazardous chemicals.

Instructor: Designated on-the-job trainer.

Validation: Completion memo signed by Area Director, trainer, and trainee.

Evaluation:

1. Written evaluation by trainer.
2. Review by Area Director.

Note: Training techniques and task assignments should be appropriate to the experience and education profile of the trainee.



Topic: Shipbreaking

Length: 1 Week

Tasks:

1. Observe cutting and burning operations and note the hazards. Use the following as a guide:
 - o Availability of fire protection equipment
 - o Use of personal protective equipment
 - o Use of electric or pneumatic tools.
2. Audit the employer's pressure vessel systems.
 - o Record of inspection and tests
 - o Hydrostatic testing
 - o Safety relief valve setting (lowest safe working pressure for either the system or the pressure vessel).
3. Ascertain gas-free condition of compartments where hot work is taking place and those immediately adjacent to them.

Expectation: Completion of the tasks will enable the trainee to:

1. Recognize hazards in cutting and burning operations.
2. Assess compliance of employer with respect to pressure vessel systems.
3. Evaluate hazard control of hot work areas.

Instructor: Designated on-the-job trainer.

Validation: Completion memo signed by Area Director, trainer, and trainee.

Evaluation:

1. Written evaluation by trainer.
2. Review by Area Director.

Note: Training techniques and task assignments should be appropriate to the experience and education profile of the trainee.



Topic: Longshoring

Length: 1 Week

Tasks:

1. Observe breakbulk cargo handling activities and note hazards and violations associated with the following activities:
 - o Discharging cargo
 - o Bulling cargo
 - o Stowing cargo.
2. Perform carbon monoxide (CO) tests in deep tanks where forklifts are operating.
3. Conduct a survey of container cargo activities and prepare a report on hazard control.
 - o Review cargo stowage plan.
 - o Observe loading and unloading operations.
 - o Examine ship's hold for location of employees while containers are handled.

Expectation: Completion of the tasks will enable the trainee to:

1. Recognize hazards associated with breakbulk cargo handling.
2. Perform tests for presence of carbon monoxide.
3. Assess hazard control in container cargo activities.

Instructor: Designated on-the-job trainer.

Validation: Completion memo signed by Area Director, trainer, and trainee.

Evaluation:

1. Written evaluation by trainer.
2. Review by Area Director.

Note: Training techniques and task assignments should be appropriate to the experience and education profile of the trainee.



<u>Topic:</u>	Gear Certification
<u>Length:</u>	1 Week
<u>Tasks:</u>	1. Review the employer's procedures to determine if the gear aboard a given vessel is certified. 2. Examine gear certification documents aboard a vessel. Report the following dates: - o Last quadrennial inspection - o Last annual inspection. 3. Identify two certifying agencies in your area. 4. Perform a spot check of a shipboard crane by observing crane operation and hoisting: - o Condition of wire rope - o Obvious signs of overloading, such as bend in boom - o Smooth operations and prevention of shockloading.
<u>Expectation:</u>	Completion of the tasks will enable the trainee to: 1. Assess compliance of employer with respect to gear certification procedures. 2. Conduct a review of gear certification documents. 3. Recognize hazards associated with crane operations and hoisting.
<u>Instructor:</u>	Designated on-the-job trainer.
<u>Validation:</u>	Completion memo signed by Area Director, trainer, and trainee.
<u>Evaluation:</u>	1. Written evaluation by trainer. 2. Review by Area Director.
<u>Note:</u>	Training techniques and task assignments should be appropriate to the experience and education profile of the trainee.