DOCUMENT RESUME

ED 219 614 CE 033 347

TITLE	Military Curriculum Materials for Vocational and Technical Education. Plumbing Specialist IV & V, 3-23.
INSTITUTION	Air Force Training Command, Sheppard AFB, Tex.; Ohio State Univ., Columbus. National Center for Research in Vocational Education.
SPONS AGENCY	Office of Vocational and Adult Education (ED), Washington, DC.
PUB DATE	[82]
NOTE	532p.; For related documents see CE 033 345-346.
EDRS PRICE	MF02/PC22 Plus Postage.
DESCRIPTORS	Behavioral Objectives; *Equipment Maintenance; Equipment Utilization; Instructional Materials; Learning Modules; Lesson Plans; Military Personnel; Military Training; Occupational Safety and Health; *Plumbing; Postsecondary Education; Safety; *Sanitary Facilities; Skilled Occupations; Study Guides; *Utilities; Vocational Education; *Waste Disposal; Waste Water; *Water; Workbooks
IDENTIFIERS	Military Curriculum Project

ABSTRACT

These military-developed curriculum materials consist of a course description, course chart, plan of instruction, lesson plans, study guides, and workbooks for use in training plumbing specialists IV and V. Covered in the course blocks are fixtures and appurtenances and utility equipment. Block IV on fixtures and appurtenances deals with installation of bathtubs and showers, water closets, urinals, lavatories, and water lines; inspection and maintenance of plumbing systems; recovery and restoration; and planning and layout of plumbing systems. Addressed in course block V, on utility equipment, are the following topics: winterization of piping; maintenance of valves, sewers, and grease traps; emergency maintenance and exterior piping, fire hydrants, and sprinkler systems; utility equipment; and corrosion control. (MN)

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

Agriculture	Food Service
Aviation	Health
Building & Construction Trades	Heating & Air Conditioning
Clerical Occupations	Machine Shop
Communications	Management & Supervision
Drafting	Meteorology & Navigation
Electronics	Photography
Engine Mechanics	Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
Director
100 North First Street
Springfield, IL 62777
217/782-0759

MIDWEST
Robert Patton
Director
1515 West Sixth Ave.
Stillwater, OK 74704
405/377-2000

NORTHEAST
Joseph F. Kelly, Ph.D.
Director
225 West State Street
Trenton, NJ 08625
609/292-6562

NORTHWEST
William Daniels
Director
Building 17
Airdustrial Park
Olympia, WA 98504
206/753-0879

SOUTHEAST
James F. Shill, Ph.D.
Director
Mississippi State University
Drawer DX
Mississippi State, MS 39762
601/325-2510

WESTERN
Lawrence F. H. Zane, Ph.D.
Director
1776 University Ave.
Honolulu, HI 96822
808/948-7834

The National Center Mission Statement

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

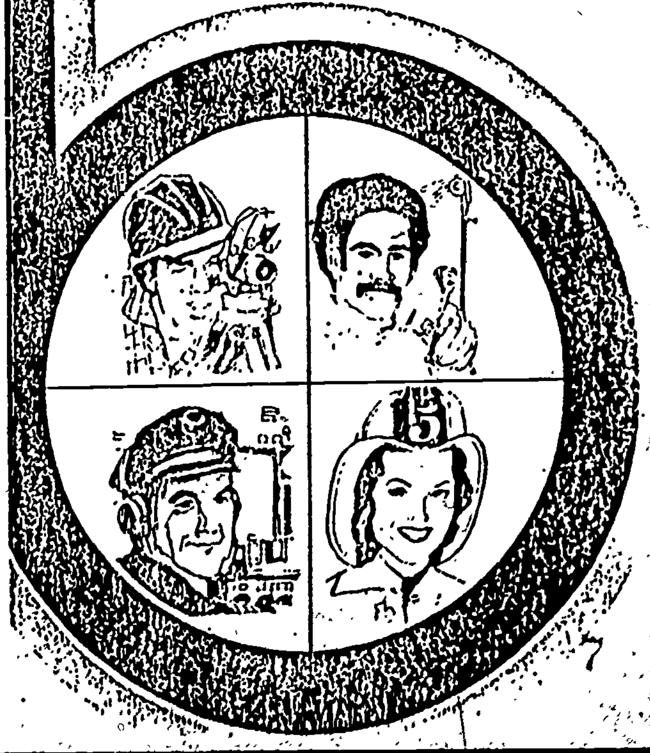
FOR FURTHER INFORMATION ABOUT
Military Curriculum Materials
WRITE OR CALL
Program Information Office
The National Center for Research in Vocational Education
The Ohio State University
1960 Kenny Road, Columbus, Ohio 43210
Telephone: 614/486-3655 or Toll Free 800/848-4815 within the continental U.S. (except Ohio)

THE NATIONAL CENTER
FOR RESEARCH IN VOCATIONAL EDUCATION

Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education



PLUMBING SPECIALIST, IV AND V

Table of Contents

Developed by:

United States Air Force

Development and Review Dates

July 2, 1975

D.O.T. No.:
862.287

Occupational Area:

Building and Construction

Target Audiences:

Grades 10-adult

Print Pages

535

Cost:

$10.75

Availability:
Military Curriculum Project, The Center for Vocational Education, 1960 Kenny Rd., Columbus, OH 43210

Contents:	Type of Materials:	Lesson Plans:	Programmed Text:	Student Workbook:	Handouts:	Text Materials:	Audio-Visuals:	Instructional Design:	Performance Objectives:	Tests:	Review Exercises:	Additional Materials Required:	Type of Instruction:	Group Instruction:	Individualized:
				No. of pages											
Block IV															
Fixtures and Appurtenances		●		29		●	★		●	★		★		●	
Block V															
Utility Equipment		●		44		●	★		●	★		★		●	

★ Materials are recommended but not provided.

Course Description

Because of its long length Plumbing Specialist has been divided into three (3) courses for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Training for this series of courses includes instruction on plumbing system operation principles and configurations, construction and maintenance of fixtures, faucets, and plumbing system valves, and utilization and maintenance of tools, equipment, and supplies. The series involves 243 hours of instruction.

This is the third course in the series. It includes Block IV—*Fixtures and Appurtenances* and Block V—*Utility Equipment.* Students should not start Plumbing Specialist, IV and V before they have completed Plumbing Specialist, I and Plumbing Specialist, II and III (courses 3-21 and 3-22 in this catalog). The lesson titles and hours for the course are listed below:

Block IV — *Fixtures and Appurtenances* contains eight lessons with 58 hours of instruction.

Installation of Bathtubs and Showers (6 hours)
Installation of Water Closets (6 hours)
Installation of Urinals (6 hours)
Installation of Lavatories (6 hours)
Insulation of Water Lines (6 hours)
Inspection and Maintenance of Plumbing Systems (6 hours)
Recovery and Restoration (12 hours)
Planning and Layout of Plumbing Systems (10 hours)

Block V — *Utility Equipment* contains seven lessons with 39 hours of instruction. Two additional lessons were deleted because they deal with military resources and communication security.

Winterization of Piping (2 hours)
Maintenance of Valves (4 hours)
Maintenance of Sewers and Grease Traps (6 hours)
Emergency Maintenance of Exterior Piping (6 hours)
Fire Hydrants and Sprinkler Systems (12 hours)
Utility Equipment (6 hours)
Corrosion Control (3 hours)

Materials for both student and teacher use are included. Printed materials for the instructor include a plan of instruction for each block and lesson plans for each lesson. These contain an outline of instruction, objectives, activities, materials and tools needed, text assignments, and references. Student materials consist of study guides and workbooks for each block. Shop drawings are attached to the workbooks. Thirty-two slide sets and eight films are suggested for the series but these are not provided.

COURSE CHART

NUMBER	POS CODE	DATE
3ABR55235	ARL	2 July 1975

COURSE TITLE
Plumbing Specialist

ATC OPR AND APPROVAL DATE	CENTER OPR	SUPERSEDES COURSE CHART
TTMS, 13 November 1974	Sheppard/TTOXU	3ABR55235, 5 April 1973

DEPARTMENT OPR	APPLICABLE TRAINING STANDARD
Department of Civil Engineering Training	STS 552X5, 15 Feb 73;Ch1, 25 Feb74
LOCATION OF TRAINING	**COURSE SECURITY CLASSIFICATION**
Sheppard AFB, Texas	UNCLASSIFIED
INSTRUCTIONAL DESIGN	**TARGET READING GRADE LEVEL FOR PREPARATION OF TRAINING LITERATURE**
Group/Lock Step: Proficiency Advancement	9

LENGTH OF TRAINING (9 Weeks, 0 Days)

		Hours
Technical Training		322
Classroom/Laboratory (C/L)	270	
Complementary Technical Training (CTT)	52	
Related Training		38
Standard Traffic Safety, Course I (AFR 50-24)	12	
Local Conditions Course, Course II (AFR 50-24)	2	
Supplemental Military Training (SMT) (ATCR 50-20)	12	
Commander's Calls/Briefings	2	
End of Course Appointments; Predeparture Safety Briefing (ATCR 127-1)	10	
Total		360

REMARKS
Effective date: 11 August 1975 with class 750811.

TABLE I. MAJOR ITEMS OF EQUIPMENT

Lavatory
Urinals
Valve Repair Kits
Water Heaters
Shower Unit
Water Closet
Grooving Tool
Tapping Machine
Test Plugs
Die Sets
Shop Benches
Power Grinder
Plumber Furnaces
Plumber Fire Pot
Sewer Augers
Centrifugal Pumps
Diaphragm Pump
Soil Pipe
Copper Pipe
Galvanized Pipe
Black Pipe
Vitrified Tile
Traps
Valves
Insulating Materials
Pipe Locator

ATC FORM DEC 74 449 REPLACES PREVIOUS EDITIONS AND ATC FORM 449 B, NOV 72

3ABR55235 COURSE CHART – TABLE II – TRAINING CONTENT

NOTE: Include time spent on technical training (TT) (classroom/laboratory (C/L) and complementary technical training (CTT)) and related training (RT). Exclude time spent on individual assistance (remedial instruction). A single entry of time shown for a unit is C/L time. When a double entry is shown, the second entry is CTT time.

WK OF TNG / HRS PER DAY (1 2 3 4 5 6 7 8)		
1 2(4/5)	Course Material - UNCLASSIFIED 54 Hours TT BLOCK I - Introduction to Plumbing Orientation (2 hrs); Career Field and Civil Engineer Organization (2 hrs); Plumbing Safety (2 hrs); Plumbing Systems, Terminology, and Engineering Drawings (12 hrs); Publications (6 hrs); Exterior Sewer Systems (4 hrs); Maintenance of Tools (2 hrs); Installation of Building Sewer Systems (6 hrs); Individual Waste Disposal Systems (12 hrs); Structural Openings (4 hrs); Measurement Test and Test Critique (2 hrs). (Safety as Applicable) 54 Hours C/L	18 Hours RT
2(1/5) 3 4(4/5)	Course Material - UNCLASSIFIED 72 Hours TT BLOCK II - Building Waste Systems Building Drains (12 hrs); Vents and Stacks (12 hrs); Floor Drains and Roof Drains (3 hrs); Waste Rough-In for Lavatories (3 hrs); Installation of Back Vents (6 hrs); Rough-In for Urinal Drains (6 hrs); Rough-In for Showers and Tub Drains (6 hrs); Rough-In for Water Closet Drains (6 hrs); Testing Drainage Systems (4 hrs); Measurement Test and Test Critique (2 hrs). (Safety as Applicable) 60 Hours C/L	8 Hours RT 12 Hours CTT
4(1/5) 5 6(2/5)	Course Material - UNCLASSIFIED 62 Hours TT BLOCK III - Exterior and Interior Water Supply Systems Exterior Water Supply (3 hrs); Steel Pipe Assembly (3 hrs); Installation of Building Service Lines (6 hrs); Building Distribution Systems (12 hrs); Copper Tubing Assembly (12 hrs); Water Supply Rough-In for Fixtures (6 hrs); Installation of Domestic Water Heaters (4 hrs); Measurement Test and Test Critique (2 hrs). (Safety as Applicable) 48 Hours C/L	2 Hours RT 14 Hours CTT

FORM APR 73 449A PREVIOUS EDITION OBSOLETE.

COURSE CHART - TABLE II - TRAINING CONTENT 3ABR55235

NOTE: Include time spent on technical training (TT) (classroom/laboratory (C/L) and complementory technical training (CTT) and related training (RT). Exclude time spent on individual assistance (remedial instruction). A single entry of time shown for a unit is C/L time. When a double entry is shown, the second entry is CTT time.

WK OF TNG \ HRS PER DAY	1 2 3 4 5 6	7 8
	Course Material - UNCLASSIFIED 80 Hours TT BLOCK IV - Fixtures and Appurtenances	20 Hours CTT
6(3/5) 7 8(2/5)	Installation of Bathtubs and Showers (6 hrs); Installation of Water Closets (6 hrs); Installation of Urinals (6 hrs); Installation of Lavatories (6 hrs); Insulation of Water Lines (6 hrs); Inspection and Maintenance of Plumbing Systems (6 hrs); Recovery and Restoration (12 hrs); Planning and Layout of Plumbing Systems (10 hrs); Measurement Test and Test Critique (2 hrs). (Safety as Applicable) 60 Hours C/L	
	Course Material - UNCLASSIFIED 54 Hours TT BLOCK V - Utility Equipment	6 Hours CTT
8(3/5) 9	Winterization of Piping (2 hrs); Maintenance of Valves (4 hrs); Maintenance of Sewers and Grease Traps (6 hrs); Emergency Maintenance of Exterior Piping (6 hrs); Fire Hydrants and Sprinkler Systems (12 hrs); Utility Equipment (6 hrs); Corrosion Control (3 hrs); Project and Resource Management (3 hrs); Communication Security (2 hrs); Measurement Test and Test Critique (2 hrs); Course Critique and Graduation (2 hrs). (Safety as Applicable) 48 Hours C/L	10 Hours RT

ATC FORM 449A APR 73 PREVIOUS EDITION OBSOLETE.

PLAN OF INSTRUCTION	COURSE TITLE Plumbing Specialist
BLOCK TITLE Fixtures and Appurtenances	

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION HOURS 2	SUPPORT MATERIALS AND GUIDANCE 3
1. Installation of Bathtubs and Showers a. Using the manufacturer's specifications and procedures provided, install a shower. The mixing faucets must operate easily, the shower head must be the correct distance from the floor and the drain must be installed correctly.	8 (6/2) Day 28 (6/2)	Column 1 Reference 1a STS Reference 6a(6), 13a(3), 14a Instructional Materials SG 3ABR55235-IV-1, Installation of Bathtubs and Showers WB 3ABR55235-IV-1-P1, Installing Mixing Faucets and Showers Manufacturer's Rough-In Specifications Audio Visual Aids Slides, Installation of Bathtubs and Showers Training Equipment Hand Tools for Plumbing (1) Shop and Special Tools for Plumbing (2) Mock-Up Trainer (2) Shower (2) Training Methods Discussion and Demonstration (2 hrs) Performance (4 hrs) Outside Assignments (2 hrs) Instructional Environment/Design Classroom (2 hrs) Laboratory (4 hrs) Study Hall (Dormitory) (2 hrs) Group/Lockstep: Proficiency Advancement

PLAN OF INSTRUCTION NO. 3ABR55235	DATE 2 July 1975	BLOCK NO. IV	PAGE NO. 41

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
		Instructional Guidance Use slides and samples when discussing the types of tubs and drains. Discuss floor and wall preparation procedures. Identify the symbols used to represent various types of tubs. Use manufacturer's rough-in specifications for references. Discuss the types of showers, valves, and shower heads. While in the booth area, enforce correct lifting procedures and techniques designed to reduce damage to fixtures. Demonstrate the correct leveling techniques. Demonstrate techniques used in preventing surface damage to chromeplated accessories. Discuss the procedures for protecting the finish on fixtures during the installation process. Have the students complete the work project. At the end of day 28, make the following outside assignment: Read SG 3ABR55235-IV-2, Answer the questions. Fill in the blanks of WB 3ABR55235-IV-2-P1. Be prepared for a quiz over this material The following references should be used in preparing the lesson: AFR 127-101, Ground Accident Prevention Handbook National Plumbing Code
2. Installation of Water Closets a. Using the manufacturer's specifications and procedures provided, install a tank-type water closet bowl. Bowl must be securely attached to closet flange.	8 (6/2) Day 29 (3/1)	Column 1 Reference — STS Reference 2a — 14a 2b — 14a Instructional Materials SG 3ABR55235-IV-2, Installation of Water Closets WB 3ABR55235-IV-2-P1, Installing Tank-Type Water Closets Manufacturer's Rough-In Specifications

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PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)	3 SUPPORT MATERIALS AND GUIDANCE
b. Following the procedures provided, install a flush tank. The tank must be level and attached securely to the bowl.	(3/1)	<u>Audio Visual Aids</u> Slides, Water Closet and Mechanism <u>Training Equipment</u> Hand Tools for Plumbing (1) Shop and Special Tools for Plumbing (2) Water Closet (2) Flush Tank (2) <u>Training Methods</u> Discussion and Demonstration (2 hrs) Performance (4 hrs) Outside Assignment (2 hrs) <u>Instructional Environment/Design</u> Classroom (2 hrs) Laboratory (4 hrs) Study Hall (Dormitory)(2 hrs) Group/Lockstep: Proficiency Advancement <u>Instructional Guidance</u> Use slides and samples when discussing the types of water closets, flushing actions, and flushing mechanisms. Demonstrate the installation of flush tank internal mechanisms. Explain the purpose and installation of a wax ring. Have the students assemble a flush tank. Emphasize the precautions to be taken when handling water closets. Identify methods of fabricating and installing supply lines. Have the students complete the work projects.

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
		For day 29, make the following outside assignment: Read SG 3ABR55235-IV-2, and answer the questions. Complete WB 3ABR55235-IV-2-P1. The following references should be used in preparing the lesson: AFR 127-101, Ground Accident Prevention Handbook National Plumbing Code
3. Installation of Urinals	8 (6/2)	Column 1 Reference / STS Reference 3a / 14a
a. Install a wall-mounted urinal in accordance with the manufacturer's installation instruction. Urinal must be securely attached and must be the correct distance from the floor.	Day 30 (4/1)	3b / 10a(3), 14a 3c / 13a(5), 14a Instructional Materials SG 3ABR55235-IV-3, Installation of Urinals WB 3ABR55235-IV-3-P1, Installation of Urinals Manufacturer's Rough-In Specifications
b. Using instructions provided, install a flushometer and a vacuum breaker. The installed items must not leak and must be aligned with the fixture inlet.	(1/1)	Audio Visual Aids Slides, Identification and Installation of Urinals
c. Using the instructions provided, install a P-trap. The trap must be aligned with the fixture outlet.	(1/0)	Training Equipment Hand Tools for Plumbing (1) Shop and Special Tools for Plumbing (2) Urinal (2)

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
		Training Methods Discussion and Demonstration (2 hrs) Performance (4 hrs) Outside Assignments (2 hrs) **Instructional Environment/Design** Classroom (2 hrs) Laboratory (4 hrs) Study Hall (Dormitory)(2 hrs) Group/Lockstep: Proficiency Advancement **Instructional Guidance** Use slides and available samples to describe various types of urinals and discuss the codes governing the use of each type. Discuss the types of traps used, vacuum breakers, and flushing mechanisms. Identify and demonstrate the use of spud wrenches. Describe wall preparation when installing wall-hung urinals. Reference students to specific manufacturer's specifications for wall-hung urinal. Have students install and connect a wall-hung urinal. Demonstrate how flushometers can be adjusted and discuss repair procedures. Have the students perform an operational check of urinal installation. Help the students analyze possible causes of malfunctions if they exist, and permit them to correct them. Have the students complete the work projects. At the end of day 30, make the following outside assignment: Read SG 3ABR55235-IV-4, and answer the question. Complete WB 3ABR55235-IV-4-P1. Be prepared for a test over this material. The following reference should be used in preparing the lesson: AFR 127-101, Ground Accident Prevention Handbook

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
4. Installation of Lavatories	8 (6/2) Day 31	**Column 1 Reference** — **STS Reference** 4a — 14a 4b — 13a(3) 4c — 11f(10), 13a(5)
a. Install a wall-mounted lavatory in accordance with the manufacturer's specifications. Lavatory must be mounted securely and be the correct height from the floor.	(3/1)	**Instructional Materials** SG 3ABR55235-IV-4, Installation of Lavatories WB 3ABR55235-IV-4-P1, Installing Lavatories Manufacturer's Specifications
b. Using a basin wrench and following the procedures provided, install a faucet and supply lines. The faucet must be securely fastened to the fixture, must open and close easily but must not leak when closed.	(2/1)	**Audio Visual Aids** Slides, Installation of Lavatories
c. Following the instructions provided, install a lavatory trap. The trap must be aligned with fixture outlet and the connections must be water tight.	(1/0)	**Training Equipment** Hand Tools for Plumbing (1) Shop and Special Tools for Plumbing (2) Lavatory with Faucet and Drain (2) **Training Methods** Discussion and Demonstration (2 hrs) Performance (4 hrs) Outside Assignments (2 hrs) **Instructional Environment/Design** Classroom (2 hrs) Laboratory (4 hrs) Study Hall (Dormitory)(2 hrs) Group/Lockstep:Proficiency Advancement

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	DURATION (HOURS)	SUPPORT MATERIALS AND GUIDANCE
		Instructional Guidance Use slides and samples to describe types of lavatories. Use manufacturer's rough-in specifications to discuss wall preparation and installation procedures. Describe drain components and installation, types of traps, and installation procedures. Discuss the codes governing the use of slip joints. Identify and demonstrate the use of a basin wrench. Monitor the students as they prepare a wall for a lavatory installation. Stress the care of fixtures and accessories to prevent undue damage. Have the students install the lavatory and test for leaks. At the end of day 31, make the following outside assignment: Read SG 3ABR55235-IV-5, and answer the questions. Complete WB 3ABR55235-IV-5-P1. Be prepared for a test on this material. The following references should be used in preparing the lesson: AFR 127-101, Ground Accident Prevention Handbook National Plumbing Code
5. Insulation of Water Lines a. Using preformed insulation, cement, paste, cheesecloth, and metal bands and following instructions provided, insulate a water line. Pipe must be completely covered and the insulation secured with cheesecloth, metal bands and cement.	8 (6/2) Day 32 (6/2)	**Column 1 Reference** 5a — **STS Reference** 12h, 12g **Instructional Materials** SG 3ABR55235-IV-5, Insulation of Water Lines WB 3ABR55235-IV-5-P1, Insulating Water Lines and Fittings **Audio Visual Aids** Slides, Types of Insulations Slides, Installation Procedures

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVE	DURATION (HOURS)	SUPPORT MATERIALS AND GUIDANCE
		Training Equipment Hand Tools for Plumbing (1) Shop and Special Tools for Plumbing (2) **Training Methods** Discussion and Demonstration (1 hr) Performance (5 hrs) Outside Assignments (2 hrs) **Instructional Environment/Design** Classroom (1 hr) Laboratory (5 hrs) Study Hall (Dormitory)(2 hrs) Group/Lockstep: Proficiency Advancement **Instructional Guidance** Use slides and samples while describing the types and use of insulating materials. Discuss the need for insulating hot and cold water pipe. Demonstrate the installation of preformed insulation with cheesecloth, wheat paste, and metal bands. Demonstrate the use of magnesium asbestos cement. Demonstrate the safe use of knives, scissors, or hacksaws in cutting materials. Have the students insulate the hot water lines from the heater and a valve body. At the end of day 32, make the following outside assignment: Read SG 3ABR55235-IV-6, and answer the questions. Be prepared for a test over this material. The following references should be used in preparing the lesson: AFR 127-101, Ground Accident Prevention Handbook National Plumbing Code

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
6. Inspection and Maintenance of Plumbing Systems	8 (6/2) Day 33	Column 1 Reference / STS Reference 6a — 10a(4), 10a(5) 6b — 12c 6c — 10a(1), 10a(2) 6d — 10a(3), 10e 6e — 12a, 12b 6f — 13b(3) (c) 6g — 13b(3)(d) 6h — 13b(3)(b)
a. Locate leaks visually or with instruments in buried or hidden water lines. Each student must locate at least one leak.	(1/1)	
b. Given a drawing of a water supply system, sketch one method of reducing water hammer. The method sketched must comply with the national plumbing code.	(0.5/0)	**Instructional Materials** SG 3ABR55235-IV-6, Inspection and Maintenance of Plumbing Systems WB 3ABR55235-IV-6-P1, Inspection and Maintenance of Plumbing Systems Manufacturer's Rough-In Specifications National Plumbing Code
c. Following given procedures, visually check the pressure and flow of water in a building or base water supply system. Each student must visually check the pressure and flow.	(0.5/0)	**Audio Visual Aids** Slides, Building Plumbing Systems
d. Make an operational check of the water supply lines, vent and waste system, and pipe hangers in the booth area. List all malfunctions or problem areas that must be corrected. Each student must find all the malfunctions and problem areas found by the instructor.	(1/1)	**Training Equipment** Hand Tools for Plumbing (1) Shop and Special Tools for Plumbing (2)
e. Following given procedures, repair all the leaking joints and replace all the defective pipe in the booth area. All leaks must be repaired and all defective pipe replaced.	(1/0)	**Training Methods** Discussion and Demonstration (2 hrs) Performance (4 hrs) Outside Assignments (2 hrs)

PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)	3 SUPPORT MATERIALS AND GUIDANCE
f. Given a tank type water closet with a malfunctioning flush valve, float valve, and necessary repair procedures, perform the necessary repairs to place the valves in operational condition.	(0.5/0)	Instructional Environment/Design Classroom (2 hrs) Laboratory (4 hrs) Study Hall (Dormitory)(2 hrs) Group/Lockstep:Proficiency Advancement
g. Using a valve repair kit, necessary hand tools, and prescribed procedures, repair a leaking water faucet or valve to restore it to serviceable condition.	(0.5/0)	Instructional Guidance Use samples and existing plumbing systems when discussing the inspection, maintenance, and repair of piping, fixtures, and appurtenances. Demonstrate the methods of inspecting water systems for flow, pressure, valve operation, leaks. Discuss the possible causes and correction of low water pressure and flow, water hammer, friction, pipe alignment, leaking pipe, and joint. Demonstrate how a leaking faucet may be repaired by using a valve seat repair tool. Describe the possible malfunctions in both drain and vent systems and the techniques used to locate malfunctions. The plumbing systems which the students have installed should be "bugged" so the students will have to (1) repair a leak in water lines; (2) repair and/or replace a leaking water faucet and drain; and (3) adjust, repair, and/or replace flush tank mechanisms, and flushometers. Help the students to diagnose problems and determine appropriate repair procedures. Stress safety while working with heavy pipe tools and equipment. At the end of day 33, make the following outside assignment: Read SG 3ABR55235-IV-7, and answer the first five questions. The following references should be used when preparing the lesson: AFR 127-101, Ground Accident Prevention Handbook National Plumbing Code
h. Given a malfunctioning flushometer, and repair procedures, perform the necessary repairs to place the unit in operational condition.	(1/0)	

PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)	3 SUPPORT MATERIALS AND GUIDANCE
7. Recovery and Restoration a. Working as a member of a team and following verbal and written instructions, remove, clean, inspect, and salvage all of the plumbing fixtures, valves, pipe, and tubing from the booth area. Salvaged equipment must be cleaned, inspected, assorted as to size, material, and type and returned to the correct storage area.	16 (12/4) Days 34 and 35 (12/4)	Column 1 Reference: 7a STS Reference: 3a(7), 11f(9)(c), 12b Instructional Materials SG 3ABR55235-IV-7, Recovery and Restoration WB 3ABR55235-IV-7-P1, Recovering and Restoring Piping and Fixtures Manufacturer's Rough-In Specifications Audio Visual Aids Slides, Building Plumbing Systems Training Equipment Hand Tools for Plumbing (1) Shop and Special Tools for Plumbing (2) Salvageable Plumbing Equipment (2) Training Methods Discussion and Demonstration (2 hrs) Performance (10 hrs) Outside Assignments (4 hrs) Instructional Environment/Design Classroom (2 hrs) Laboratory (10 hrs) Study Hall (Dormitory)(4 hrs) Group/Lockstep:Proficiency Advancement

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
		Instructional Guidance Discuss the circumstances in which piping may be recovered for later reuse. Discuss the codes governing recovery and reuse of pipe. Discuss the best methods of dismantling various types of pipe and joints. Emphasize the careful handling of fixtures to prevent damage and injury to the personnel. Have the students dismantle, clean, and store bathroom fixtures, piping and fittings. At the end of day 34, make the following outside assignment: Review SG 3ABR55235-IV-7 and answer questions 6 thru 10. At the end of day 35, make the following outside assignment: Read SG 3ABR55235-IV-8 and answer the questions at the end of the text. The following references should be used when preparing the lesson: AFR 127-101, Ground Accident Prevention Handbook National Plumbing Code
8. Planning and Layout of Plumbing Systems	14 (10/4) Days 36 and 37	**Column 1 Reference** / **STS Reference** 8a — 6a(3), 8a, 8c(1), 8d 8b — 8c(2) 8c — 14a
a. Given a floor plan, make a working drawing and specify the method of installation of the plumbing system that is required in this specific plan. The drawing must be complete enough to be used to make a bill of materials.	(4/1)	**Instructional Materials** SG 3ABR55235-IV-8, Planning and Layout of Plumbing Systems WB 3ABR55235-IV-8-P1, Planning and Layout of a Plumbing System National Plumbing Code
b. Using a working drawing of a plumbing system, make a bill of materials that would be needed to construct the system. The bill of materials must accurately identify all required materials without shortages and without excess greater than 10%.	(2/1)	

PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)	3 SUPPORT MATERIALS AND GUIDANCE
c. Using a floor plan, a working drawing, and the required materials, install a plumbing system in the miniature model house. Completed system must comply with the National Plumbing Code.	(4/2)	Training Equipment Miniature Pipe and Fittings (12) Training Methods Discussion and Demonstration (4 hrs) Performance (6 hrs) Outside Assignments (4 hrs) Instructional Environment/Design Classroom (4 hrs) Laboratory (6 hrs) Study Hall (Dormitory) (4 hrs) Group/Lockstep: Proficiency Advancement Instructional Guidance Discuss the use of floor plans and the necessity of making complete working drawings. Divide the class into groups and have them complete the work project. At the end of Day 36, make the following outside assignment: Review SG 3ABR55235-IV-8 and WB 3ABR55235-IV-8-P1 and prepare for a test over Block IV. At the end of Day 37, make the following outside assignment: Read SG 3ABR55235-V-1, and answer the questions. Read SG 3ABR55235-V-2, and answer the questions. Be prepared for a test over this material. The following reference should be used in preparing the lesson: National Plumbing Code
9. Measurement Test and Test Critique	2 (2/0) Day 37	

PLAN OF INSTRUCTION	COURSE TITLE Plumbing Specialist	
BLOCK TITLE Utility Equipment		
UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
1. Winterization of Piping a. Working as a member of a team, winterize the plumbing fixtures in the building latrine. All water must be removed from the fixture traps. b. Working as a member of a team, and using either a propane torch or rags and hot water, thaw a frozen pipe (frozen pipe may be simulated). The pipe must be heated until it is warm when touched.	2 (2/0) Day 38 (1/0) (1/0)	Column 1 Reference / STS Reference 1a / 12g 1b / 12f Instructional Materials SG 3ABR55235-V-1, Winterization of Piping WB 3ABR55235-V-1-P1, Winterizing Building Plumbing System National Plumbing Code Audio Visual Aids Slides, Winterization of a Building Plumbing System Slides, Techniques in Thawing Pipes Training Equipment Hand Tools for Plumbing (1) Training Methods Discussion and Demonstration (1.5 hrs) Performance (0.5 hr) Instructional Environment/Design Classroom (1.5 hrs) Laboratory (0.5 hr) Group/Lockstep: Proficiency Advancement
PLAN OF INSTRUCTION NO. 3ABR55235	DATE 2 July 1975	BLOCK NO. V — PAGE NO. 54

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION HOURS 2	SUPPORT MATERIALS AND GUIDANCE 3
		Instructional Guidance Describe the effects of freezing temperatures on plumbing systems and how water freezing and expanding within the system causes pipe, joints, or fittings to leak. Use slides to show the materials and procedures used to thaw pipe systems. Have the students complete the workbook exercises.
2. Maintenance of Valves a. Given a globe valve, locate and name each of the major components. All components must be correctly named. b. Following given instructions, repair a globe valve. The completed valve must open and close easily but must not leak when closed.	6 (4/2) Day 38 (1/1) (3/1)	Column 1 Reference — STS Reference 2a — 13b(3)(a) 2b — 13b(3)(a) **Instructional Materials** SG 3ABR55235-V-2, Maintenance of Valves WB 3ABR55235-V-2-P1, Maintaining Valves **Audio Visual Aids** Slides, Valves Used in Plumbing Systems Training Film: FLC 16/118, Piping Pointers **Training Equipment** Hand Tools for Plumbing (1) Shop Tools for Plumbing (2) **Training Methods** Discussion and Demonstration (1 hr) Performance (3 hrs) Outside Assignments (2 hrs)

PLAN OF INSTRUCTION (Continued)

<table>
<tr><th>UNITS OF INSTRUCTION AND CRITERION OBJECTIVES</th><th>DURATION (HOURS) 2</th><th>SUPPORT MATERIALS AND GUIDANCE 3</th></tr>
<tr><td></td><td></td><td><u>Instructional Environment/Design</u>
Classroom (1 hr)
Laboratory (3 hrs)
Study Hall (Dormitory)(2 hrs)
Group/Lockstep: Proficiency Advancement

<u>Instructional Guidance</u>
Use slides to describe the components of globe, gate, plug, and check valves. Discuss how the valve seats and other valve components may be repaired. Have the students dismantle, inspect, and perform repairs on valves.

At the end of day 38, make the following outside assignment: Read SG 3ABR55235-V-3, and answer the questions. Be prepared for a test over this material. The following references should be used in preparing the lesson:
AFM 85-13, Maintenance and Operation of Water Plants and Systems
AFR 127-101, Ground Accident Prevention Handbook</td></tr>
<tr><td>3. Maintenance of Sewers and Grease Traps

a. Working as a member of a team and using an engine or electrically powered auger, steel tape or chemicals, clean a sewer line. Cleaned line must pass water readily.

b. Using maps, probes, or electrical instruments, locate a buried pipe. Two or more students must individually locate the same pipe.</td><td>8
(6/2)
Day 39
(2/1)

(2/0.5)</td><td><u>Column 1 Reference</u> — <u>STS Reference</u>
3a — 3a(1), 3a(2), 12e(1), 12e(2), 12e(3), 12e(4)
3b — 12i
3c — 10b, 14c, 15b

<u>Instructional Materials</u>
SG 3ABR55235-V-3, Maintenance of Sewer and Grease Traps
WB 3ABR55235-V-3-P1, Maintaining Sewer
WB 3ABR55235-V-3-P2, Maintaining Grease Traps

<u>Audio Visual Aids</u>
Slides, Maintenance of Main Sewer
Slides, Maintenance of Grease Trap</td></tr>
</table>

PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)	3 SUPPORT MATERIALS AND GUIDANCE
c. Following given procedures and working as a member of a team, inspect and clean a grease trap or septic tank. The cleaned grease trap or septic tank must operate correctly without leaking and without undue odor.	(2/0.5)	<u>Training Equipment</u> Hand Tools for Plumbing (1) Shop and Special Tools for Plumbing (2) Grease Trap (12) Pipe Detection Instruments and Devices (12) Power Auger (8) <u>Training Methods</u> Discussion and Demonstration (2 hrs) Performance (4 hrs) Outside Assignments (2 hr) <u>Instructional Environment/Design</u> Classroom (2 hrs) Laboratory (4 hrs) Study Hall (Dormitory)(2 hrs) Group/Lockstep: Proficiency Advancement <u>Instructional Guidance</u> Use slides and maps when discussing the methods of locating buried pipe. Demonstrate the use of maps and probes in locating pipe. Describe the procedures used for checking the flow in a main sewer. Discuss the safety precautions to be observed when working in manholes. Show the sewer auger and demonstrate how it is used. Explain why chemicals should be added to the sewer after rodding. Discuss methods of locating and isolating an area of malfunction. Briefly discuss the procedures for coordinating with affected activities and supporting work centers. Describe various methods of removing drainage pipe, including plastic, steel, cast iron, cement asbestos, clay tile, when joints are threaded, flanged, lead-caulked, sleeved, or compression-fitted. Discuss the purpose, location, and maintenance of grease traps. Have the students

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	DURATION (HOURS)	SUPPORT MATERIALS AND GUIDANCE
		clean a grease trap. Have the students rod out the main sewer used in the booth area. Using equipment and maps, have students locate a buried pipe. Have students complete workbook projects. At the end of day 39, make the following outside assignment; Read SG 3ABR55235-V-4, and answer the questions. Be prepared for a test over this material. The following references should be used in preparing the lesson: AFR 127-101, Ground Accident Prevention Handbook National Plumbing Code
4. Emergency Maintenance of Exterior Piping	8 (6/2) Day 40	Column 1 Reference / STS Reference 4a — 12d 4b — 6b(2), 11f(4)
a. Given specific tools, equipment, and instructions, make a temporary repair to a line by installing a clamp-on repair device. Completed repair must withstand base water pressure without leaking.	(3/1)	Instructional Materials SG 3ABR55235-V-4, Emergency Maintenance of Exterior Piping WB 3ABR55235-V-4-P1, Temporary Maintenance of Exterior Piping
b. Using given instructions, grooved pipe and necessary fittings, assemble a grooved pipe connection. Completed connection must withstand base water pressure without leaking.	(3/1)	Audio Visual Aids Slides, Emergency Maintenance of Exterior Piping Training Equipment Hand Tools for Plumbing (1) Shop and Special Tools for Plumbing (2)

PLAN OF INSTRUCTION (Continued)

1 UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	2 DURATION (HOURS)	3 SUPPORT MATERIALS AND GUIDANCE
		<u>Training Methods</u> Discussion and Demonstration (2 hrs) Performance (4 hrs) Outside Assignments (2 hrs) <u>Instructional Environment/Design</u> Classroom (2 hrs) Laboratory (4 hrs) Study Hall (Dormitory)(2 hrs) Group/Lockstep: Proficiency Advancement <u>Instructional Guidance</u> Due to the complexity of a repair job or to relocate a completed operational unit, it will be necessary to construct temporary or emergency plumbing systems. Manufacturers have developed pipe, fittings, and joints that can be quickly assembled or dismantled and are ideal for construction of emergency or temporary piping systems. Use slides and samples in describing pipe materials, joints, and/or temporary piping systems. Demonstrate the assembly of pipe joints and methods of temporarily stopping leaks. Have the students assemble a grooved joint and a compression coupling. Have the students complete the workbook projects. At the end of day 40, make the following outside assignment: Read SG 3ABR55235-V-5, and answer the questions. Be prepared for a test over this material. The following references should be used in preparing the lesson: AFM 85-13, Maintenance and Operation of Water Plants and Systems AFR 127-101, Ground Accident Prevention Handbook

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	DURATION (HOURS)	SUPPORT MATERIALS AND GUIDANCE
5. Fire Hydrants and Sprinkler Systems a. Disassemble, check, repair (if necessary), and reassemble a fire hydrant. Completed fire hydrant must be assembled correctly. b. Measure, cut, and assemble plastic pipe to install a portion of a lawn and sprinkler system. All measurements must be within ± 1/8 inch of given specifications. c. Using given instruction and working as a member of a team, inspect a pneumatic system for operation and identify the major components. All components must be identified correctly.	12 (12/0) Days 41, 42 (6/0) (5/0) (1/0)	**Column 1 Reference** — **STS Reference** 5a — 6a(8), 13a(1), 13b(1) 5b — 3a(2), 11e(2), 11e(10), 11f(2), 13a(2), 13b(2) 5c — 6a(5), 10d **Instructional Materials** SG 3ABR55235-V-5, Fire Hydrants and Sprinkler Systems WB 3ABR55235-V-5-P1, Maintaining Fire Hydrants WB 3ABR55235-V-5-P2, Assembling Plastic Pipe WB 3ABR55235-V-5-P3, Pneumatic System Components **Audio Visual Aids** Slides, Maintenance of Fire Hydrants Slides, Maintenance of Sprinkler Systems **Training Equipment** Hand Tools for Plumbing (1) Shop and Special Tools for Plumbing (2) Fire Hydrant (8) **Training Methods** Discussion and Demonstration (4 hrs) Performance (8 hrs) **Instructional Environment/Design** Classroom (4 hrs) Laboratory (8 hrs) Group/Lockstep: Proficiency Advancement

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
		Instructional Guidance Use maps, slides, and samples when discussing street, building, and aircraft parking apron fire protection systems. Describe the installation procedures for fire hydrants. Describe the operational checks and other items subject to periodic maintenance. Briefly mention fire protection sprinkler systems. Discuss field and lawn sprinkler systems, types, material compositions, and maintenance required. Demonstrate how plastic pipe joints are "solvent-welded" together. Have the students cut pipe to measured length, ream, and solvent-weld pipe together. Explain the toxic effect of solvent fumes and emphasize the need for proper ventilation. Discuss the purpose, construction, and maintenance of pneumatic piping systems. Have the students complete the workbook projects. The following references should be used in preparing the lesson: AFM 85-13, Maintenance and Operation of Water Plants and Systems AFM 85-20, Plumbing AFR 127-101, Ground Accident Prevention Handbook
6. Utility Equipment a. Working as a member of a group, install and maintain the water supply and drain system for utility equipment such as electric water fountains. The water supply line must withstand base water pressure without leaking, and drain system must not leak when used. b. Clean, lubricate and maintain plumbing hand tools and plumbing shop equipment according to the specifications in TO 32-1-101.	6 (6/0) Day 43 (3/0) (3/0)	Column 1 Reference — STS Reference 6a — 14a, 14b 6b — 4e, 9a, 9d **Instructional Materials** SG 3ABR55235-V-6, Utility Equipment WB 3ABR55235-V-6-P1, Installing Utility Equipment WB 3ABR55235-V-6-P2, Cleaning and Maintaining Tools and Equipment TO 32-1-101, Maintenance and Care of Hand Tools **Audio Visual Aids** Slides, Utility Equipment Slides, Utility Equipment Water and Drain System

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
		Training Equipment Hand Tools for Plumbing (1) Shop and Special Tools for Plumbing (2) Water Cooler (12) **Training Methods** Discussion and Demonstration (2 hrs) Performance (4 hrs) **Instructional Environment/Design** Classroom (2 hrs) Laboratory (4 hrs) Group/Lockstep: Proficiency Advancement **Instructional Guidance** Use slides when discussing the types of utility equipment. Discuss pipe connection and drains. Point out that some utilities are forbidden by codes from having a direct connection to the drain system. Have the students complete the workbook projects. The following references should be used in preparing the lesson: AFM 85-13, Maintenance and Operation of Water Plants and Systems AFR 127-101, Ground Accident Prevention Handbook
7. Corrosion Control a. Inspect a plumbing piping system for evidence of corrosion and list the type of corrosion found. All students must find the same type of corrosion.	3 (3/0) Day 44 (1/0)	Column 1 Reference / STS Reference 7a — 6d, 10f 7b — 6d, 12k 7c — 11j

PLAN OF INSTRUCTION NO. 3ABR55235	DATE 2 July 1975	BLOCK NO. V	PAGE NO. 62

PLAN OF INSTRUCTION (Continued)

UNITS OF INSTRUCTION AND CRITERION OBJECTIVES 1	DURATION (HOURS) 2	SUPPORT MATERIALS AND GUIDANCE 3
b. Using given information list two types of protective coating or wrappings that are used to prevent pipe corrosion. The coatings or wrappings listed must be those most often used by plumbers. c. Identify two impressed current cathodic protection devices from their physical characteristics. Both devices must be identified correctly.	(1/0) (1/0)	<u>Instructional Materials</u> SG 3ABR55235-V-7, Corrosion Control WB 3ABR55235-V-7-P1, Corrosion Prevention <u>Audio Visual Aids</u> Slides, Corrosion Control <u>Training Equipment</u> Corroded Pipe Samples (12) <u>Training Methods</u> Discussion and Demonstration (1.5 hrs) Performance (1.5 hrs) <u>Instructional Environment/Design</u> Classroom (1.5 hrs) Laboratory (1.5 hrs) Group/Lockstep: Proficiency Advancement <u>Instructional Guidance</u> Use slides and samples of corroded pipe when discussing identifications, types, causes of corrosion and corrosion prevention methods. Discuss the causes and effects of scale build-up. Have the students inspect the piping in the building for corrosion. Have them complete the workbook projects. The following references should be used in preparing the lesson: AFM 88-5, Maintenance and Operation of Cathodic Protection Systems AFM 88-9, Chapter 4, Corrosion Control

MODIFICATIONS

Pages 64-66 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE	INSTRUCTOR
B.R. Armington TCETC/3Sep75	
COURSE NUMBER 3ABR55235	COURSE TITLE Plumbing Specialist
BLOCK NUMBER IV	BLOCK TITLE Fixtures and Appurtenances

LESSON TITLE
Installation of Bathtubs and Showers (Day 28)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
6 Hrs	2 Hrs	8 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
41	2 July 1975	1

STS/CTS REFERENCE

NUMBER	DATE
552X5	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Mock-up Trainer Hand Tools Showers Shop Tools	None	None	SG IV-1 WB IV-1-P1 Rough-In Specifications Slides: Installation of Bathtubs and Showers

CRITERION OBJECTIVES AND TEACHING STEPS

1a. Using the manufacturer's specifications and procedures provided, install a shower. The mixing faucets must operate easily, the shower head must be the correct distance from the floor and the drain must be installed correctly.

(1) Types of showers
(2) Use of escutcheon on piping and nipples through walls
(3) Types of valves
(4) Shower heads
(5) Wall and floor preparation for shower
(6) Floor drains and traps
(7) Cross connections

ATC FORM AUG 72 770

Course No: 3ABR55235
Day: 28

Branch Approval: [signature]
Date: 5 September 1975

PART II

INTRODUCTION (45 Minutes)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY I

PRESENTATION:

1a. Using the manufacturer's specifications and procedures provided, install a shower. The mixing faucets must operate easily, the shower head must be the correct distance from the floor and the drain must be installed correctly.

(1) Types of showers

(a) Bathtub and shower combination

(b) Individual shower

(c) Gang

(d) Corner - Is not Basic Type of shower

NOTE: Rough-in to Mfg Spec or height specified by user. USE TO ASSEMBLE SHOWER

(2) Use of escutcheon on piping and nipples through walls

(a) Keep out insects

(b) Keep out cold air

(c) Improve appearance of job

(d) Two types

1 Slip on type

2 Split hinged

(3) Types of valves

(a) Manual mixing valve

1 Two compression stops

2 One spray delivery pipe

(b) Pressure control mixing valve

1 Works on pressure differential

2 Piston slides to equalize pressure

3 One handle regulates initial temperature setting

(c) Thermostatically controlled mixing valve

1 Sensitive to both pressure and temperature

2 ONE HANDLE

3 WATER TEMPERATURE INDICATION ON FRONT IN DEGREES

4 Pressure sensitivity similiar to that of pressure controlled valve

5 Used in showers only

(4) Shower heads

(a) Attached to chrome plated shower arm

(b) Many different types

1 Circular

2 Economy

(c) Use proper wrenches on chrome

1 Friction strap wrench on round surface

2 Smooth jaw on flat surface

3 Never use pipe wrench on chrome finish

NOTE: Show students how to use strap wrench

NOTE: MOST COMMON MAINTENANCE IS TO CLEAN SHOWER HEAD

(d) Ball and socket joint (to adjust direction of spray)

(e) Materials shower heads may be made of

1 Chrome plated brass

2 Nickle plated brass

3 Plastic-will not corrode

(f) Maintenance-needs occasional cleaning because deposits form chemicals in water

(5) Wall and floor preparation for shower

(a) Metal type base (no additional protection)

(b) Other showers require shower pan if above ground level or on wooden flooring

1 Lead

2 Copper

NOTE: Fold at least 6 inches up on wall

(c) Insure that walls of shower enclosure are water proof.

(6) Floor drains and traps

(a) Constructed so pan can be fastened at see page entrance (if need pan)

(b) Strainer shall be removable

(c) Minimum size drain

1 2" for single shower installation

2 3" for gang shower

3 1-1/2" for tub and shower combo

(d) P-traps, common and deep seal

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(7) Cross connections

(a) Definition-any physical connection or arrangement between two otherwise separate piping systems, one of which contains potable water and the other of unknown or questionable safety, whereby water my flow from one system to the other, the direction of flow depending on the pressure differential between the two systems.

(b) Prevention

1 Air gaps

a Between faucet spout and fixture flood level

b Between fixture drain and waste pipe

2 Backflow preventers

a Vacuum breaker

b Fixed air gap fitting

APPLICATION:

NOTE: Show student how to check mixing valve for level

Have student install shower head and base using WB IV-I-P1

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 Minutes)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

3ABR55235-IV-2, Installation of Water Closets, have students read study guide and answer questions 1 through 10.

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE	INSTRUCTOR
TCETC/25Aug75	
COURSE NUMBER 3ABR55235	COURSE TITLE Plumbing Specialist
BLOCK NUMBER IV	BLOCK TITLE Fixtures and Appurtenances

LESSON TITLE
Installation of Water Closets (Day 29)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
6 Hrs	2 Hrs	8 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
42	2 July 1975	2

STS/CTS REFERENCE

NUMBER	DATE
552X5	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools Shop Tools Water Closet	Flush tank	None	SG IV-2 WB IV-2-P1 Manufacturer's Rough-in Specifications Slides: Water Closet and Mechanism

CRITERION OBJECTIVES AND TEACHING STEPS

2a. Using the manufacturer's specifications and procedures provided, install a tank-type water closet bowl. Bowl must be securely attached to closet flange.

(1) Types of water closets
(2) Closet bowl operation and design

2b. Following the procedures provided, install a flush tank. The tank must be level and attached securely to the bowl.

(1) Flushing mechanisms
(2) Installation procedures
(3) Types of toilet seats

ATC FORM AUG 72 770

BODY (5 hrs. 15 minutes)

PRESENTATION:

2a.

Using the manufacturer's specifications and procedures provided, install a tank-type water closet bowl. Bowl must be securely attached to closet flange.

(1) Types of water closets

(a) Wall hung (chair carrier)

(b) Floor Mounted (floor flange)

(2) Closet bowl operation and design

(a) Washdown

1 Simplest

2 Small trap in front of bowl

3 Works on siphon only

4 Water flows into bowl from rim

Course No: 3ABR55235
Day: 29

Branch Approval: [signature]
Date: 26 August 1975

PART II

INTRODUCTION (40 Minutes)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

(b) Washdown bowl with jet

1 Similar to common washdown

2 Jet immediately starts siphon

(c) Reverse trap

1 Trap on back part of bowl

2 Bowl is longer than washdown type

3 Holds more water

4 Quieter flushing action

(d) Siphon Jet

1 Most expensive

2 Quietest

3 Most efficient

4 Holds more water

2b. Following the procedures provided, install a flush tank. The tank must be level and attached securely to the bowl.

(1) Flushing mechanisms

(a) Tank type

1 Close coupled tank

a Sets on back part of bowl

b Held on by two or three close coupled gasket to seal between flush valve & bowl. (gasket of sponge rubber)

2 Wall hung tank

a Fastened to wall (backing boards)

b Connected by flush ell from flush valve to bowl with spud, with slip nuts & washers.

3 Water supply

a 1/2 inch

b Ferrele fitting used with jiffy connections

4 Internal parts

NOTE: Discuss parts of tank use T.A. & Slides.

a Ball cock (tank type closet)

b Operating handle

c Trip handle

d Refill tube (hush tube)

e Trap refill tube

f Plunger

g Overflow

h Connecting wire

i Lift wire

j Flush valve (Douglas Valve)

k Flush tank ball

l Float rod

m Flush tank ball float

n Float rod

NOTE: Explain how to control water level by bending float rod or with adjustment screw on top of ballcock. (water lossed float)

(b) Flushometers (Barracks, Schools, etc.)

1 Types

a Piston (10 seconds) (operated by lever discharging water into dashpot chamber.)

b Diaphram (10 seconds)

b Diaphram (10 seconds)
(adjustment on top)

c Hydraulic (motion of liquid, 10 seconds)

2 Water supply

a One inch

b Quick discharge
(air chamber reduces water hammer)

(2) Installation procedures

(a) Setting closet bowl'

1 Place closet bolts into closet flange

2 Place bowl upside down on paper

3 Place compound around bottom rim

NOTE: Omit in booth

4 Place wax ring around horn outlet

5 Check floor level

NOTE: Use 2 wax rings if flange is low

6 Set bowl on closet flange

7 Rock bowl gently to seat bowl onto flange

8 Snug up nuts evenly

NOTE: Don't overtighten-will crack bowl

(b) Installing close coupled tank

1 Install ball cock

a Gasket

b Tighten hex nut.

NOTE: If plastic ballcock be careful not to strip threads

2 Install flush valve

a Gasket

b Tighten hex nut

NOTE: If plastic flush valve be careful not to strip threads.

3 Put in close coupled belts

a Placement of rubber washers

b Placement of nuts

NOTE: May vary, check installation instructions

4 Put close couple gasket on outlet of flush valve

NOTE: Position of level

5 Set tank onto bowl

6 Tighten nuts evenly

NOTE: Don't forget friction washer
and don't over tighten nuts.

7 Install operating handle assembly

8 Install flush tank ball & lift & connecting wires

9 Install float rod & float

10 Connect jiffy connection

11 Check operation

a Stop leaks

b Adjust tank water level

(1) Adjustment screw on ballcock-if provided.

(2) Bend float rod-if no adjustment screw on ballcock

NOTE: Emphaseze care in handling water closet to prevent personnel injuries & fixture damage.

(3) Types of toilet seats

(a) Close front (Residential building)

(b) Open front (Industrial building)

APPLICATION:

Have student complete WB IV-2-P1.

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 Minutes)

SUMMARY:

REMOTIVATION:

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TTC 25Aug75	INSTRUCTOR
COURSE NUMBER 3AL 55235	COURSE TITLE Plumbing Specialist
BLOCK NUMBER IV	BLOCK TITLE Fixtures and Appurtenances

LESSON TITLE
Installation of Urinals (Day 30)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
6 Hrs	2 Hrs	8 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
44	2 July 1975	3

STS/CTS REFERENCE

NUMBER	DATE
532 35	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools Shop Tools	Urinals	None	SG IV-3 WB IV-3-P1 Manufacturer's Rough-in Specifications Slides: Identification and Installation of Urinals

CRITERION OBJECTIVES AND TEACHING STEPS

3a. Install a wall-mounted urinal in accordance with the manufacturer's installation instructions. Urinal must be securely attached and must be the correct distance from the floor.

(1) Types of urinals
(2) Wall-hung
(3) Pedestal
(4) Trough
(5) Stall
(6) Install wall-hung urinal

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3b. Using instructions provided, install a flushometer and a vacuum breaker. The installed items must not leak and must be aligned with the fixture inlet.

(1) Flushing mechanisms
(2) Tank
(3) Flushometer

3c. Using the instructions provided, install a P-trap. The trap must be aligned with the fixture outlet.

(1) Type
(2) Size

Course No: 3ABR55235 Branch Approval: [signature]
Day: 30 Date: 26 August 1975

PART II

INTRODUCTION (45 Minutes)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (300 minutes)

PRESENTATION:

3a.

Install a wall-mounted urinals in accordance with the manufacturer's installation instruction. Urinals must be securely attached and must be the correct distance from the floor.

(1) Types of urinals

(a) Wall hung

(b) Pedestal

(c) Trough

(d) Stall

(e) Symbols

(2) Wall hung

(a) Siphon jet

(b) Washdown

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(3) Pedestal

(a) Installed like water closets

(b) Siphon jet design

(4) Trough

(a) Not Air Force approved

(b) Washdown design

(5) Stall

(a) Not Air Force approved

(b) Wash down design

(6) Install wall hung urinal

(a) Use manfacturers specifications (includes hanger height)

(b) Install height according to user

(c) Height usually 20-25 inches high

(d) Support of fixture

(e) Traps

3b. Using instructions provided, install a flushometer and a vacuum breaker. The installed items must not leak and must be aligned with fixture inlet.

(1) Flushing mechanisms

(a) Tank

(b) Flushometer

(2) Tank

(a) Close coupled

(b) Wall hung

(3) Flushometer

(a) Diaphram

(b) Piston

(c) Adjusted for 10 seconds

(4) Vacuum breaker

3c. Using the instructions provided, install a P-trap. The trap must be aligned with the fixture outlet.

(1) Types

(a) Cast iron

(b) Chrome plated brass

(c) Max. Vertical distance from fixture (24 inches)

(2) Sizes

(a) 2" cast iron

(b) 1 1/2" P-trap

APPLICATION:
Have students complete WB 3ABR55235-IV-3-P1

EVAULATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (15 minutes)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:
Read Study Guide 3ABR55235-IV-4 and answer the questions at the end of the chapter.

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LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/25Aug75	INSTRUCTOR
COURSE NUMBER 3ABR55235	COURSE TITLE Plumbing Specialist
BLOCK NUMBER IV	BLOCK TITLE Fixtures and Appurtenances

LESSON TITLE
Installation of Lavatories (Day 31)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
6 Hrs	2 Hrs	8 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
46	2 July 1975	4

STS/CTS REFERENCE

NUMBER	DATE
552X5	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools Shop Tools	Lavatory with faucet and drain	None	SG IV-4 WB IV-4-P1 Manufacturer's Specifications Slides: Installation of Lavatories

CRITERION OBJECTIVES AND TEACHING STEPS

4a. Install a wall-mounted lavatory in accordance with the manufacturer's specifications. Lavatory must be mounted securely and be the correct height from the floor.

(1) Types
(2) Installation procedures

4b. Using a basin wrench and following the procedures provided, install a faucet and supply lines. The faucet must be securely fastened to the fixture, must open and close easily but must not leak when closed.

(1) Types
(2) Installation procedures

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LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

4c. Following the instructions provided, install a lavatory trap. The trap must be aligned with fixture outlet and the connections must be water tight.

(1) P-trap
(2) Slip joints
(3) Assembly procedures

Branch Approval: [signature]
Date: 26 August 1975

Course No: 3ABR55235
Day 31

PART II

INTRODUCTION (45 Minutes)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (5 Hours, 5 minutes)

PRESENTATION:

4a. Installation of Laboratories-Install a wall-mounted laboratory in accordance with the manufacturer's specifications. Laboratory must be mounted securely and be the correct height from the floor.

(1) Types

(a) Wall hung

1 Hangs on wall bracket

2 Comes in different sizes

3 Most commonly used (wall hung & flat rim)

(b) Pedestal

1 Stands on floor

2 Used in barber shops, beauty shops, etc.

3 Not in common use

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4 Uses S Trap

(c) Counter Top (flat rim)

1 Mounts in cabinet

2 Uses retaining ring to hold basin in cabinet

3 Custom installation

4 In common use

(d) Trough

1 Comes in two general shapes

a Circular

b Semi-circular

2 Used in workshop

3 Many people can use at one time

(2) Installation procedures

(a) Use manufacturer's rough-in specification

(b) Hangers fastens to backing board

1 Level hanger

2 Use brass screws

(c) Lip height 31" from finished floor

(d) Drain 1 1/4" (min)

(e) Type drains

1 P.O. plug

2 Pop up

NOTE: Show and explain TA's

(f) Place putty around strainer flange

(g) Position cone shaped rubber washer and friction washer on drain.

(h) Tighten locknut against washers (use basin wrench on compression nuts)

(i) Install tail piece

1 1 1/4"

2 Threads into drain (illegal to install slip nuts on outlet side of trap)

3 Use strap wrench

NOTE: Demonstrate use of strap wrench on T.A.

4b. Using a basin wrench and following the procedures provided, install a faucet and supply lines. The faucet must be securely fastened to the fixture, must open and close easily but must not leak when closed.

(1) Types

(a) Single

1 Individual faucets

2 Globe construction

a Washers

b Seat

(b) Mixing

1 Two faucets in one body with one spigot.

a Two handles (H & C)

b Some have single handle to control hot and cold flow

2 Globe construction with washers and seat or "o" rings

(2) Installation procedures

(a) Put putty or rubber gasket on bottom edge of faucet

(b) Insert in laboratory

(c) Install composition washers, metal friction and jam nut.

(d) Use basin wrench

1 Different size jaws

2 For nuts in hard to reach areas

NOTE: Explain how to use and demonstrate on T.A.'s

(e) Supply risers (jiffy connector)

1 Chrome plated copper tubing

2 Flex

3 Types of end constructions

a Flared

b Ferrule

4c. Following the instructions provided, install a laboratory trap. The trap must be aligned with fixture outlet and the connections must be water tight.

(1) P-trap

(2) Slip joints

(3) Assembly procedures

(a) Show correct positioning of of P-trap no lower than 24" from bottom of fixture.

(b) Point out inlet and outlet of trap

(c) Explain degree of tightness desired for slip joints (hand tight and 3/4 turn with smooth jaw wrench) approximately

(d) Measure and cut tail piece to proper length (use large tubing cutter or hacksaw with 32 teeth per inch.)

(e) Troubleshooting

1 Leaks (preform operational check to locate)

a Tighten joint

b Replace washer

c Most common leaks are in valves.

2 Broken or cracked slip nut-replace

APPLICATION:

Complete WB 3ABR55235-IV-4-P1 and install laboratory including faucets and trap.

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 minutes)

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SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

SG 3ABR55235-IV-5, Insulation of Hot Water Piping, read and answer questions.

LESSON PLAN (Part I, General)

... Aug 75	INSTRUCTOR
275	COURSE TITLE Plumbing Specialist
BLOCK NUMBER V	BLOCK TITLE Fixtures and Appurtenances

TITLE
... of Water Lines (Day 3?)

LESSON DURATION

LABORATORY	COMPLEMENTARY	TOTAL
... Hrs	2 Hrs	8 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
7	2 July 1975	5

STS/CTS REFERENCE

	DATE
... 3	15 February 1973, Chg 1, 15 ... 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools Shop Tools	Pipe Insulation	None	SG IV-5 WB IV-5-P1 Slides: Types of Insulation, Installation Procedures

CRITERION OBJECTIVES AND TEACHING STEPS

... using preformed insulation, cement, paste, cheesecloth, and metal bands and following instructions provided, insulate a water line. Pipe must be completely covered and the insulation secured with cheesecloth, metal bands and cement.

(1) Purpose
(2) Types
(3) Rigid preformed
(4) Blank insulation
(5) Installation of insulation
(6) Maintenance

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Course No: 3ABR55235
Day: 32

Branch Approval: [signature]
Date: 26 August 1975

PART II

INTRODUCTION (45 minutes)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

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BODY (5 hrs 5 minutes)

PRESENTATION:

5a. Using preformed insulation, cement, paste cheesecloth, and metal bands and following instructions provided, insulate a water line. Pipe must be completely covered and the insulation secured with cheesecloth, metal bands and cement.

(1) Purpose

(a) To prevent

1 Heat loss

2 Heat gain

3 Condensation (sweating)

4 Freezing

5 Noise & vibration

(b) Safety aspects

1 Burns to personnel

2 Fire prevention

(2) Types

(a) Blanket

(b) Rigid Preformed

(3) Rigid Preformed

(a) Fits object for which designed

(b) Various different types of material.

1 Cork

2 Flex rubber

3 Anti-sweat

4 Frost proof

5 Wool-felt

6 Fiberglass

7 Sponge felt paper

8 Air cell

9 Magnesia

(c) Construction and use of different types

1 Cork

a Granulated

b Finished with asphalt

c Use on cold lines (Cold water, ice water, brine, ammonia.)

d Will not rot or burn

2 Flex rubber

a. Man-made (synthetic) rubber

b Water resistant flame resistant

c Used on cold water & refrigeration

d lines

3 Anti-sweat

a Asphalt saturated asbetos paper & wool felt layers

b Keeps water cold

4 Frost proof

a Similar to anti-sweat

b Installed on exposed lines outdoors

c Helps prevent freezing of lines

d Wool-felt

e Fibers of wool, fur & hair

f Fiberglass

(1) Fine fibers of glass stuck with resin

(2) Long life won't shrink, swell, rot or burn

(3) Good on all piping

g Sponge felt paper

(1) Asbestos paper & sponge

(2) Close construction

(3) Used on medium & low pressure steam & vapor lines.

h. Air Cell

(1) Fine quality asbestos felt

(2) Used on medium and low pressure steam and vapor lines.

i Magnesia

(1) 85% magnesia and
15% asbestos

(2) Used on high temperature
lines, steam and hot water.
Used solely for these systems

(3) Canvas or cheese cloth
covering. Held in place
by wheat paste.

NOTE: Magnesia is the type of insulation
we will use.

(3) Blanket insulation

(a) Comes in sheets, blocks,
strips and rolls

(b) Types

1 Asbestos folds

2 Asbestos cardboard sheets

3 Wool and hair felt rolls

4 Asbestos cement blocks

5 Air cell rolls

6 Aluminum foil rolls

7 Fiberglass rolls

8 Asbestos powder

(4) Installation of insulation

(a) Preformed insulation

1 Quickly and easily installed

2 Made in two halves

3 Choose cloth covering

4 Apply wheat paste to flap

5 Install metal bands within every 18"

6 Can be painted with enamel paint

(b) Blanket insulation

1 Sheet and roll

a Put on unit to be insulated

b Fasten insulation securely (bands 18" apart)

c If need be, cover with cheese cloth

d Use wheat paste to secure cheese cloth

2 Powder insulation

a For valves and fittings (powdered magnesia, most commonly used)

b Mix with water

c Form cement around fitting

d Wrap with cheese cloth

e Use wheat paste to hold cloth

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(c) Cutting insulation

1 Hacksaw

2 Knife

(3) Maintenance

(a) Tear or puncture

1 Use cheese cloth

2 Patch holes or tears

(b) Leak in pipe

1 Remove insulation

2 Repair pipe

APPLICATION: Have student complete workbook IV-5-P1

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 Minutes)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

3ABR55235-IV-6, Read study Guide and answer question.

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LESSON PLAN (Part I, General)

APPROVAL OF FILE AND DATE TCETC/26Aug75	INSTRUCTOR
COURSE NUMBER 3ABR55235	COURSE TITLE Plumbing Specialist
BLOCK NUMBER IV	BLOCK TITLE Fixtures and Appurtenances

LESSON TITLE
Inspection and Maintenance of Plumbing Systems (Day 33)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
6 Hrs	2 Hrs	8 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
49	2 July 1975	6

STS/CTS REFERENCE

NUMBER	DATE
552X5	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools Shop Tools		None	SG IV-6 WB IV-6-P1 Rough-In Specifi- cations Plumbing Code Slides: Building Plumbing System

CRITERION OBJECTIVES AND TEACHING STEPS

6a. Locate leaks visually or with instruments in buried or hidden water lines. Each student must locate at least one leak.

(1) Purpose
(2) Methods

6b. Given a drawing of a water supply system, sketch one method of reducing water hammer. The method sketched must comply with the national plumbing code.

(1) Cause of water hammer
(2) Remedy

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LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

6c. Following given procedures, visually check the pressure and flow of water in a building or base water supply system. Each student must visually check the pressure and flow.

(1) Inspection of exterior water system
(2) Inspection of interior water system

6d. Make an operational check of the water supply lines, vent and waste system, and pipe hangers in the booth area. List all malfunctions or problem areas that must be corrected. Each student must find all the malfunctions and problem areas found by the instructor.

(1) Detecting leaks in water supply
(2) Detecting leaks in vent and waste systems
(3) Detecting leaks in appurtenances

6e. Following given procedures, repair all the leaking joints and replace all the defective pipe in the booth area. All leaks must be repaired and all defective pipe replaced.

(1) Methods of repairing leaking screwed joints
(2) Repair hole in tubing or a defective fitting

6f. Given a tank type water closet with a malfunctioning flush valve, float valve, and necessary repair procedures, perform the necessary repairs to place the valves in operational condition.

(1) Troubleshooting water closet tank flush valve (Douglas valve)
(2) Troubleshooting water closet tank float valve (ball cock)

6g. Using a valve repair kit, necessary hand tools, and prescribed procedures, repair a leaking water faucet or valve to restore it to serviceable condition.

(1) Repair leak at stem (valve or faucet)
(2) Repair faucet leaking through seat

6h. Given a malfunctioning flushometer and repair procedures, perform the necessary repairs to place the unit in operational condition.

(1) Types of flushometer
(2) Troubleshooting flushometers

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Course No: 3ABR55235
Day: 33

Branch Approval: [signature]
Date: 27 August 1975

PART II

INTRODUCTION (45 minutes)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (5 Hrs 10 minutes)

PRESENTATION:

6a. Locate leaks visually or with instruments in buried or hidden water lines. Each student must locate at least one leak.

(1) Purpose

(a) Locate buried pipe

(b) To locate leaks

(2) Methods

(a) Probe

1 Steel rod with "T" handle

2 Used for locating shallow lines

3 Not too good in hard-packed, frozen or rocky soil.

(b) Detectors

1 Electronic Devices

a Metal detector

b Electronic stethoscope
(Headset and stethoscope)

NOTE: Explain use of equipment

2 Stethoscope

3 Maps

4 Sight

a Small leaks

(1) Always green grass
in area

(2) Wet ground

b Large leaks

(1) Very soggy ground

(2) Water flowing
from ground

NOTE: Sometimes water goes underground for some distance before coming up.

6b. Given a drawing of a water supply system, sketch one method of reducing water hammer. The method sketched must comply with the national plumbing code.

(1) Caused of water hammer

(a) Sudden increase in pressure

(b) Valve closing too quickly

(2) Remedy

(a) Install air chamber

(b) Install commercial shock absorber

(c) Secure piping

6c. Following given procedures, visually check the pressure and flow of water in a building or base water supply system. Each student must visually check the pressure and flow.

(1) Inspection of exterior water system

(a) Mains constructed to meet certain demands

(b) Sizing of main is done by the engineer

1 Large enough for all buildings

2 Allow for expansion

3 Sizing factors

a Elevation

NOTE: Use booster pumps for high buildings

b Directional changes

c Friction loss

(c) Loss of pressure possibilities

1 No water available

NOTE: Well or lake dry

2 Restrictions

a Dents

b Kinks

c Debries inline

d Partially closed valves

e Scale

f Mortar or lead protruding in line

g Friction loss (too many bends) (resistance to flow)

h Too small a main

i Elevation

3 Punctures

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a Breaks

NOTE: Causes rapid loss of pressure

b Small leaks

(1) Corrosion

(2) Defective joints

(3) Punctures (nails)

(d) Testing of exterior system for pressure & flow

1 Using gauges at hydrants

a Pressure gauge

b Pitot tube (used for velocity pressure reading)

2 Purpose of testing

a Primarily done for availability of fire fighting equipment

b Determine restrictions or leaks in line

3 Using pressure gauge

a Pressure gauge

(1) Put gauge on 2 1/2" hydrant opening

(2) Tighten other caps

(3) Turn on hydrant fully

NOTE: Hydrant must be fully open in order to get a correct reading.

(4) This indicates static pressure

(5) Turn off hydrant

(6) Take off other 2 1/2" cap

(7) Turn hydrant fully on

(8) This indicates velocity pressure

(9) Not the most accurate for velocity test

b Pitot tube (velocity pressure test only)

(1) Remove 2 1/2" cap

(2) Turn hydrant fully on

(3) Insert end of tube in center of stream

(4) Hold end 1" form from outlet

(5) More accurate reading of velocity pressure

(2) Inspection of interior water system

(a) Locating leaks

1 Visual

2 Sound

(b) Causes of leaks

1 Faulty material

2 Faulty workmanship

3 Expansion & contraction

4 Water hammer

5 Freezing

6 Corrosion

7 Defective valves

8 Misalignment

9 Packing on valve

NOTE: Will discuss in depth later

6d. Make an operational check of the water supply lines, vent and waste system, and pipe hangers in the booth area. List all malfunctions or problem areas that must be corrected. Each student must find all the malfunctions and problem areas found by the instructors.

(1) Detecting leaks in the water supply

(a) Visual

(b) Sound

(2) Detecting leaks in vent & waste system

(a) Visual

(b) Sound

(c) Smell

(3) Detecting leaks in appurtenances

(a) Types of appurtenances

1 Faucets

2 Valves

3 Components of fixtures
(example parts of a w/c tank)

(b) Methods

1 Visual

2 Sound

6e. Following given procedures, repair all the leaking joints and replace all the defective pipe in the booth area. All leaks must be repaired and all defective pipe replaced.

(1) Methods of repairing leaking screwed joints

(a) Tighten joints (show illustration in study guide)

(b) Replace fittings or pipe

1 Cut pipe

2 Tighten or replace fitting or pipe

3 Install union & nipple (explain)

(2) Repair hole in tubing or a defective fitting

(a) Cut tubing on hole

(b) Join tubing with coupling

(c) Replace defective fittings

6f. Given a tank type water closet with a malfunctioning flush valve, float valve, and necessary repair procedures, perform the necessary repairs to place the valves in operational condition.

(1) Trouble shooting water closet tank flush valve (Douglas Valve)

(a) Improperly seats

(b) Leaks through flush valve

(c) Tank will not fill

(d) Replace worn flush

(e) Check alignment

(f) Reseat flush valve seat

(2) Trouble shooting water closet tank float valve (ballcock) (controls flow of water into tank)

(a) Repair or replace worn seat under plunger

(b) Replace worn washers in valve (bend float rod if required)

(c) Replace valve (use a adjustable jaw wrench)

NOTE: Use training aid during explanation.

6g. Using a valve repair kit, necessary hand tools, and prescribed procedures, repair a leaking water faucet or valve to restore it to serviceable condition.

(1) Repair seat at stem (valve or faucet)

(a) Tighten packing nut

(b) Replace packing or "o" ring

(c) Replace damaged stem

(2) Repair faucet leaking through seat

(a) Replace washer

(b) Reface seat

(c) Replace seat (show picture of reseating tool)

NOTE: Explain & demonstrate use of reseating tool

(d) Replace faucet or valve

1 When labor would cost more than valve

2 When valve is beyond economical repair (test valve before installing)

6h. Given a malfunctioning flushometer, and repair procedures, perform the necessary repairs to place the unit in operational condition.

(1) Types of flushometers

(a) Diaphragm

(b) Piston

(c) Hydraulic

(2) Troubleshooting flushometers

NOTE: Use T.A. & point out trouble areas.

(a) Diaphragm type

1 Diaphragm type

2 Plunger seat on diaphragm wears out, replace diaphragm

3 Plunger wears out replace

4 Orifice in diaphragm plugs up, clean

5 Replace handle or parts of handle as required

6 Flush cycle, adjust screw at top of valve

7 Replace valve as last resort

(b) Piston type

1 Seals of piston wears out, replace seals

2 Piston scales up, clean or replace

3 Bypass strainer plugs up, clean

4 Flush cycle; adjust screw at top of valve

5 Replace valve as last resort

(c) Hydraulic type

1 Baffels wear out, replace baffels

2 Hydraulic fluid low, refill to correct level

3 Flush cycle adjust screw
at top of valve

4 Replace valve as last resort

(d) Troubles and remedy common to
all types of flushometers

1 Angle stop, as volume control
and shut off to flushometer

2 Leaks at flushpipe

a Tighten slip nuts

b Replace worn slip washers

c Replace defective parts

d Backflow preventer

(1) Purpose (explain)

(2) Leaks, replace

(e) Flushometer repair procedures

1 Diagnose problem

2 Shut off water at angle stop

3 Disassemble flushometer (if necessary)

4 Repair or replace worn components

5 Reassemble flushometer

6 Test and adjust repaired unit

7 To replace flushometer

a Shut off water at angle stop

b Disconnect flushometer from angle stop at union.

APPLICATION: Complete WB 3ABR55235-IV-6-P1

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 minutes)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT: SG #3ABR55235-IV-7

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE TCETC/27Aug75	INSTRUCTOR
COURSE NUMBER 3ABR55235	COURSE TITLE Plumbing Specialist
BLOCK NUMBER IV	BLOCK TITLE Fixtures and Appurtenances

LESSON TITLE
Recovery and Restoration (Days 34 and 35)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
12 Hrs	4 Hrs	16 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
51	2 July 1975	7

STS/CTS REFERENCE

NUMBER	DATE
552X5	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools Shop Tools Salvageable Plumbing Equipment	None	None	SG IV-7 WB IV-7-P1 Rough-in Specifications Slides: Building Plumbing Systems

CRITERION OBJECTIVES AND TEACHING STEPS

7a. Working as a member of a team and following verbal and written instructions, remove, clean, and salvage all of the plumbing equipment, fixtures, valves, pipe, and tubing from the booth area. Salvaged equipment must be cleaned, inspected, assorted as to size, material, and type and returned to the correct storage area.

(1) Purpose
(2) Cold water disassembly
(3) Hot water disassembly
(4) Drainage

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COURSE NO: 3ABR55235
Days: 34 & 35

BRANCH APPROVAL: Robert B Haynes
DATE: 27 August 1975

PART II

INTRODUCTION (40 Minutes)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (11 Hours 15 minutes)

PRESENTATION:

7a. Working as a member of a team and following verbal and written instructions, remove, clean, inspect, and salvage all of the plumbing fixtures, valves, pipes, and tubing from the booth area. Salvaged equipment must be cleaned, inspected, assorted as to size, material, and type and returned to the correct storage area.

(1) Purpose

(a) To use material on other jobs

(b) Save money

(2) Cold water disassembly

(a) Shut off water (stop & waste valve)

(b) Turn off gas or electricity to water heater

(c) Drain piping

1 Keep area dry to prevent accidents

2 Open highest and lowest faucets

(d) Drain fixture

1 Closet tank & bowl

a Flush fixture--removes most of the water in the tank, sponge out the remainder.

b Bowl--Use force cup or plunger then sponge out the remainder.

c Disconnect supply line

d Remove tanks from bowl

e Remove bowl

f Remove wax from bowl

g Clean fixture and return to storage

2 Lavatory

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a Remove trap

NOTE: Use pail to catch water in trap.

b Disconnect jiffy connections

c Remove fixture

d Remove hinge bracket
and screws

3 Shower

a Remove shower head

b Remove shower valves

NOTE: Keep half unions with valve:
Screw on hand tight.

7

c Remove strainer

d Take out shower pan

4 Urinal

a Remove flushometer and angle stop

NOTE: Keep two together by joining hand tight.

b Disconnect trap

NOTE: Use pail to catch trap water

c Remove fixture

d Remove hanger brackets and screws

NOTE: Clean all fixtures and store in proper bins.

(d) Remove water lines

1 Start with risers

a Fixtures

b Water heater

2 Break unions at distribution main (keep all union halfs together)

3 Remove piping in large sections

4 Remove all piping hanger straps, and nails

5 Break down large sections of piping

NOTE: Use back up wrenches when necessary

6 Clean and store reuseable fittings and pipe

7 Place all unusable or damaged pipe and fittings in correct salvage barrels

(3) Hot water disassembly

(a) Turn off source of heat (gas)

1 Disconnect tubing to heater

2 Remove adapter from valve and cap opening

(b) Hook up hose to water heater and drains

(c) Remove relief valve

NOTE: Allows air into system

(d) Take insulations off piping

(e) Remove risers

(f) Break unions at heater

NOTE: Keep halfs of unions together

(g) Remove copper tubing

1 Make sure line is drained

2 Use care and asbestos pad when working on joints near floors and walls

3 Twist fittings slightly and pull with pliers

a Don't grasp ends of fittings

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NOTE: Use care not to damage
fitting so they are useable.

b Wear gloves and goggles

(4) Drainage

(a) Start at highest point

(b) Remove lavatory back vent

NOTE: Use 3 wheel cutter if necessary

(c) Remove lead from joints

1 Pick out irons

a Where torch can't
be used

b Very slow method

2 Sledge hammer

a Last resort

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b Wear face shield

3 Blow torch

a Unconcentrated flame

b Not used too often

4 Oxyacetylene torch

a Goggled protest eyes

b Asbestos gloves

c Preferably long sleeved shirt

d Use in well ventilated areas

NOTE: Be sure to emphasize safety in any job especially those involving using torches.

e Have fire extinguisher handy

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f Hot part of flame is tip of inner cone.

(d) Booth disassembly of cast iron pipe

1 Remove vertical pipes in booth area

2 Use special wrench to remove clamp from first joint under floor and remove pipe.

3 Remove clamps from 2" shower drain

4 Melt out joint at main sewer

NOTE: Be sure to use drip pan to catch molten lead.

5 Use care and remove building drain

6 Place supports under system and melt out joints

a Start at top and work down each side

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b Don't hold torch tip too close to joint (It will pop and flash back or go out)

c Use drip pan to catch lead

d Remelt lead on plumbers furnace

e Make ingots of lead

NOTE: Use regular laddle and pore two laddles full in small lead put, this is about 5 lbs.

f Separate pipe and fittings

g Sound out pipe and fittings

h Save good and destroy bad pipe and fittings

i Clean hubs and spigots on pipe and fittings. (Reclaimed C.I. must have a hub)

j Place pipe and fittings in proper place.

APPLICATION: Have students complete
WB: 3ABR55235-IV-7-P1.
Have students disassemble
system in booth area and
restore wood blanks.

NOTE: If there are no new wood blanks
your class will cut some.

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 minutes)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT: Read and Answer the questions at the end of SG 3ABR55235-IV-8.

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE	INSTRUCTOR
TCETC/27Aug75	

COURSE NUMBER	COURSE TITLE
3ABR55235	Plumbing Specialist
BLOCK NUMBER	**BLOCK TITLE**
IV	Fixtures and Appurtenances

LESSON TITLE
Planning and Layout of Plumbing Systems (Days 36 and 37)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
10 Hrs	4 Hrs	14 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
52	2 July 1975	8

STS/CTS REFERENCE

NUMBER	DATE
552X5	15 February 1973, Chg 1, 25 February 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Miniature Pipe and Fittings	None	None	SG IV-8 WB IV-8-P1 Plumbing Code

CRITERION OBJECTIVES AND TEACHING STEPS

8a. Given a floor plan, make a working drawing and specify the method of installation of the plumbing system that is required in this specific plan. The drawing must be complete enough to be used to make a bill of materials.

(1) Blueprints
(2) Working drawings
(3) Scale

8b. Using a working drawing of a plumbing system, make a bill of materials that would be needed to construct the system. The bill of materials must accurately identify all required materials without shortages and without excess greater than 10%.

(1) Information found in bill of materials
(2) Location of information

ATC FORM AUG 72 770

LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

8c. Using a floor plan, a working drawing, and the required materials, install a plumbing system in the miniature model house. Completed system must comply with the National Plumbing Code.

(1) Means of supporting pipe and fittings
(2) How to obtain proper grade on pipe
(3) How pipe and fittings are joined together

Course No: 3ABR55235
Day 36 & 37

Branch Approval: [signature]
Date: 2 September 1975

PART II

INTRODUCTION (40 Minutes)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (4 Hours and 15 minutes)

PRESENTATION:

8a. Given a floor plan, make a working drawing and specify the method of installation of the plumbing system that is required in this specific plan. The drawing must be complete enough to be used to make a bill of materials.

(1) Blueprints

(a) Types of blueprints

1 Plot plan

2 Foundation plan

3 Floor plan

4 Elevations

(b) Plot plan

1 Size of lot

2 Elevation or contour lines

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3 Location of building

4 Location of utilities

5 Directional indicator

(c) Foundation plan

1 Footing

a Depth

b Width

c Reinforcing

2 Foundation wall

a Height

b Width

c Reinforcing

3 Floor plan

a Room sizes

b Location of windows

c Location of doors

d Location of fixtures
(taken from floor plans)

4 Elevations

a Vertical measurements

b Location and size of
windows and doors

c Location of vents
through roof

(2) Working drawings

(a) Top view

(b) Side view

(c) Isometric (NOTE: Drawn on 30° or 45° angle) (Used to make a bill of materials)

(3) Scale-Blueprints will normally be drawn to a scale of $\frac{1}{4}$" = 1' - 0" but larger or smaller scales may be used.

NOTE: Split the class into four groups and assign each group to a section of the model house.

NOTE: Instructor discuss drawing before going to the next project

8b. Using a working drawing of a plumbing system, make a bill of materials that would be needed to construct the system. The bill of materials must accurately identify all required materials without shortages and without excess greater than 10%.

(1) Information found in the bill of materials

(a) Discription (nomenclature)

(b) Part number

(c) Quantity

(d) Size

(e) Cost

(2) Location of information

(a) Nomenclature

(b) Part number-found in either a manufactures catalog, GSA, or research catalogs.

(c) Quantity-found on the working drawings and specification sheets.

(d) Size-found on the working drawing and specification sheets.

(e) Cost-if necessary is found in commercial literature or research catalogs.

APPLICATION:

Using the working drawing in WB 3ABR55235-IV-8-P1 make a working drawing and a bill of materials, for the waste and vent system for the model house.

CONCLUSION (Day 36, 5 minutes)

SUMMARY: Outline the main points of the lesson and explain their importance to future lessons.

STUDY ASSIGNMENT: Conclude the lesson by emphasizing how today's work will fit into tomorrow's lesson. Have the students study SG 3ABR55235-IV-8 and review their notes.

INTRODUCTION (Day 37, 40 minutes)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT

REVIEW:

OVERVIEW:

MOTIVATION:

PRESENTATION:

8c. Using a floor plan, a working drawing, and the required materials, install a plumbing system in the miniature model house. Completed system must comply with the National Plumbing Code.

(1) Means of supporting miniature Pipe and fittings.

(2) How to obtain proper grade on miniature pipe

(3) How miniature pipe and fittings are joined together.

APPLICATION:

Using WB 3ABR55235-IV-8-P1, and Materials listed on bill of materials, install miniature pipe and fittings in model house. After project is checked by instructor, remove pipe and fittings and return them to supply. Clean work area.

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (5 Minutes)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT: Read and answer the questions in SG-3ABR55235-V-I, Winterization of piping, and SG-3ABR55235-V-II, Maintenance of Valves.

3-23 132

Department of Civil Engineering Training

Plumbing Specialist

FIXTURES AND APPURTENANCES

November 1974

SHEPPARD AIR FORCE BASE

Designed For ATC Course Use

DO NOT USE ON THE JOB

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This supersedes SG 3ABR55235-IV-1 through 7, 27 June 1973.

Department of Civil Engineering Training
Sheppard Air Force Base, Texas

SG 3ABR55235-IV-1
1 November 1974

INSTALLATION OF BATHTUBS AND SHOWERS

OBJECTIVE

The objective of this study guide is to develop your knowledge of procedures that must be used when installing a bathtub.

INTRODUCTION

The bathtub or shower is one of the most important installations in any modern building. The cleaning of the body is important to good health. The shower is favored by many people from a sanitary viewpoint. This makes it more practical where more than one person uses the same fixture. Some homes have the bathtub and shower combination which reduces cost of installation of two fixtures.

TYPES OF BATHTUBS

There are several types of bathtubs on the market today, such as recess, corner recess, and sunken. Most types of tubs are made in several sizes ranging from 4 to 6 feet in length. The most common length tub used is five feet. They are designated as a right- or left-hand tub, depending on the location of the drain. Most bathtubs are made of enameled cast-iron or enameled-pressed steel.

INSTALLATION OF BATHTUBS

Modern cast-iron tubs are designed to rest on the floor and normally span an area from wall-to-wall. The tub sets firmly on the subfloor and the rim of the tub is supported by leveled blocks or a piece of 2 x 4 nailed lengthwise on the studs. This is shown in figures 1 and 2.

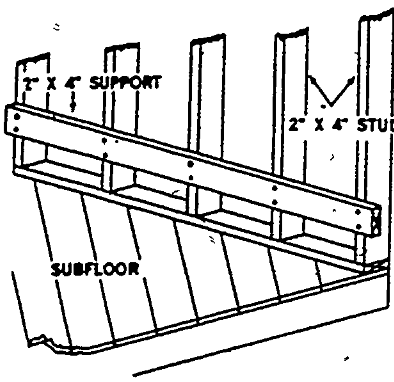


Figure 1. A 2" x 4" Used As A Bathtub Support

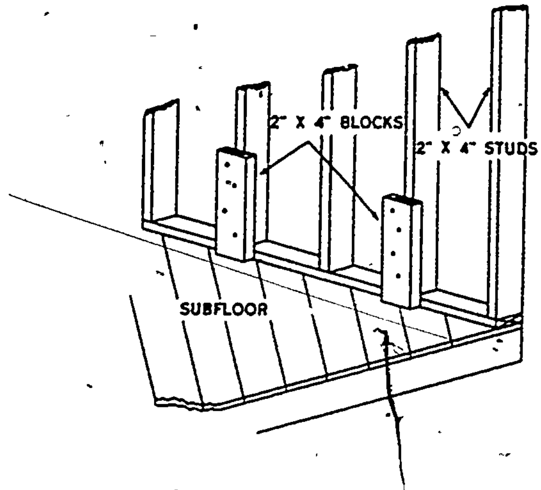


Figure 2. Blocks Used As A Bathtub Support

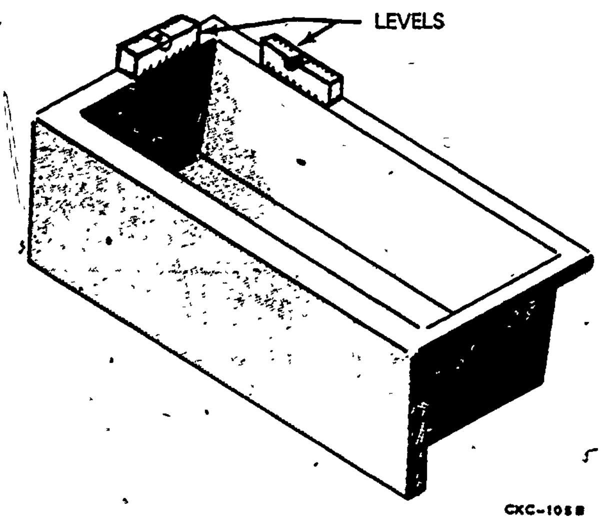


Figure 3. Leveling the Bathtub

After the tub is installed against the studs and the rim of the tub is resting on its supports, it should be checked as shown in figure 3 to assure that it is level.

The drain and overflow of the tub is usually of a type with a popup drain plug and then there ~~is the~~ one with the pullout stopper. The drain is installed in the space provided by the studs at the end of the tub. The overflow and waste drain are made of highly finished chrome. The hidden parts are made of rough brass and brass tubing. The fittings are 1 1/2 inches in diameter and come with a popup waste or a rubber stopper fastened to the overflow by a chrome chain. This drain and overflow combination is connected to the drum or a P-trap with slip joint nuts and rubber washers to seal off the leaks. The drain in the bottom of the tub is sealed against leaks by using plumber's putty and rubber rings.

TYPES OF SHOWERS

With respect to disposition of waste, showers are of two general classes, those which discharge into the bathtub and those which discharge into a separate receptor or floor pan. The latter strictly speaking constitutes a shower; the other is simply an attachment to a bathtub water supply. Both types are used in the modern homes today. The only reason for the difference is economy; each accomplishes the same purpose.

INSTALLATION OF SHOWERS

The faucet and shower combination for a bathtub and shower is connected to the hot and cold water lines that are installed when the piping is roughed-in. The manufacturer's specifications are used to determine the height of the risers; however, the height may be specified by the user.

The faucet's hidden parts are constructed of rough brass, while the parts that extend through the finished wall have a chrome finish.

All nipples coming through walls should have escutcheons installed on them to prevent insects from entering the building, keep out cold air, and also to improve the appearance of the installation. Escutcheons are made in a number of designs. The two most common types are made to slip over nipples coming out of walls before fittings are installed. Another type is designed on hinges and can be opened up and installed on piping after the pipe and fittings have been installed. A typical bathtub and shower unit is shown in figure 4.

A nipple is connected to the bottom of the tee fitting in order to extend the tub spout to within 2 to 4 inches of the tub's top; spacing the spout above the tub rim prevents siphoning of the water from the tub in case the faucet is left open, and the water pressure drops at the same time. This installation prevents cross connection between potable and nonpotable water.

A diverter, see figure 4, is used in the downspout of the tub to divert the water up through the shower head. The diverter will return to normal position when the faucets are turned off.

Mixing valves in the shower system are used to supply a uniform temperature of the water for shower or tub. Temperature of the water may be regulated between the limits of the temperatures of the cold water supply and the hot water supply.

Three methods are used for this control of temperature; they are manual, pressure, and thermostatic.

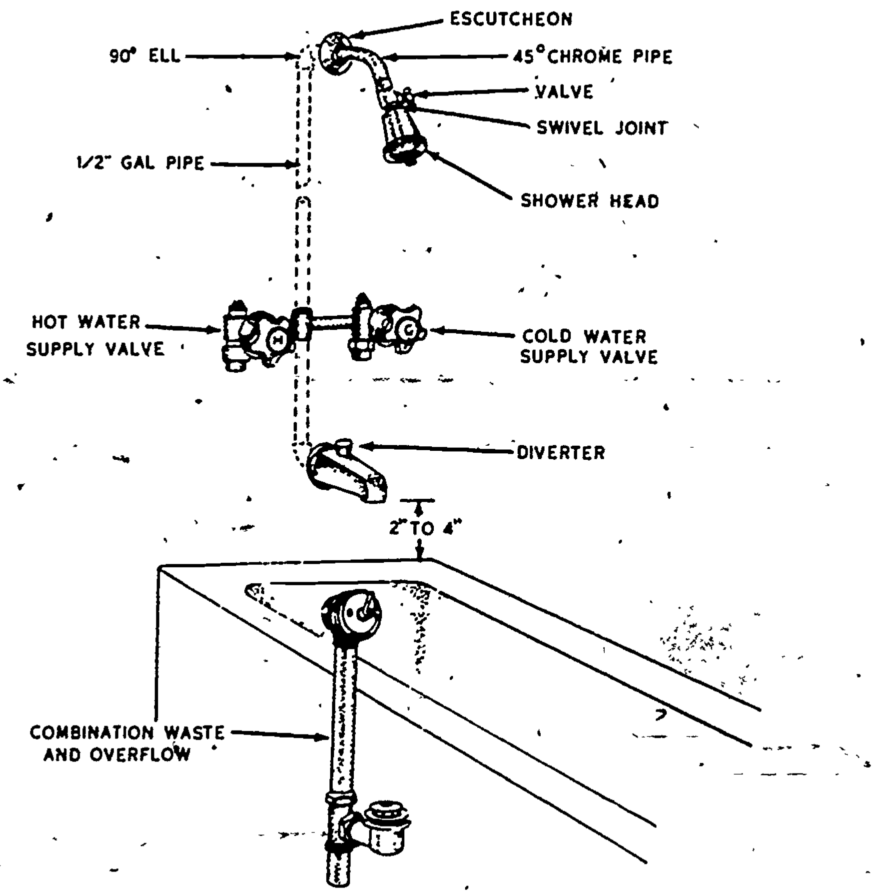


Figure 4. Bathtub and Shower Unit

A manually-controlled mixing valve consists of two compression stops cast in one body and downspout and spray delivery pipe. The mixture and temperature of the water discharged by the tub spout or shower spray is regulated manually. This type of valve, however, does not provide protection against sudden changes of temperature due to surges of hot or cold water caused by varying pressures of water temperatures in the supply lines, see figure 4.

A pressure-controlled mixing valve consists of a brass mixing chamber containing a sliding piston. The piston is provided with jets to allow hot and cold water to pass through them and mix when the handle of the valve is operated. The setting of the handle controls the water temperature by establishing the mixing ratio, a change in pressure on one side of the piston will cause the piston to move, increasing the flow from the low pressure supply to maintain a nearly constant temperature; see figure 5.

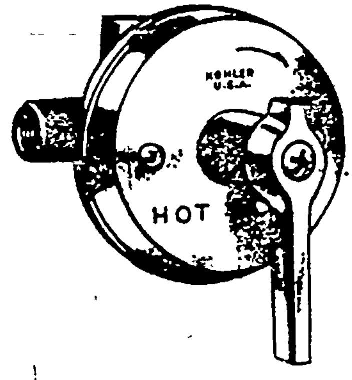


Figure 5. Pressure Controlled Mixing Valve

A thermostatically-controlled mixing valve is sensitive to changes in both temperature and pressure. The temperature of the water delivered by the valve remains constant regardless of temperature and pressure changes in the hot and cold water lines. This type is for showers only, see figure 6.

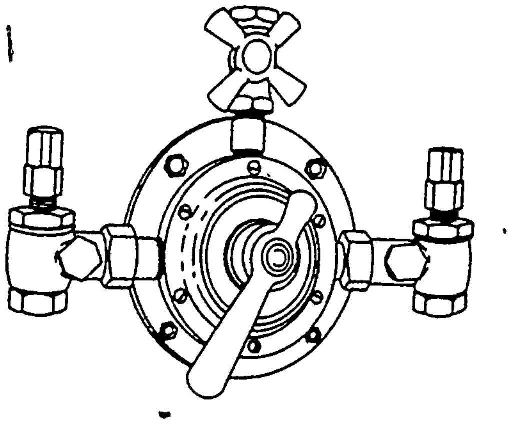


Figure 6. Thermostatically Controlled Mixing Valve

The shower head is attached to a shower arm mounted on highly finished chrome pipe. Shower heads have a ball and socket joint to adjust direction of the spray. Shower heads are usually made of chrome or nickle-plated brass. Newer types of shower heads are being made of plastic and have the advantage of being noncorrosive. Due to the chemical contents of water, it has a tendency to form deposits on the shower head; therefore, occasional maintenance will be required to keep them functioning properly.

There are two types of shower heads commonly used in Air Force installations. These two types are the circular head and the economy head. The circular head has notches or grooves around the outer edge of the face that allows regulation of the spray. The economy head has a restricted nozzle that provides a fine spray. The economy head uses less water than other types of heads.

The shower bath differs from the tub and shower combination in that the tub is replaced by a floor receptacle. The floor slopes to a floor drain either in the center or on the ends. The sides and floor of the shower may be metal, tile, or any suitable waterproof material. A door or curtain provides the fourth wall to hold the water within the shower area.

SUMMARY

Some of the types of bathtubs on the market today are the recess, corner recess, sunken, and leg or roll rim types. These tubs range in size from 4 to 6 feet. Most bathtubs today are made of enameled cast-iron or enameled-pressed steel. In most cases they rest on the subfloor and are level and supported by 2 x 4 timbers nailed to the studs. The bathtub is connected to the previously roughed-in plumbing system.

One of the two types of showers used in the modern home today discharges waste water into the bathtub and the other discharges its waste water into a separate receptor or floor pan. Faucets for shower combinations are installed on the hot and cold water lines previously installed for bathtub and shower. Manufacturer's or user instructions are consulted when installing the shower combination. A diverter is used in the downspout of the bathtub to divert water up through the shower head. Several types of valve systems are used in bathtub-shower combinations and single shower installations. The manually-controlled mixing valve does not provide protection against sudden changes of temperature in the supply lines. The pressure controlled mixing valve is used where bathtub and shower are separated. This valve is constructed so it will maintain a nearly constant water supply temperature. A thermostatically-controlled mixing valve is used in a shower installation. The valve maintains constant temperature and pressure of the water.

QUESTIONS

1. What type of material and finish is used to manufacture a bathtub?
2. How is a bathtub supported to keep it level?
3. How is the drain in the bottom of the bathtub sealed to prevent leaking?
4. What two (2) types of showers are in common use?
5. Why is a 2- to 4-inch space left between the rim of the bathtub and the bottom of the tub spout?
6. What is the purpose of the diverter?
7. What type mixing valves are used in the installation of showers?
8. Which type valve maintains constant temperature and pressure of the water regardless of water change?
9. What type of shower heads are used in shower installations?
10. How is the economy spray constructed so it will operate on less water?
11. What is the purpose of the ball-and-socket joint on the shower head?
12. How does the pressure controlled mixing valve maintain a nearly constant temperature?

REFERENCES

1. AFM 85-20, Plumbing

2. C-760, How to Design and Install Plumbing

INSTALLATION OF WATER CLOSETS

OBJECTIVE

The purpose of this study guide is to aid you in gaining a better understanding of the types and installation procedures of a water closet.

INTRODUCTION

The water closet is the most commonly used fixture. From the standpoint of sanitation, it is the most efficient. The water closet is a plumbing fixture used to convey organic body wastes to the plumbing system. It is made of clay with a quality equal to that used in the manufacture of fine china. A water closet is cast in about thirteen pieces. These are molded together by skilled mechanics to form the closet bowl. The closet is then treated with liquid glaze, placed in dry kilns, and fired at temperature of 2500°F. This process renders it entirely impervious to moisture.

CLOSET BOWL OPERATION

Vitreous china water closets are available in a wide variety of types, including the common washdown bowl, the washdown bowl with jet, the reverse trap bowl, and the siphon jet bowl; although each of these water closet types is installed in the same way, they differ in their flushing action.

Washdown Bowl

The washdown bowl is the simplest type of water closet. The trap is at the front of the bowl and is somewhat smaller than in other types of water closets. Proper functioning of this type of closet is dependent upon siphon action alone. During the flushing action of all these types of water closets, water flows from inside the rim down the side of the bowl through the integral trap and out of the fixtures, see figure 7.

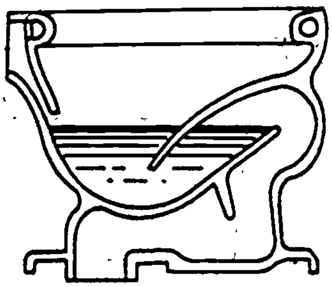


Figure 7. A Common Washdown Bowl

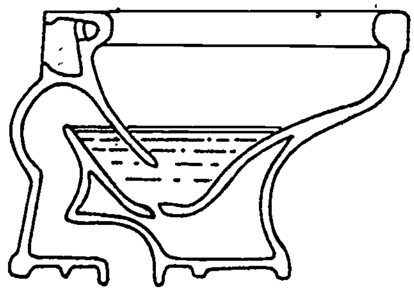


Figure 8. Reverse Trap Bowl

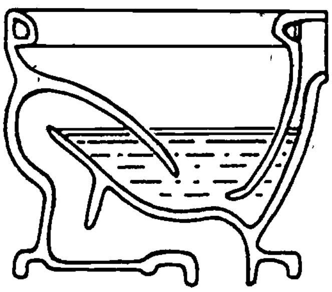


Figure 9. Washdown With Jet

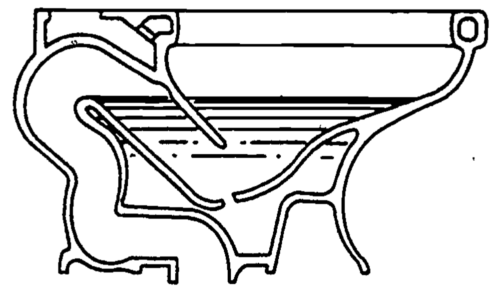


Figure 10. Siphon Jet Bowl

Reverse Trap Bowl

The reverse trap bowl is similar to the washdown bowl except that the trap is at the rear of the bowl, lengthening the bowl for a more graceful appearance. It holds more water than the washdown bowl and is quieter in operation, see figure 8.

Washdown Bowl with Jet

The washdown bowl with jet is similar in appearance to the common washdown bowl, but it has a different flushing action, see figure 9. The unit has a small hole in the bottom which delivers a direct jet or stream of water into the upper arm of the trap, starting a siphoning action immediately upon flushing the unit.

Siphon Jet Bowl

The siphon jet bowl, see figure 10, is the most expensive, quietest in operation, and most efficient type of water closet. It is similar in appearance to the reverse trap bowl, but maintains an almost full bowl of water. Very little of the inside surface of the bowl is left uncovered when the water is at rest in the bowl.

INSTALLATION SPECIFICATIONS

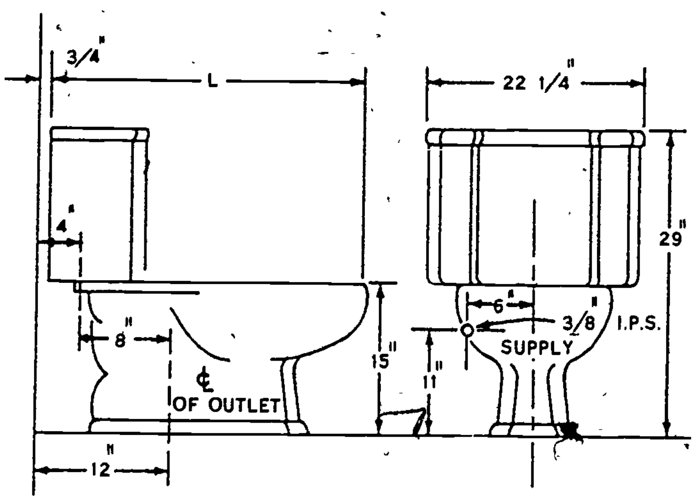
To properly install a water closet, the plumber should refer to the working drawings furnished by manufacturers of plumbing fixtures. Ability to read blueprints in general will enable you to visualize these simple but necessary directions to roughing-in and to set plumbing fixtures.

Water closet roughing-in sheets are indicated in figures 11, 12, 13, 14, and 15. These roughing-in sheets are exact types furnished the plumber by the manufacturers for on-the-job installation. Referring to figures 11, 12, 13, and 14, find out how much space is required for the closet. Notice that the drawings indicate how far the sewer opening must be from the wall or floor for certain types of closets. Even though the measurements should be followed by the plumber in installing the fixture, some manufacturers allow up to a 1/2-inch variation in these types of installations.

Notice in figures 13 and 14 the latest types of wall-hung water closets supplied by manufacturers. These type closets make cleaning of the floor much easier than the floor type. The type indicated in figure 13 is used more extensively in residential areas while the one indicated in figure 14 is used more extensively in public places.

In figure 15 is illustrated the manufacturer's approved support for wall hanging closet. The adjustable combined fitting and chair carrier permits each wall-hung closet to be set at a uniform height from the floor by providing an elongated opening in the fitting which allows setting up to 4 inches of pitch on the drainage line.

The integral fitting is nonadjustable and recommended primarily for use on single closet installations or on vertical lines where narrow wall construction limits the pipe space available.



L = 29 3/4"   Measurements may vary 1/2"

Figure 11. Siphon Jet Closet Combination With Tank

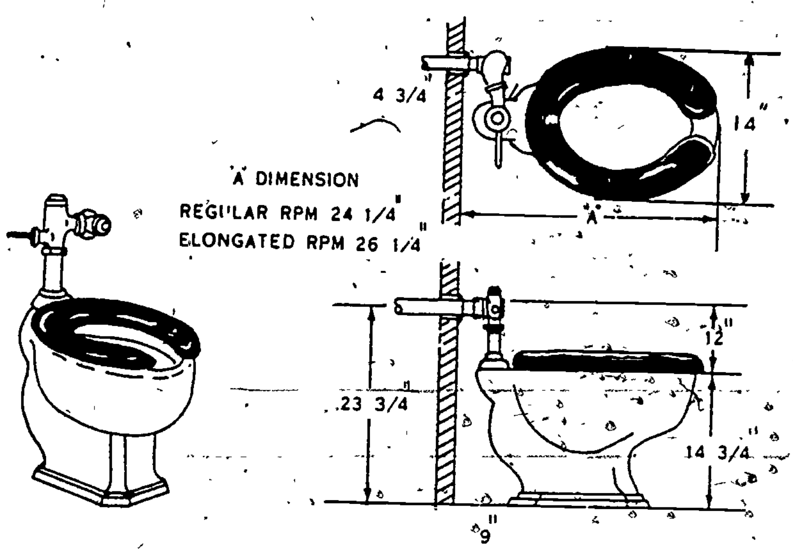


Figure 12. Floor Support Water Closet With Flushometer Type Valve

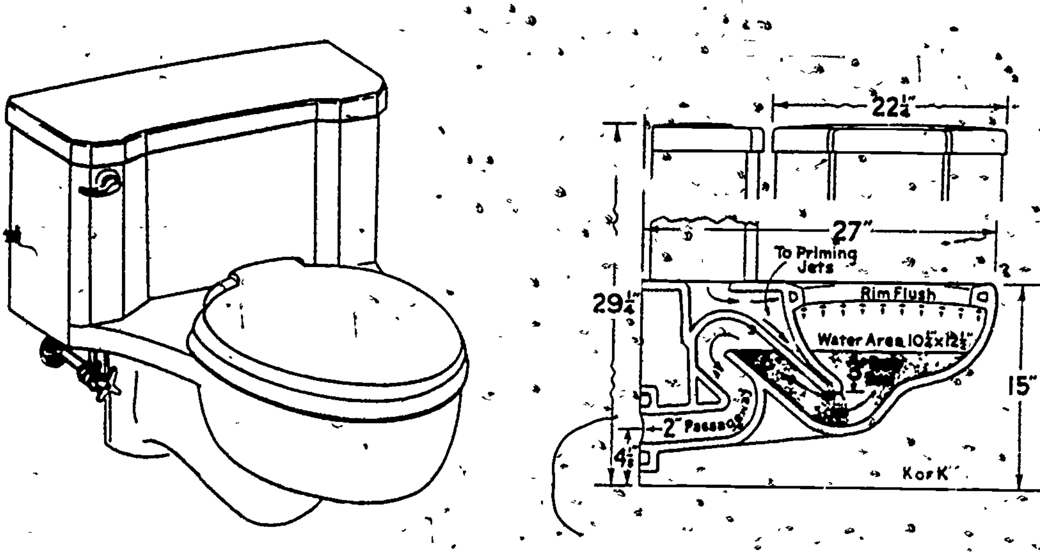


Figure 13. Tank Type Wall Hung Close-Coupled Reverse Trap Closet

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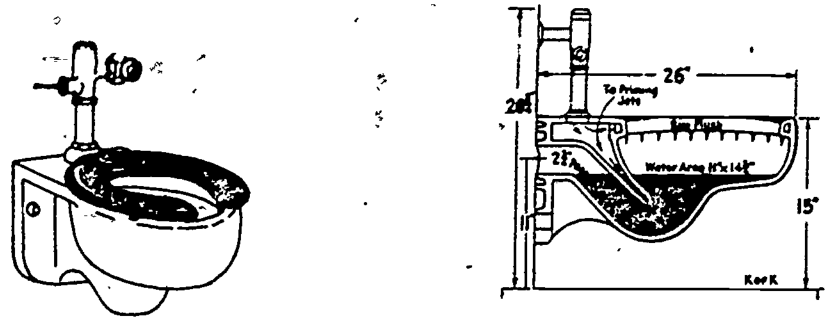
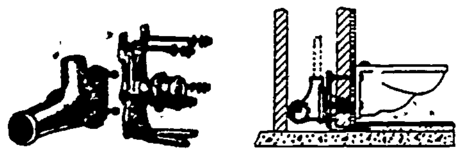
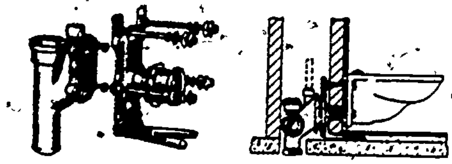


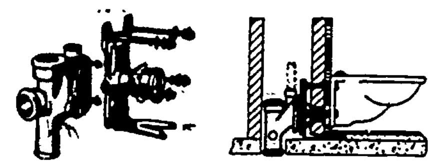
Figure 14. Flushometer Type Wall-Hung Water Closet



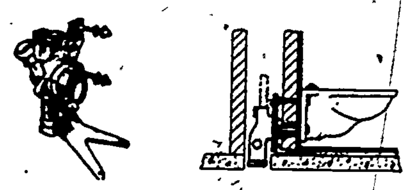
15A - Horizontal Adjustable System



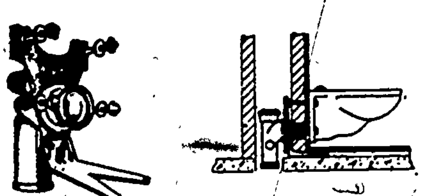
15B - Vertical Adjustable System



15C - Vertical Inlet Adjustable System



15D - Integral Vertical Offset System



15E - Integral Vertical System

Figure 15. Manufacturer's Supports for Wall-Hanging Water Closets

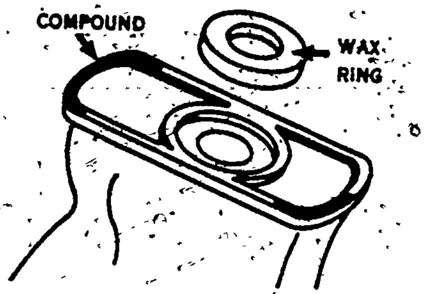


Figure 17. Installing Wax Ring Gasket and Compound

The compound ring should be about 1-inch thick. Arrange the compound ring on the rim of the bowl so it will squeeze inward. This is accomplished by rolling the compound toward the inner edge of the rim. If the floor is not level and the floor has been raised above the top of the floor-flange, use two wax rings. Next lift the bowl up (it is heavy, and to set it properly, requires two people) and set it gently down over the floor-flange making sure the wax ring stays in place. Continue letting it straight down into final position, see figure 18.

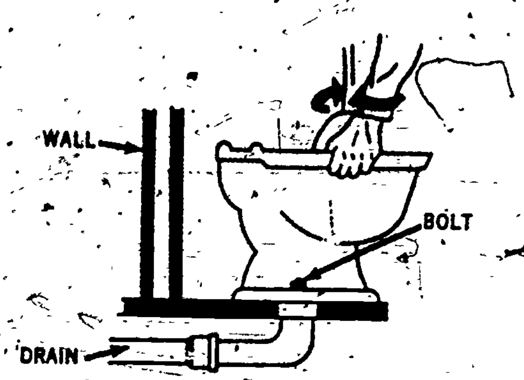


Figure 18. Installing Closet Bowl

Press down on top center (not one end or the other) of the bowl. Use your full weight and twist it lightly to settle it into the compound and also to settle it firmly on the floor. The closet bowl should be perfectly level when settled. Use a level if you are in doubt. Wedge the bowl to level it if necessary. Be sure that if any wedging is used, it does not leave airgaps in the compound around the bowl. Do not force tightening the nuts on the bolts because of the danger of cracking the bowl flange.

INSTALLING CLOSET BOWL

The bases of all water closet bowls are installed in about the same way as is indicated in figures 16, 17, and 18.

Air Force type of plumbing requires a floor flange installed so that it rests upon the floor around the opening of the drain line. The connection between the water closet and the soil pipe will depend on the type of closet bend available for the job, see figure 16 for one type of installation.

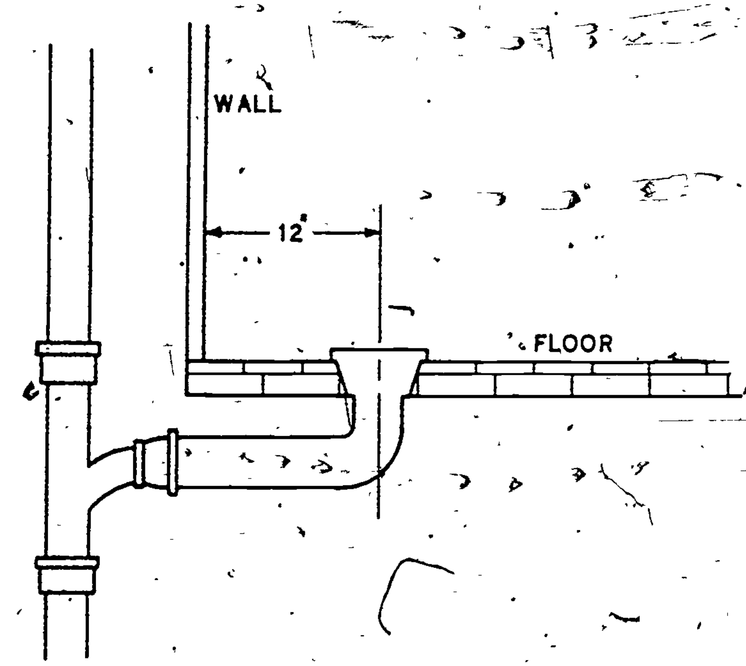


Figure 16. Closet Drain Opening

To set a bowl that is held by two bolts, simply place the bolts in the flange slots provided. If, however, the particular designed bowl requires four bolts, then place the closet on the floor properly over the flange, mark the locations (on the floor) for the additional (front) bolts, then install these bolts into the floor at the place marked. If, however, the floor is wood, use toilet bowl bolts, which have wood threads at one end and machine threads at the other. With a floor that is tile or concrete, set the heads of the bolts in previously prepared holes and fill with cement to level of the floor.

Before the bowl is turned upside down, put wood or papers under the bowl to prevent scratching and when you handle the bowl, be sure not to drop it, because it is made of vitreous china and will break easily. After you have turned the bowl, place a roll of approved compound completely around the rim, and a prepared wax ring around the discharge opening, see figure 17. In case of emergency the Air Force permits the use of rubber gaskets or putty around the discharge of closet bowl. This forms a seal between the floor flange and the water closet bowl.

INSTALLING FLUSHING MECHANISMS

Cold water for flushing a water closet can be supplied to a water closet by a closet tank or a flushometer-type flushing valve. The closet tank is used in residential water closets. With such a tank, a minimum of water is effective in quietly and efficiently flushing the water closet. Flushometer-type flushing valves are more advantageous in installations where noise and economy are not particularly important. The required size water line for a water closet equipped with a flushometer is 1 inch and for a water closet equipped with a tank 1/2 inch.

Installing Tank

The close coupled tank design is a later revision of the wall-hung tank type with a similar flushing and fill mechanism. The difference in the tanks are the way they are mounted. The wall-hung tank is fastened to the wall and connected to the bowl by a water closet elbow, fittings, and a spud. The fixture supply line is also connected to the bottom of tank for supplying water to the closet tank and bowl, see figure 19.

The close coupled tank sets on the back of the bowl. It is held by two bolts and the water connection is sealed with a special designed gasket, see figure 20.

The water supply to the tank is connected with a flexible connector (jiffy connection) as shown in figure 21. The jiffy connector used here is the same as the connector used to connect the water supply to the faucets of a lavatory. Refer to manufacturer's specifications for size of tube to be used.

The tank is filled through the ball cock which is controlled by the ball float. Flushing is accomplished by raising the flush tank ball from its seat with the operating handle and connecting linkage, see figure 22.

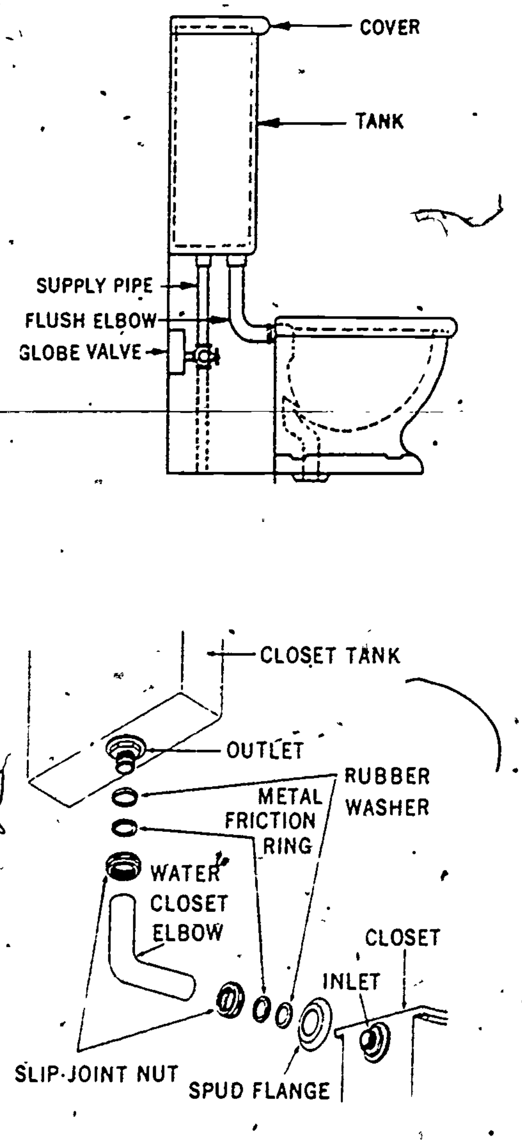


Figure 19. Water Closet and Wall-Hung Closet Tank

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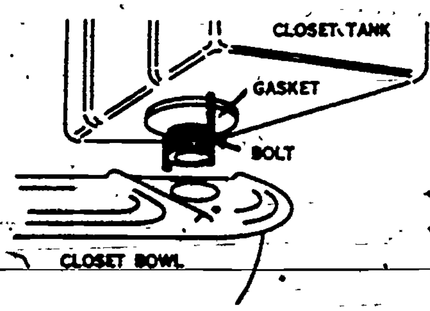


Figure 20. Mounting Tank on Closet Bowl

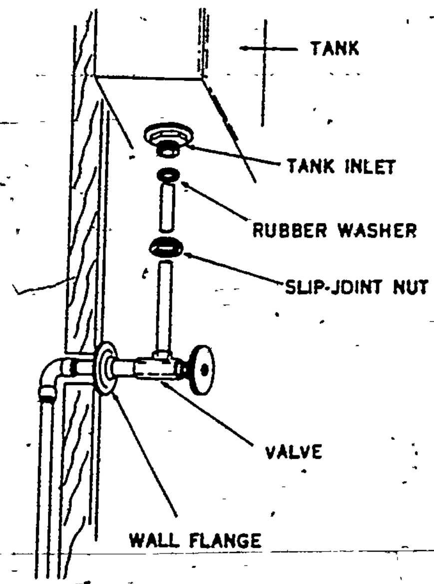


Figure 21. Fixture Supply Line

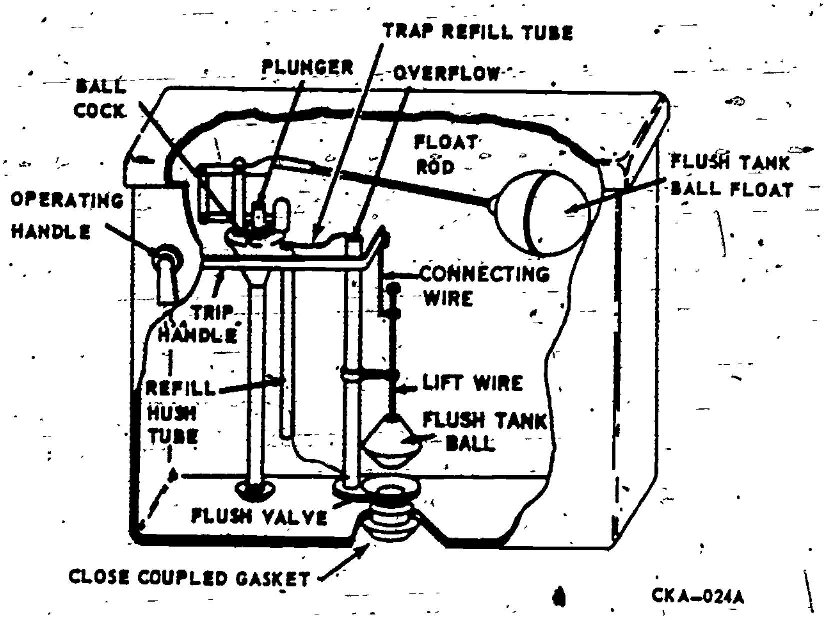


Figure 22. Flush Tank

The flush tank ball is light and when lifted floats on the top of the water; and as the water goes out of the tank, the tank ball drops back on the seat of the flush valve. The water pressure in the tank holds flush tank ball on its seat until the next flush.

Installing Flushometer Types

Most of the water closets used in the Air Force are equipped with flushometer flush valves for flushing the bowls. A flushometer valve is a compact and efficient mechanism for delivering water under pressure directly into the water closet. This type valve gives a quick, automatic flushing action, and the amount of water delivered can be adjusted. There are several types of flushometer valves, including the piston, diaphragm and hydraulic types. For proper operations, these require a 1-inch supply line.

PISTON TYPE. The piston-type flushometer valve, shown in figure 23, is operated by a lever which discharges the water from the upper chamber. The differential pressure then forces the piston assembly upward, allowing the water to enter the closet bowl. The upper chamber is filled through a bypass which is connected to the supply. When the pressure is equal on both sides of the piston, it will drop down on its seal, closing off the water supply.

DIAPHRAGM TYPE. The diaphragm-type flushometer valve, see figure 24, contains two chambers separated by a relief valve mounted on a rubber diaphragm. The upper chamber is directly connected to the main water supply by a bypass. The lower chamber is connected to a large diameter supply pipe which is usually 1 inch or more in diameter. When the valve is operated, the relief valve is moved to the open position, discharging the water from the upper chamber. Inequality of the pressures to which the two sides of the diaphragm are exposed forces the diaphragm to lift off its seats admitting water from the supply inlet into the closet bowl. Within a predetermined interval, sufficient water forces itself through the bypass into the upper chamber, moving the diaphragm down onto the seat and closing the flow of water to the bowl.

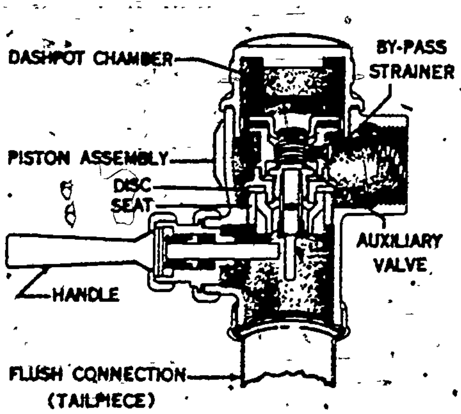


Figure 23. Piston-Type Flushometer

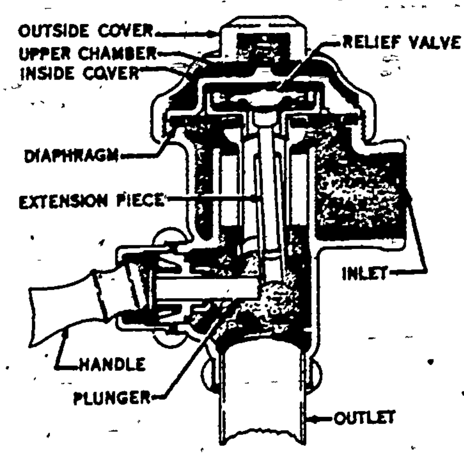


Figure 24. Diaphragm-Type Flushometer

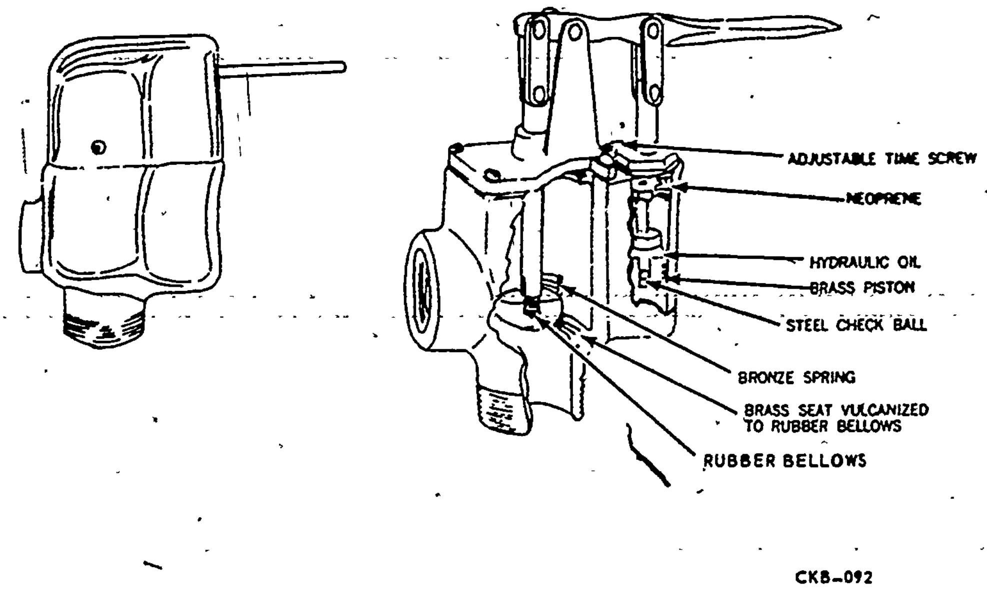
The flushing action on both piston- and diaphragm-type flushing valves should be set at 10 seconds. This gives the most desirable flushing time for water closets. The setting is made by adjusting the screw in the top of the flushometer for length of flush and adjusting the angle valve on the flushometer water for volume.

The flush valve or flushometer is connected to the closet bowl by a screwed compression fitting and to the water supply by a standard pipe thread fitting, after piping compound has been applied to the pipe threads. The last connection to be made is at the union that is built into the flush valve.

Hydraulic Type Flushometer

The hydraulic type flushometer (figure 25) contains two separate chambers, with its mechanical parts sealed in hydraulic oil. Its operating function is mechanical and therefore is independent of water pressure. The length of the flushing period is controlled by the adjustable time screw. The principle of operation is as follows.

	CONTROL CHAMBER	WATER CHAMBER
When handle is depressed....	Piston is forced down, causing hydraulic oil to lift check ball, allowing oil to pass up through piston and out into oil chamber above piston.	Bronze spring is compressed, lifting bellows off valve seat and allowing water to pass through water chamber to bowl.
When handle is released....	Piston rises and check ball returns to its seat, preventing oil from passing back through piston. Rising piston forces oil through 1/8" orifice, past adjustable needle valve, and back into the chamber below piston.	Bronze spring expands, returning bellows to valve seat, and stopping water passage.



View A View B

Figure 25 - Hydraulic Type Flushometer

After the water closet and tank or flushometer have been installed, the system should be tested for leaks and smoothness of operation. This test should be made at full water supply pressure.

Water closet trap maintenance will consist of removing stoppages, using a force cup or closet auger. If these two methods fail, then it is necessary to disconnect the bowl from the closet flange and work from the waste outlet opening.

SUMMARY

Water closets are plumbing fixtures used to convey organic body wastes to the drainage system. These vitreous china water closets are available in a wide variety of types which include the common washdown bowl, washdown bowl with jet, reverse trap bowl, and the siphon jet bowl. Even though each water closet is installed in the same way, the flushing action is different. The washdown bowl is the simplest type of water closet because it is dependent on the siphoning action alone. The siphon jet bowl is the most expensive, quietest in operation, and most efficient type of water closet.

To properly install a water closet, the plumber should refer to the manufacturer's rough-in specifications furnished by the manufacturer of the fixture.

The closet bowl is fastened to the floor by two or four bolts, depending on the design of the bowl. To seal the bowl to the floor, a ring of compound is placed around the base of the bowl and also a wax ring is used to seal the bowl to the drain opening. If the floor has been raised above the top of the floor flange, use two wax gaskets to seal the bowl to the drainage system.

The two methods of supplying water to a water closet bowl are through the closet tank and flushometer. The tank is mounted on the wall or is connected to the back of the closet bowl. A 1/2-inch water supply line furnishes water to the tank each time the tank is emptied. The tank type is used mostly in residential areas where quietness is desired. The flushometer type flushing valves are more advantageous in installations where noise and economy are not particularly important. The flushing action on flushometers is set at 10 seconds flushing time. The setting is made by adjusting the screw in the top of the flushometer for length of flush and by adjusting the valve on the water supply for volume.

QUESTIONS

1. What kind of material is used in the construction of water closets?
2. What four types of water closets are discussed in this guide?
3. Which type is the simplest water closet?
4. Which type is the quietest in operation and most efficient water closet?
5. Name 3 types of flushometers?
6. What measurements are included on the manufacturer's specifications?
7. How are the bolts anchored in the base of the closet bowl?
8. What is used to seal the bowl to the floor and the discharge opening?
9. How does the plumber cause the compound to squeeze inward when setting the closet bowl?
10. Why is it not advisable to force tighten the nuts on the base of the closet bowl?

INSTALLATION OF URNIALS

OBJECTIVE

To provide you with the background information pertaining to the types and installation of urinals.

INTRODUCTION

The installation of a urinal is common in industrial, commercial, and military installations. The fixture is of sanitary design. However, it seems that the purpose for which it is used makes it an installation not always up to standard with other plumbing fixtures as far as sanitation is concerned.

Urine is more objectionable as a waste product than other types or organic substances when considered from the standpoint of possible communication of infectious diseases.

TYPES

There are four basic types of urinals. They are the wall-hung, pedestal, trough, and stall types. The stall type is used extensively in public buildings. The wall-hung and the pedestal types are common in the military. The trough and stall-type urinals are not approved for use in new construction or maintenance replacement.

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Wall Hung

The wall-hung urinal, as shown in figure 26, is a solid porcelain, cast iron with enamel finish, or vitreous china fixture suspended from the wall with four bolts or brass screws. Wall-hung urinals come in different designs, such as: (1) syphon jet fixture with integral trap, (2) the urinal with an outside trap or exposed trap, and (3) the siphon jet urinal with side shields. All are proper for installations having tile, or other kind of impervious flooring, in which a drain may be installed.

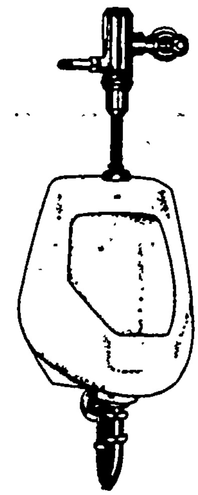

Figure 26. Wall-Hung Urinal

Trough

The trough urinal, as shown in figure 27, is installed similarly to the wall-hung type. The main difference is the trough type does not have an integral trap and must be provided with a separate trap directly under the waste outlet of the fixture.

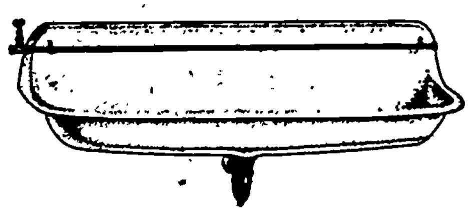

Figure 27. Trough Urinal

Pedestal

The installation of a pedestal-type urinal, as shown in figure 28, is similar to installing a floor-mounted water closet. The rough-in is made with a 4-inch closet bend and floor flange. The urinal is sealed to the floor flange by using a wax ring on the underside of the outlet. The fixture is then fastened to the floor flange with brass bolts and brass chrome-plated nuts.

The big advantage of this type of urinal is that there is less trouble with stoppages because of its large discharge opening and drain.

The cost of installation is more, but it is usually cheaper in the long run because it requires less maintenance.

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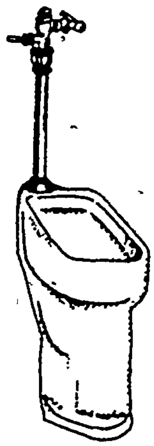


Figure 28. Pedestal Urinal

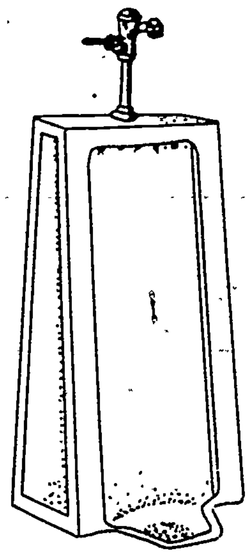


Figure 29. Stall Urinal

Stall

Stall-type urinals, as shown in figure 29, are used in public buildings where the height of the personnel using it vary and would require several wall-hung urinals installed at different heights. The stall-type urinal like the trough type is not as sanitary as the wall-hung or pedestal. It is not approved by the Air Force for use in either new constructed or maintenance replacement. This is because there is some splatter of urine back on clothing and shoes of personnel using it. The stall type has a 2-inch rough-in.

The manufacturer's specifications should be followed closely as the tolerance during installation is much closer because it is fastened to the wall and must be flush with the floor.

FLUSHING MECHANISMS

Flushometer valves are used to flush urinals. These valves are devices which discharge a predetermined quantity of water directly from the supply line to flush the urinal. The valves are self-closing and actuated by direct water pressure. These valves use less water than hand-adjusted continuous flow units and can be operated at intervals of only a few seconds, usually a 10-second flush. There are several types of flushing valves, but the piston and the diaphragm types are most widely used.

Piston Type

The piston-type flushometer valve is opened by a lever which discharges the water from the dashpot chamber. The differential of pressure then forces the piston assembly upward allowing the water to enter the urinal directly. Closing of the valve is automatic, controlled by a bypass through which water enters the dashpot chamber, forcing the piston assembly down on its seat, stopping the flow of water. It is regulated by a screw to allow the valve to be open no longer than the time required to flush the urinal. Figure 30 shows a piston-type flushometer valve.

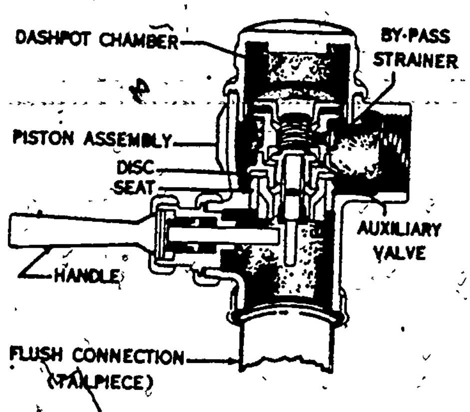


Figure 30. Piston-Type Flushometer Valve

Diaphragm Type

The diaphragm-type flushometer valve has two chambers separated by a relief valve mounted on a rubber diaphragm. The upper chamber is directly connected to the main water supply by a bypass. The lower chamber is connected to a large diameter. When the valve is operated, the relief valve is titled to the open position, discharging the water from the dashpot chamber. The differential of pressure then forces the diaphragm to lift and admit water from the distribution system into the urinal. Within a predetermined interval, sufficient water forces itself through the bypass to the dashpot chamber, forcing the diaphragm down on its seat to stop the flow of water into the fixture. Figure 31 is a cutaway of a diaphragm flushometer.

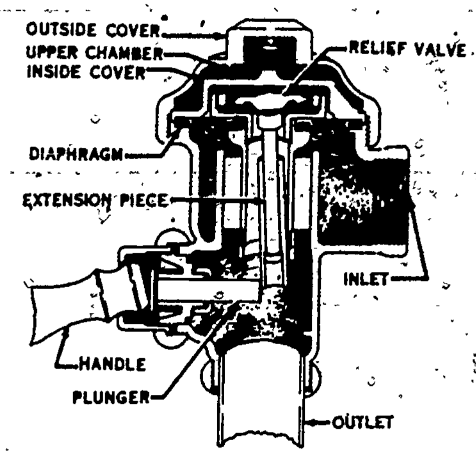


Figure 31. Diaphragm-Type Flushometer Valve

INSTALLATION PROCEDURES

Urinals, like most other fixtures, are available in a variety of shapes and sizes. Two urinals may look the same but may not be secured to the wall in the same manner. All wall-hung urinals must have a support; these are called mounting boards.

Some urinals are secured to the wall by brass screws or bolts. Care should be taken not to tighten the bolts or screws too much. The urinal may crack or break.

Regardless of the method used to mount the urinal, it should be level and mounted at the height specified for the urinal to be installed. Once the urinal is mounted, the flushometer and P-trap can be installed. Turn on the water and check the flushometer and drain for operation and leaks.

SUMMARY

There are basically four types of urinals: wall-hung, trough, stall, and pedestal. They are constructed of vitreous china or porcelain, because enameled iron will not stand up under the hard wear to which these particular fixtures are subjected. The wall and trough-type urinals are used more extensively on military installations. The urinals are suspended from the wall by brass bolts or screws. A mounting board must be installed to provide firm support for the urinals. The lip of the wall-hung urinals should be from 20 to 25 inches above the finished floor. The trough urinal does not have an integral trap and must be provided a separate trap. The water supply flushing mechanism of the trough urinal is generally an automatic or hand-adjusted continuous flow unit. Flushometer valves are used to flush wall-type urinals and may be used on trough-type urinals. There are two types of these valves; piston and diaphragm. They can be operated often without damage. The valve is operated by water pressure acting on the valve mechanism.

QUESTIONS

1. Name the types of urinals.
2. Of what type material is a urinal constructed?
3. How are urinals suspended from the wall?
4. What kind of bolts and screws are used for mounting a wall-type urinal?
5. What is the height of the lip of the wall-type urinal from the floor when properly installed?
6. What is the purpose of a mounting board?
7. What type of valves are generally used on urinals?
8. What is the height of the urinal from the finished floor to the lip?
9. What item is needed when a pedestal urinal is sealed to the floor flange?
10. How is a piston-type flushometer actuated?

REFERENCES

1. AFM 85-20, Plumbing
2. National Plumbing Code

INSTALLATION OF LAVATORIES

OBJECTIVE

The purpose of this study guide is to help you become familiar with the types of lavatories and the proper method of installing them.

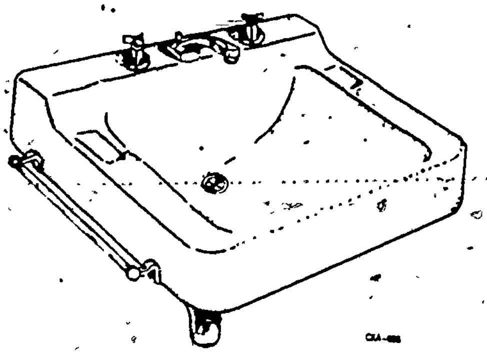
INTRODUCTION

The lavatory is a fixture of common installation. They are manufactured in many styles and colors, and equipped with hot and cold water supply.

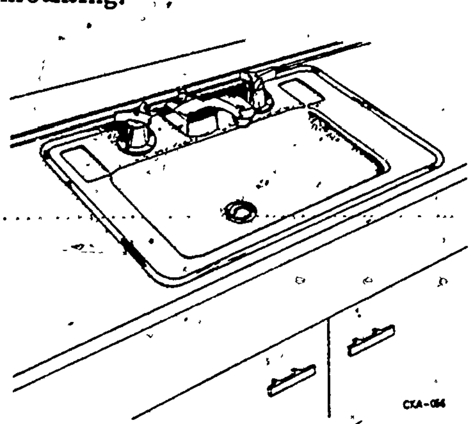
The plumber can increase the efficiency of the fixture by setting it at a proper height to serve all members of the family. As a general rule, 31 inches from the finished floor is adequate.

TYPES OF LAVATORIES

Lavatories are used for washing the hands and face. They are oblong, circular, square, or oval in shape, and made of vitreous china, porcelain, or steel, enamel cast iron or stainless steel. Figure 32 illustrates two of the most common types, the wall-hung and the flat rim for countertop mounting.



Wall-Hung



Flat Rim

Figure 32. Common Types of Lavatories

Wall-Hung Lavatory

The wall-hung lavatory illustrated in figure 32 is used extensively. Its integral soap receptacle, overflow, and self-back contribute to the convenience of the user and to sanitation as well.

A wall-hung lavatory can also be set in a cabinet to give it a console effect and added storage room to the bathroom, see figure 33.

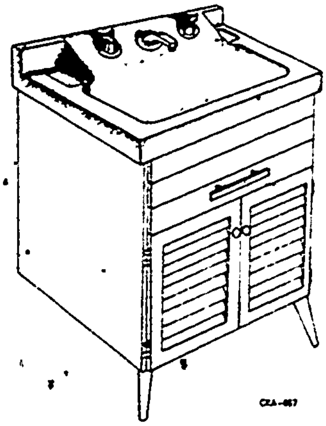


Figure 33. A Wall-Hung Type Lavatory Set In A Cabinet

Flat Rim Lavatories

The most popular trend in lavatories is the built-in or vanity design. This provides more utility top surface as well as an attractive installation. Flat rim lavatories (also called countertop) come in various sizes, shapes and colors. Therefore, it's necessary to refer to the manufacturer's rough-in specifications before you begin any job.

Trough Lavatory

Trough lavatories (figure 34) are used in industrial area washrooms, such as shops, where many people require using a lavatory at the same time. Rough-in measurements are determined by the type (circular or semicircular) that you are installing, therefore, it is desirable to refer to the manufacturer's rough-in specifications before beginning the actual roughing-in.

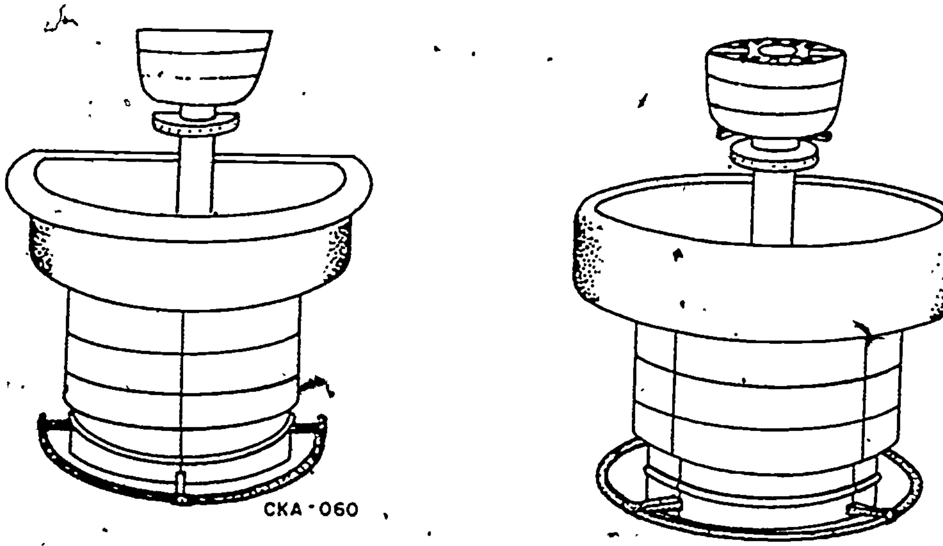


Figure 34. Circular and Semicircular Trough Washfountains

Pedestal Lavatory

Pedestal lavatories (figure 35) may be bolted or cemented to the floor or they may be held in place by drainage piping which passes through the floor instead of the walls. This type of lavatory is not in common use in the Air Force but some may be found in barber shops or beauty shops. Pedestal lavatories are being replaced by wall-hung or countertop lavatories as modifications are made to the facilities.

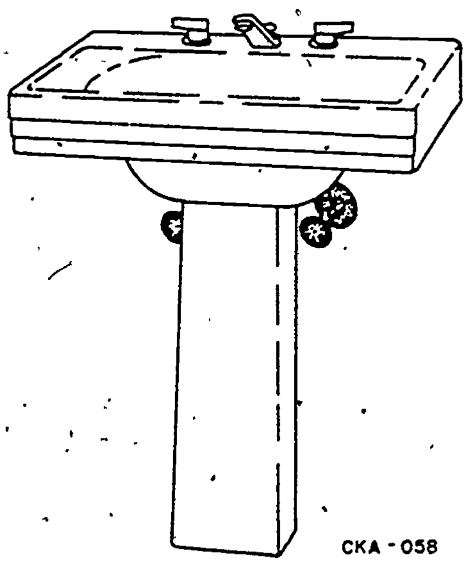


Figure 35. Pedestal Lavatory

Manufacturer's Roughing-In Catalogs

From manufacturer's rough-in specification sheets you can secure the rough-in measurements for the fixtures which are specified for the job. Figure 36 illustrates the rough-in measurements for a lavatory. These measurements are difficult to indicate on your working drawing, but you must know them when determining a total bill of material for the pipe and fittings.

VITEROUS CHINA LAVATORY

NOM SIZE	L	W	O	C	A	N
20 X 18"	20"	18"	7 1/2"	2 [illegible]"	6"	3 1/2"
24 X 20"	24"	20"	8"	3 [illegible]"	7"	4"

PLUMBERS NOTE - PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS. THESE ROUGHING MEASURE- MAY VARY 1/4" (PLUS OR MINUS) AND ARE FOR THIS JOB ONLY.

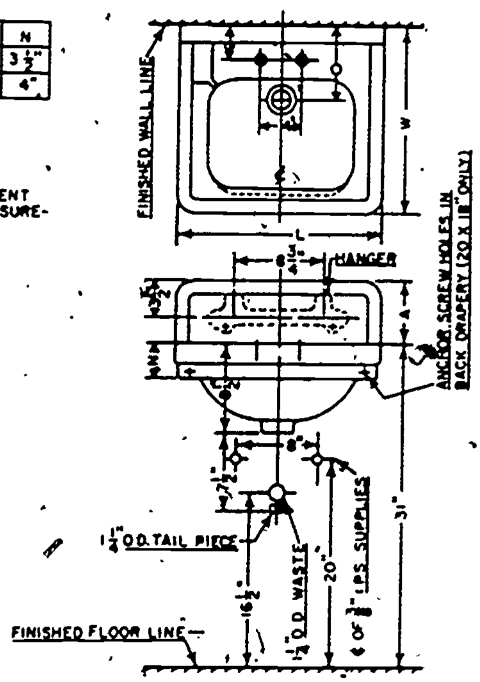


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Figure 36. Manufacturer's Rough-In Specification

INSTALLATION PROCEDURES

Wall-hung fixtures are secured to the wall by means of special hangers. The hangers are screwed to a 2" X 6" board nailed securely between two studs at a height recommended by the manufacturer. The mounting board is normally installed when the waste outlet and water supply lines are roughed in.

The hanger must be level, and if there are no manufacturer's specifications available, the hanger is installed so that the lavatory will be 31 inches above the finished floor. If possible, it should be centered over the waste outlet. A typical installation is shown in figure 37.

The flat rim lavatory is normally installed in the top of a cabinet by a carpenter because it demands close tolerances and special manufactured fittings for the type of covering that goes on the cabinet.

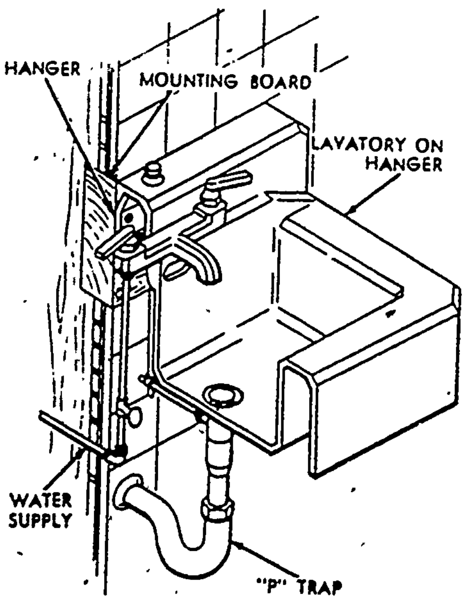

Figure 37. Lavatory Installation

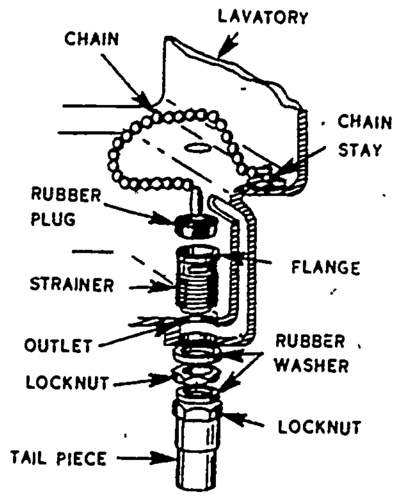

Figure 38. PO Type Plug Drain

There are two types of drains commonly used in lavatories: the chain and stopper (pull out) and the mechanical type sometimes called the popup type. When installing the drain, a ring of soft putty is placed around the flange and the flange inserted into the waste hole into the basin as shown in figure 38. The flange locknut is screwed up against a rubber washer on the threaded pipe of the flange from underneath the lavatory.

The tailpiece locknut and the tailpiece of the necessary length are then screwed on the projecting threaded pipe.

This type of plug drain is used in most cases with single hot- and cold-water faucets.

When a combination faucet is used, it usually has a built-in mechanical drain that must be installed. Figure 39 shows in detail the combination lavatory faucet with a popup drain.

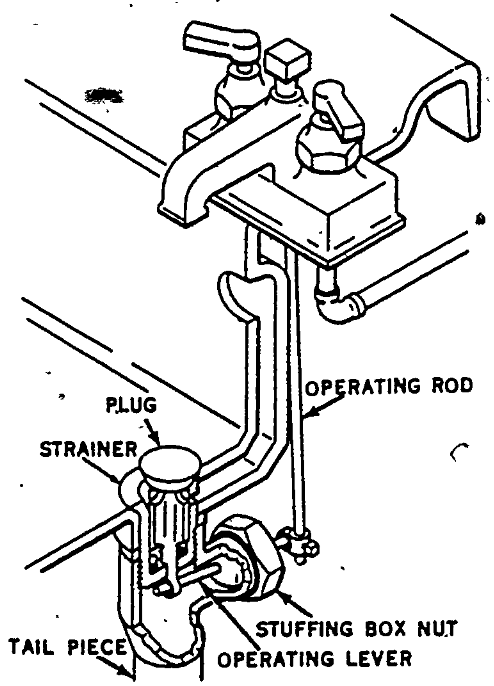

Figure 39. Combination Lavatory Faucet With Popup Drain

The size of the waste line and trap is 1 1/4 inches. All exposed waste and water lines are chrome-plated.

When making up joints a strap wrench, as shown in figure 40, should be used to prevent marring chrome-plated piping. The strap wrench has a tendency to slip and may cause damage to the equipment or injury to the plumber using it. Coat the inside of the strap with resin and use it with extreme caution.

Hot and cold water faucets are installed in holes provided in the top of the fixture. Faucets may be of the individual type shown in figure 41, or the mixing type inter-connected into one common outlet as shown in figure 39.

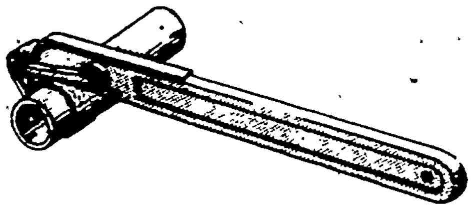

Figure 40. Strap Wrench

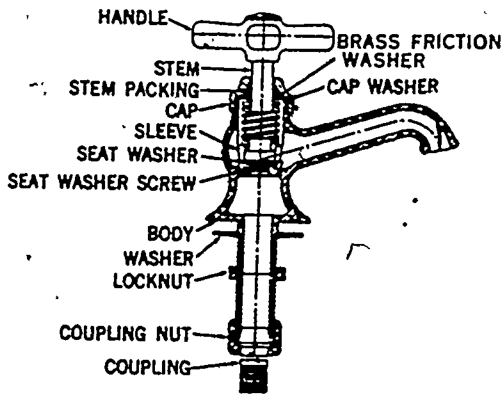

Figure 41. Compression Faucet

The mixing-type faucets may be equipped with an aerator. The aerator gives a stream of revitalized water by mixing air with the water. Aerated water tastes better, washes faster, and rinses better. Millions of bubbles swell the stream, increasing the velocity and at the same time prevents splashing, see figure 42.

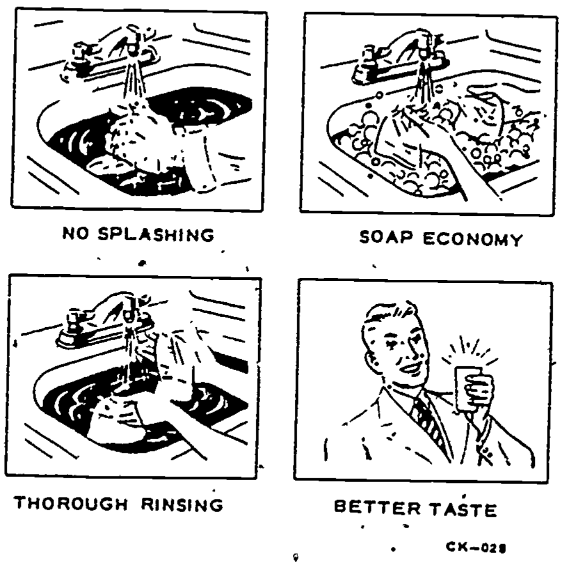

Figure 42. An Aerator in Operation

Faucets are sealed into the rim of the lavatory with a rubber gasket or plumber's putty and held tight by a hex jam nut attached from beneath the fixture. The nut cannot be reached with an ordinary wrench. A special wrench, called a basin wrench, is used, see figure 43. The basin wrench is a right-angle pipe wrench mounted on an extension bar which extends the handle below the bottom of the lavatory bowl.

The faucets are connected last. The hot water is always on the left and cold water on the right. Faucets are connected to the roughed-in supply lines (risers) with a jiffy connector. Three types are shown in figure 44.

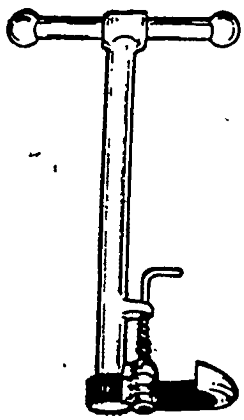

Figure 43. Basin Wrench

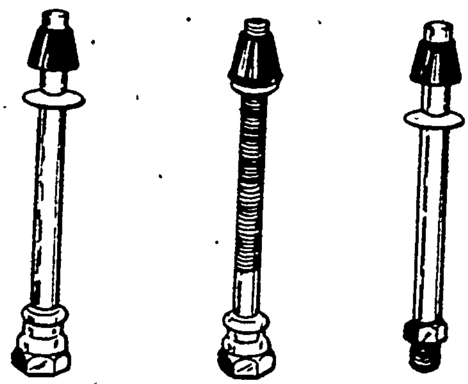

Figure 44. Jiffy-Type Connection

The connectors are chrome-plated copper or brass, and have a tapered washer. The washer is inserted into the faucet shank and held in place with a friction ring and a coupling nut. The friction ring must line up with the bottom of the faucet to start the coupling nut and to prevent stripping the threads. The friction ring protects the tapered washer as the coupling nut is tightened.

It may be necessary to bend the connector to make the correct alignment with the nipple extending through the wall from the supply riser. If the connector is made of chrome-plated brass, it will be more rigid and will require the use of a tubing bender similar to the one used in bending rigid copper tubing.

After all connections are made, the water pressure can be turned on to check for leaks. If leaks are found, turn the water off and repair them.

SUMMARY

Lavatories are classified as two general types, wall-hung and flat rim. Wall-hung lavatories are supported by a bracket attached to a mounting board in the wall. The overflow rim of a wall-hung lavatory is usually 31 inches above the finished floor unless otherwise specified by the manufacturer. The flat rim type is usually installed in a cabinet top. The lavatory must be mounted so that the tailpiece and P-trap will align with the roughed-in waste outlet. The size of the waste line of the lavatory is usually 1 1/4 inches. A strap wrench is used to prevent marring chrome pipe. Most Air Force lavatory installations have a PO plug or a popup type drain. The basin wrench is used to fasten faucets to the lavatory. Jiffy connectors are used to attach cold and hot lines to the faucets.

QUESTIONS

1. What type of connections is used to connect the hot and cold water lines to the lavatory faucets?

2. What is the purpose of a basin wrench?

3. How are faucets sealed into the rim of the lavatory?

4. What is the difference between a PO drain and a popup drain?

5. Why is a strap wrench used on the P-trap?

6. What is a mounting board and what is its purpose?

7. What are the two most common types of lavatories?

8. What size drain is used on lavatories?

9. Where would you use a strap wrench?

10. What is the function of an aerator?

REFERENCES

1. AFM 85-20, Plumbing

2. National Plumbing Code

INSULATION OF WATER LINES

OBJECTIVE

The purpose of this study guide is to acquaint you with the insulating materials used in connection with plumbing and to learn the insulating procedures used in insulating piping against heat loss, sweating, and freezing.

INTRODUCTION

Benefits derived from the use of insulation go back thousands of years to when primitive man in tropical areas stripped bark from cork trees to use for the roof of his crude hut. We can surmise that primitive people observed that cork trees withstood the severe tropical heat and concluded that the bark would make excellent protection from the rays of the sun.

Most people know the function of insulation as applied to electrical wiring. The layman knows that insulation of electrical wire is used to keep the current within the wire and prevent it from contacting other objects. He also knows that refrigerators must be insulated to obtain a satisfactory operating efficiency.

So we can say that insulation of plumbing, piping, and heating systems will be presented under the following main headings:

- PURPOSE OF INSULATION
- INSULATION MATERIALS
- INSULATING PIPING

PURPOSE OF INSULATION

In many localities, humidity causes condensation to drip off cold water pipes. The beads of moisture collect and drop off the pipe, causing property damage and other inconveniences. Water that is stationary inside a pipe or container will warm up to room temperature. When it does condensation will not form on the outside of the pipe or container. However, if cold water continues to pass through a pipe, considerable condensation will form. When this occurs between walls and floors, considerable damage may result to wallpaper and plaster as well as to structural members, such as sills and studs, which may deteriorate when wetted continually.

Condensation on cold water pipes may be prevented by covering them with an antidrip or waterproof insulation which is available in many forms. The pipes may be wrapped with thick tape containing ground cork or coated with a thick plastic paint that contains cork granules. Tubular coverings, made of air-cell asbestos or mineral wool and provided with a waterproof inner liner, may be placed around the pipe.

Insulation will prevent freezing of the liquid in a pipe due to excessive low surrounding temperature, especially when lines are run outside of buildings, or in buildings without heat.

Due to the many needs of insulation, the plumber will find several types of insulating materials on the market today.

INSULATING MATERIAL

Rigid Preformed

The rigid preformed sections are to be used on pipe runs, and for protection of other objects that they are designed to fit. Some of the rigid types on the market today are fiberglass, magnesia, cork, flexible rubber, antisweat frostproof, wool felt, sponge felt paper and air cell.

FIBERGLASS. Fiberglass pipe insulation is composed of very fine glass fibers, bound and formed together by an inactive resin type mixture. It is molded into a flexible hollow cylinder, and slit along its length to permit application of pipes or tubing. It is also shaped to fit small boilers and hot water heaters. It is furnished in three-foot lengths with or without jackets. The insulation comes in thicknesses from one-half to two inches and will accommodate pipes from one-half inch to 30 inches. Fiberglass insulation has a long life; it will not shrink, swell, rot, or burn. It is easily applied, lightweight, space saving, and has excellent insulating qualities, see figure 45.

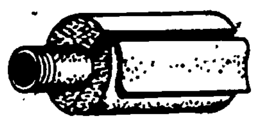

Figure 45. Fiberglass Insulation

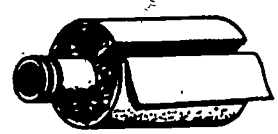

Figure 46. 85 percent Magnesia With 15 percent Asbestos Insulation

MAGNESIA. Magnesia insulation is composed of approximately 85 percent pure carbonate of magnesia, 15 percent asbestos fiber. Under the process of heat, the magnesium carbonate is transformed into tan expended light bonded material. This process permits the maximum strength, uniformity, and light weight which makes it the best insulation material.

Magnesia insulation is excellent material for high temperature (350°F) and high pressure steamlines. It is covered in a canvas jacket and accommodates piping up to and including 30 inches in diameter. Its efficiency, if installed on bare metal piping, is approximately 90 percent. This insulation can be furnished with a heavier than standard canvas waterproof jacket if exposed to outside conditions, or underground work, see figure 46.

Magnesia insulation is used in "standard thick," and "double standard thick" material. The standard thick size for 1/2-inch pipe is 7/8-inches thick and the double standard will remain about the same for all piping up to 30 inches in diameter. The double standard thick insulating material is used more extensively on the high temperature lines.

The 85 percent magnesia pipe covering is made in sections three feet in length with cloth for covering the end seams. The insulation is packed in cartons 18 1/8 X 18 X 36 inches and contains from nine to 48 sections.

CORK. Cork pipe covering is a granulated material that is processed from the bark of cork trees. Figure 47 illustrates a piece of cork pipe covering. This pure, clean, granulated cork is compressed and molded to exact size and shape. It is finished with a coating of plastic asphalt. which is an ideal covering for cold water, brine, ammonia, and ice water lines. It has excellent insulating qualities over a wide low temperature range. It will not rot or support combustion. It is clean, sanitary and odor free. Cork covering is available in a wide variety of sizes and shapes that can be used on different size pipes and fittings.

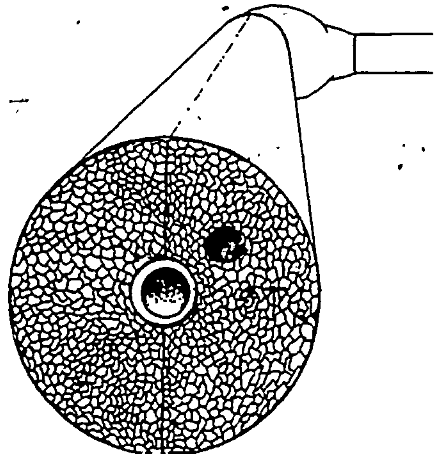

Figure 47. Moulded Cork Pipe Covering

FLEX RUBBER. Flex rubber is a tough flexable rubber material, constructed of millions of uniform closed cells. It is a man-made rubber that has good insulating qualities, water resistant, good cementing qualities, excellent weather aging qualities, flame resistant and excellent for prevention of sweating of cold water lines. It is an ideal material for covering tubing used in refrigeration and cold water lines used in homes as well as industrial plants and commercial buildings. This rubber insulation material comes in random lengths and its wall thickness size is 3/8 to 3/4 inch. It is made to fit pipe sizes up to 4 inches (see figure 48).

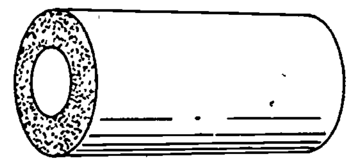

Figure 48. Flex Rubber Insulation

ANTISWEAT. Antisweat insulation (see figure 49) is designed for use on cold water pipes. It keeps the water colder in the pipes than most types of insulation and, if properly installed, prevents condensation or sweating of the pipes. The outstanding feature of antisweat insulation is its construction. It is composed of an inner layer of asphalt-saturated asbestos paper, a 1/2-inch layer of wool felt, two layers of asphalt-saturated asbestos felt, another 1/2-inch layer of pure wool felt, and an outer layer of deadening felts combined with asphalt-saturated felts. The outer layer has a flap about 3-inches long extending beyond the joint to help make a perfect seal. A canvas jacket is placed around each three-foot length to protect the outer felt covering.

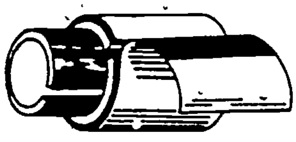

Figure 49. Antisweat Insulation

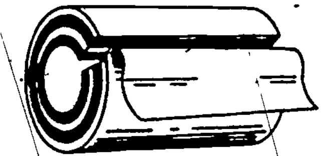

Figure 50. Frostproof Insulation

FROSTPROOF. Frostproof insulation, (see figure 50), is manufactured to be used on cold water service lines that pass through unheated areas and those exposed to outside weather conditions. Frostproof insulation is generally constructed with five layers of felt, These layers include three of pure wool felt and two of asphalt saturated asbestos felts. Frostproof insulation comes in three-foot lengths and is 1 1/4 inches thick with a canvas cover.

WOOL FELT. Wool felt is made of matted fibers of wool, or wool and fur or hair, worked into a compact material by pressure rolling. It is used on cold water service and hot water return lines. Wool felt preformed pipe covering is manufactured in thicknesses of 1/2 to 1 inch with a canvas jacket (see figure 51). It is manufactured in three-foot lengths to accommodate straight runs of piping.

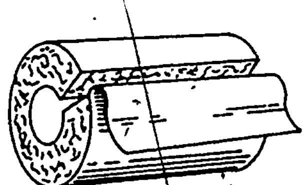

Figure 51. Wool Felt Pipe Covering

SPONGE FELT PAPER. Sponge felt paper is composed of asbestos paper with a maximum amount of sponge evenly distributed within it, as shown in figure 52. It has approximately 37 to 43 laminations to the inch, and is uniformly round, rigid, and closely constructed. Sponge felt paper is manufactured to fit most pipe sizes. It comes in three-foot lengths and from one to three inches in thickness. Sponge felt paper can be purchased in blocks of straight and preformed shapes to be used on valves and fittings.

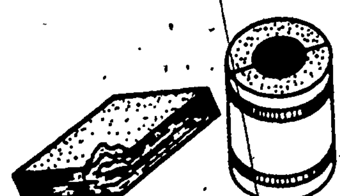

Figure 52. Sponge Felt Paper Insulation

AIR CELL. Air cell pipe covering is made of fine quality asbestos paper. The covering is generally used to cover low pressure steam and vapor lines. Air cell insulation is formed by layers of plain asbestos felt that is alternated with corrugated asbestos felt, with each lamination or ply approximately 1/4 inch thick. Air cell insulation is furnished in three-foot lengths unless otherwise specified and is covered with a canvas jacket (as shown in figure 53).

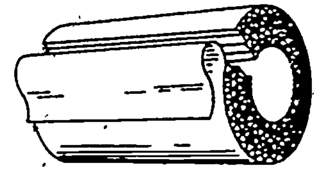

Figure 53. Air Cell Insulation

Blanket Type

The blanket-type insulation is manufactured in strips, sheets, and blocks. It is used to wrap around objects that are irregular in shape and for large flat areas. It is used to insulate against heat loss and fire. This type insulation is used on boilers, furnaces, tanks, drums, driers, ovens, flanges, and valves. It comes in asbestos paper rolls, asbestos cardboard sheets, wool, and hair felt rolls, asbestos cement blocks, air-cell rolls, aluminum foil rolls, irregular preformed covering, and asbestos powder.

The blanket insulation comes in different widths and thicknesses depending on the type of equipment to be insulated. It is vermin, rodent, and acid resistant, and fireproof. The asbestos type will stand more heat than the other types; therefore, you should use it on equipment that contains high temperature and where protection is required against open flame.

INSULATING PIPING

Pipe coverings illustrated in figures 51 and 53 indicate some of the types of covering available to the plumber today. These coverings are quickly and easily installed because each section is split in half and has a canvas cover with flap for quick sealing. Joint collars are furnished to cover joint seams on insulation exposed to outside conditions.

Cheesecloth is used on some types of insulation instead of canvas. If this type is installed, a wheat paste is used to hold the cheesecloth in place. Enough cheesecloth extends over the end of each preformed, three-foot section to cover the joints. If the cheesecloth is properly smoothed after the wheat paste has been applied, it makes a good uniform installation. After the insulation has been properly installed, metal bands are used to hold the insulation firmly in place. These metal bands should not be less than 3/4-inch wide and should be spaced not more than 18 inches apart, see figure 54. Where the insulation needs to be kept clean, it may be necessary to paint with a special type enamel paint. This glossy type finish can then be kept free of dust, water, and oil.

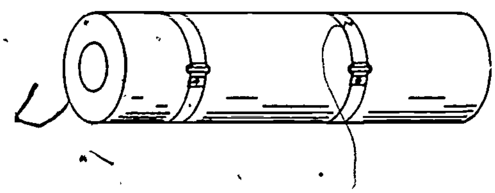

Figure 54. Pipe Insulation Showing Metal Straps

Installing Covering on Valves and Fittings

Valves and fittings can be covered with magnesia cement or mineral wool cement of the same thickness as the pipe covering. These materials are molded into shape to conform with the rest of the insulation. If magnesia or mineral wool cement insulation is used, the insulation is covered with cheesecloth to help hold the insulation in place.

Installing Covering on Boilers and Tanks

Most small boilers, such as hot water heaters for domestic use, are covered with insulation by the manufacturers. On the other hand, if the boiler or tank is to be installed by the plumber, he will need to know something about installing covering so as to retain heat and prevent fire.

Insulation may be either block or blanket type and must be securely wired in place in an approved manner. Insulation applied to the outside of a boiler or storage tank should be applied over 1 1/2-inch wire mesh, held away from the metal surface by metal spacers providing airspace of not less than one inch. When blanket or block type material is used, the joints in the insulation should be filled with magnesia, mineral wool, or other equally suitable cement. The surface of the insulation should be covered with a 3/4-inch thickness of hard-finishing cement, trowelled smooth and even, and reinforced with 1 1/2-inch wire mesh held approximately 1/4 inch away from the surface of the insulation.

Maintenance of Insulation

Very little maintenance is required on insulation if it is properly installed. Insulation exposed to weather and subject to being damaged by sharp objects will require frequent inspections and some maintenance. If canvas covering gets torn or punctured, it should be patched with another piece of canvas. The paste for installing a patch on insulation that is used on the inside of buildings should be different than the kind used on insulation exposed to outside conditions.

Where a leak is detected in a piping system covered with insulation, it requires a major repair. The insulation must be removed back far enough to install a union and a short length of pipe. Then the pipe and union can be insulated, using the same type of insulation as on the rest of the piping system. Sometimes it is not permissible to install a short length of pipe, therefore, remove the insulation and pipe back to the first joint, then replace the piping and reinsulate with the same type of insulation.

Loose straps or loose material around valves and fittings may be found during the inspection. The straps should be retightened and the loose insulating material should be replaced or pasted down.

Proper installation of insulation and frequent inspection will minimize maintenance problems and prolong the service life of the system.

A sharp tool must be used to cut insulation material covered in this text.

When applying insulation, some type of ladder or scaffold will be needed to reach the higher parts of the piping system. Care should be taken to prevent falls. Sharp tools will be needed to do the job and safety in handling them should be practiced.

SUMMARY

Insulation is manufactured in two general types: (1) rigid preformed sections, and (2) blanket covering. Some of the most common rigid types of insulation are fiberglass, 85 percent magnesia with 15 percent asbestos. The rigid insulation is used more extensively on pipe runs and protection of other objects they are designed to fit. The blanket type is used as an undercovering on boilers, furnaces, tanks, drums, driers, ovens, flanges, and valves.

Insulation most generally consists of some material or a combination of materials. The materials are formed into different shapes and thicknesses to be used in different places to serve a particular purpose. The type of insulation to be installed on piping will be determined by the contents of the piping. For example, if a high pressure steamline is to be insulated the plumber probably would use 85 percent magnesia insulation.

Piping insulation is installed by opening the material lengthwise and then placing the two halves around the pipe. The canvas and cheesecloth covering on the insulation is sealed with a mineral wool or magnesia cement. Metal straps 3/4-inch wide are placed around the insulation up to 18 inches apart to hold it firmly in place.

Some types of insulation must be molded around the valves and fittings and held firmly in place by a cement and canvas or cheesecloth covering. Other types of insulation are already premolded and can be readily installed.

Small boilers and tanks that are not insulated must be covered with insulation to hold heat and to minimize the danger of fires. Insulation may be either block or blanket type with a final covering of 3/4 inch of hard finishing cement.

Some of the causes of damage to insulation are exposure to weather, sharp objects that puncture the insulation, and piping leaks. A minor damage can be repaired by cementing a canvas or cheesecloth patch over the damaged surface. A major repair such as a pipe leak, will require removing the old insulation, repairing the pipe and replacing the same type of insulation. All these maintenance problems can be minimized by properly installing the piping and pulling frequent inspections.

QUESTIONS

1. Give several reasons for using piping insulation.

2. What are the two general types of insulation?

3. What type of material is used in the two general types?

4. What is the maximum length of preformed cellular pipe covering?

5. What size metal bands are used to hold insulation in place? How far are they placed apart?

6. What procedure is used to insulate irregular shaped items such as valves and fittings?

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7. What maintenance requirements are required on insulation?

8. How do you repair a water leak if the pipe has been covered by insulation?

9. Name two types of material that are used as an outer covering on insulation.

10. Name the type of blanket insulation that will withstand the most heat.

REFERENCE

AFM 85-20, Plumbing

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INSPECTION AND MAINTENANCE OF PLUMBING SYSTEMS

OBJECTIVE

The purpose of this study guide is to introduce you to plumbing system trouble-shooting techniques and maintenance procedures.

INTRODUCTION

The Air Force plumber is more often engaged in maintenance or repair then actual systems construction. Faucets leak, pipes corrode and burst, and drains clog. A plumber is usually called to perform maintenance and repair after trouble has developed. He must not only eliminate the trouble, but must also diagnose the cause and correct it.

This study guide will deal with some of the troubles you may encounter and the repair procedures.

For the purpose of presentation, this study guide will include subjects under the following headings:

- INSPECTION AND MAINTENANCE OF EXTERIOR WATER SYSTEMS
- INSPECTION AND MAINTENANCE OF INTERIOR WATER SYSTEMS

The building custodian complains of low water pressure. A plumber is sent to determine the cause and, if possible, correct the discrepancy. There are many factors which may cause low water pressure.

INSPECTION AND MAINTENANCE OF EXTERIOR WATER SYSTEMS

Water Demand and Availability

Water systems are constructed to deliver the maximum amount of water under pressure to the using areas. The pressure and volume in the mains is often reduced when all service areas are using a maximum amount of water at the same time.

A low reservoir or malfunctioning water processing equipment may also cause low water pressure in the system.

In either case, this is beyond the plumbers capability to correct.

Pipe Sizing

Determining the pipe sizing in a water main is an engineering function. Pipe sizing is directly related to use demand and water availability described in the previous paragraphs. Systems design is also a contributing factor.

System Design

Pressure and flow rates are greater near the water source. Pressure and volume will decrease as the distance from the source increases.

Pressure and flow rate also decrease if the outlet is near the same level as the source. When the outlet is above the level of the source then water weight will begin to work against the pressure trying to push it up. Hills provide a good example of elevations over which water mains are laid. Multistory buildings such as hospitals, may have lower pressure and flow rate on the top floor then on the basement. Booster pumps are often used to overcome this type pressure and rate loss.

Friction Loss

When a liquid flows smoothly through a pipe, particles of the liquid stick to the pipe wall. Other particles moving past are slowed by the motionless particles. The stream of water in a pipe can be pictured as having a series of layers moving at different speeds, with the center moving fastest, see figure 55. The resistance to flow caused by the particles in these layers is called pipe friction. Pipe friction causes a drop in the pressure of the water flow through the pipe. In a small pipe, this friction loss may be overcome by supplying water at a higher pressure than otherwise would be required. In a location where higher water pressure is not available, friction loss may be reduced by increasing the size of the pipe.

Friction loss is compounded when obstructions such as unreamed pipe or excessive mortar or lead is left in the pipe during construction.

Excessive directional changes also contribute to friction loss. This is why plumbing systems are designed with the least number of directional changes as possible.

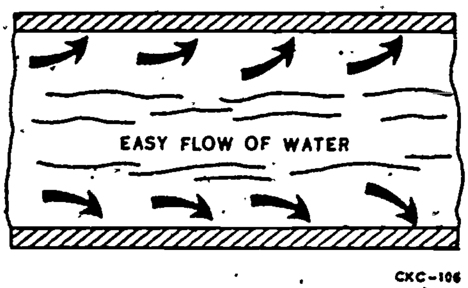


Figure 55. Cutaway Showing Flow of Liquids Within Pipes

Restrictions and Punctures

Pressure loss in the water mains can also be attributed to restrictions or leaks.

Valves may be malfunctioning and remain partially closed. Mortar, lead, or oakum protruding into the stream may increase friction loss. Mineral deposits from the water may accumulate on the pipe walls reducing the water carrying capacity of the pipe.

Water pressure is also effected by excessive leakage caused by punctures, ruptures, defective joints, and corroded piping.

Testing System For Pressure and Flow

Periodic testing of the water flow and pressure in the mains is accomplished primarily to insure sufficient water availability for firefighting. Instruments are used to measure velocity pressure being expelled from fire hydrants. The data collected can also be used to determine if a restriction is developing in the line. Periodic inspection may discover the existence of leaks in the line. Data may also indicate requirements for additional mains.

Figures 56 and 57 illustrate two instruments used to measure velocity pressure of the water mains.

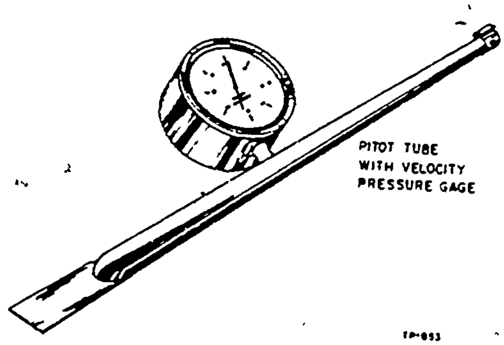


Figure 56. Standard Fire-Flow Testing Equipment

Locating Buried Pipe

If a decrease in water pressure is attributed to a leak then the leak must be repaired. Finding leaks in buried pipe is not always easy. Water will flow in the direction offering the least resistance. For this reason, visual observation is not reliable as a means of determining the location of the leak, see figure 58.

Commercial sound detecting instruments are used as a more reliable method of locating leaks. These instruments may range from simple rod and stethoscope to very complex electronic instruments, see figure 59.

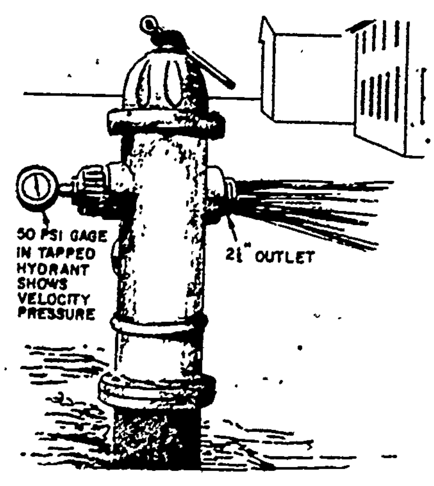


Figure 57. Measuring Velocity Pressure at Hydrant Outlet

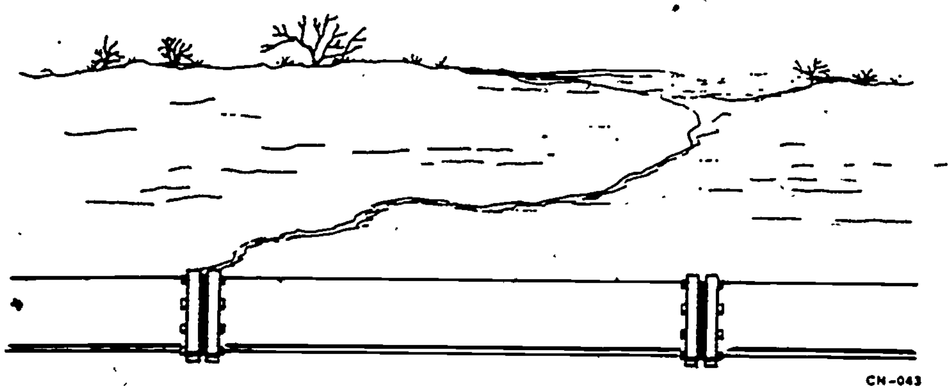


Figure 58. Leak in Water Main

Figure 59. Using Microphone and Prodding Rod to Locate Leaks by Sound

Repairs

The location of leaks are promptly staked or otherwise noted so that repairs can be made promptly.

Inspection, maintenance and repair is not restricted to the piping systems alone. Control valves as well as fire hydrants and pumps are inspected for operation. Malfunctions and discrepancies including leaks are noted and corrected.

INSPECTION AND MAINTENANCE OF INTERIOR WATER SYSTEMS

Testing Systems

Regardless of whether the plumbing system carries drinking water, waste, gas, air, oil, or other liquids, a leakproof system is required.

The same testing rule applies to both new and repaired systems. Various methods may be used. Water, air, soap, and water solutions are the more common agents used in performing leak tests.

Water Tests

Once a water system is installed all openings are capped or plugged. Loosen some or all caps to let the air escape out of the lines. All openings are then closed. Normal system water pressure is allowed to build up. All joints are then visually inspected for water seepage. To avoid confusion between condensation and leaks, joints should be wiped dry and observed for a few minutes.

Air Test

The air test may be applied to the water system as well as gas and air systems. All openings are closed tight and a gage installed in the system. Air pressure, several times higher than normal pressure, is applied. The gage is read and the result compared with another reading ten minutes later. A pressure loss indicates a leak.

Once leaks have been discovered appropriate action must be taken to correct the leaks.

Inspection of Established Systems

Periodic inspections are made to determine the condition of piping systems. Valves are operated and their condition noted. Leaking valves are common and require repair.

Leaking joints and pipe are not too common. However, pipe deterioration, friction, excessive stress, vibrations, freezing, and pressure surges contribute to failure of pipe fitting and joints.

Water Hammer

Repeated pressure surges, sudden increases in water pressure, have been known to do extensive damage to piping, fittings, and valves.

Damage by water hammer may be reduced or eliminated by installing an air chamber near the valve, see figure 60.

Vibrations, Thermal Expansion, and Contraction

Damage from vibrations is generally associated with buried pipe near or under a road. A flexible connection, such as a gooseneck, is designed to absorb such vibrations.

Thermal contraction and expansion results in damage to pipe and joints. Expansion joints are designed to eliminate damage due to temperature changes. The expansion loop and swing joint, figure 61, are also designed to reduce damage from surges.

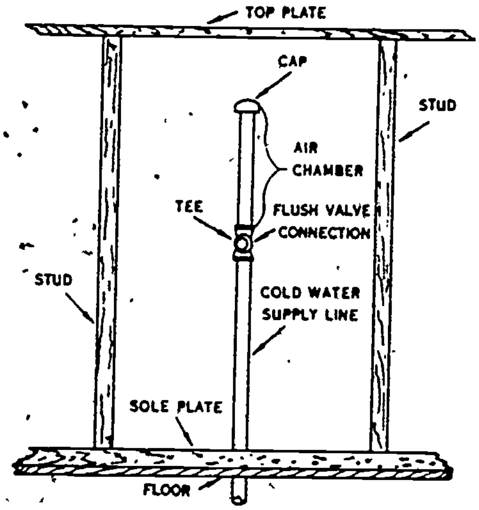


Figure 60. Cold Water Line With Air Chamber

Vibration, Thermal Expansion and Contraction

Thermal contraction, expansion, and vibration often result in damage to pipe and joints. Flexible connections, such as goosenecks, expansion loops, swing joints and expansion joints are designed to absorb such vibrations.

Expansion joint - an expansion joint is basically two tubes, one telescoping inside the other. The outer tube is firmly anchored to the structure or piping and the inner tube is allowed to move with a piston-like action as the attached pipe expands, contracts or vibrates. See figure 62.

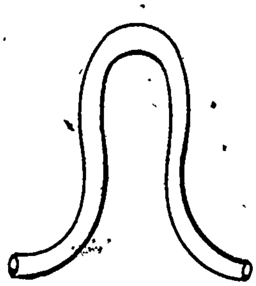


Figure 61. Expansion Loops

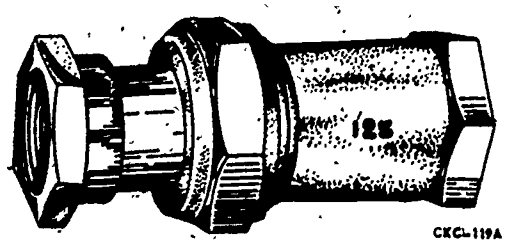


Figure 62. Expansion Fitting

Expansion loops are installed in cooper tubing water supply systems to allow for vibration, expansion and contraction. When expansion loops are installed care should be exercised to insure that the loop is below the frostline (figure 61).

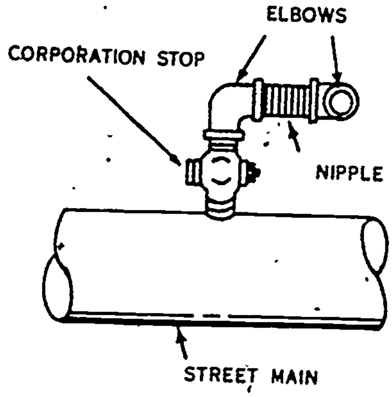


Figure 63. Typical Swing Joint

Swing joint - the swing joint is another type of flexible connector that is commonly used with a galvanized iron or steel service line. A swing joint consists of two elbows separated by a short section of pipe (figure 63).

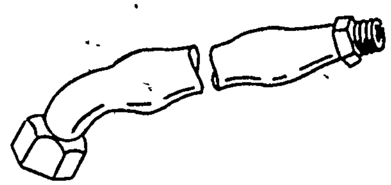


Figure 64. Flexible Gooseneck

Flexible goosenecks are available for use when galvanized iron or steel pipe is used for the supply line. The connector consists of a length of lead or copper pipe which has fittings wiped or soldered on each end for connecting to the corporation stop and supply piping (figure 64).

Expansion loops, swing joints and goosenecks are installed between the corporation stop and the supply piping to the curb stop, where as an expansion joint is installed within the building distribution system.

Repair of Established Systems

PIPING. Stopping leaks in piping and fittings may be a relatively simple operation. Items such as union, hose bibb faucets, and caps require a simple tightening or resoldering of the connection. More drastic measures are required if tightening the joint doesn't solve the problem. Figure 65 illustrates extensive damage that will require complete replacement.

Leaks developing along a pipeline or at the fittings are not so simple to repair. Such leaks often require replacement of the fittings or pipe segment. Soldered joints pose no problem. Threaded joints, on the other hand can be a difficult problem.

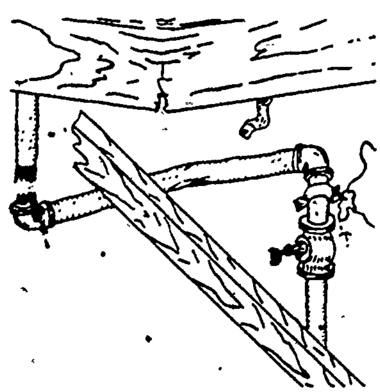


Figure 65. Defective Pipe and Fittings

Tightening the pipe to repair a leak at a fitting on one end will put a twisting force on the pipe which will loosen the joint connection on the other end, see figure 66.

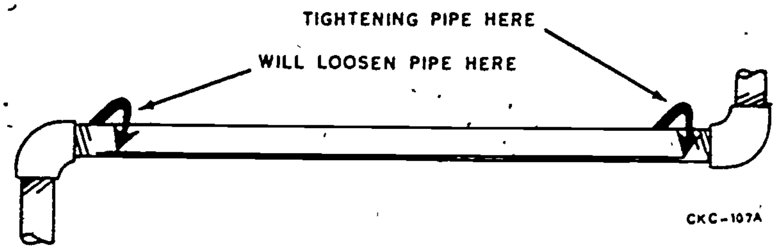


Figure 66

Problems such as these require the pipe to be cut and threaded. The defective fitting can then be replaced. A nipple is cut, threaded and installed in this fitting. A union is installed on the nipple and pipe end. When the union is connected the pipe becomes one long segment again, see figure 67. The same technique is used to replace leaking and defective pipe sections and valves. The impractical alternative is to dismantle the entire system to the point of repair.

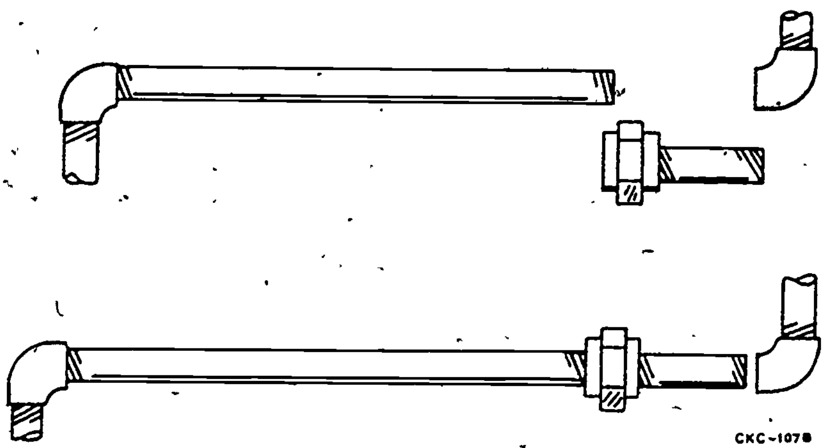


Figure 67

VALVES. Leaking valves and faucets are not only irritating but contribute to water waste. Repair may require tightening of a packing nut or replacing internal parts, see figure 68.

Some parts of the valve may be refaced. Removing small nicks from the disc or seat its surface permits the valve to seat evenly.

A refacing tool, figure 69, may be used to repair many types of valves.

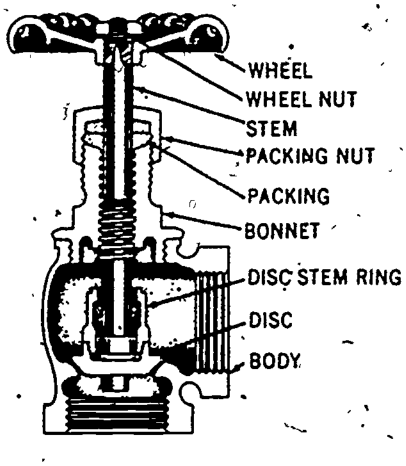


Figure 68

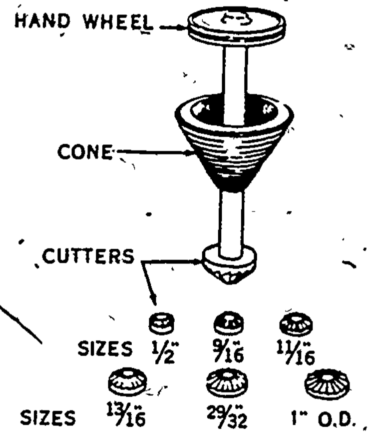


Figure 69. Reseating Tool

Aside from replacing external valve parts, some valves require occasional adjustment. The flush and fill valves of water closet flush tanks and flushometers are examples of such valves, see figure 70 and 71.

Some valves, such as the pressure-controlled and thermostatically-controlled mixing valves, are very complex (figure 72).

Valves are available in so many types and sizes that it is normally economical to replace the entire valve rather than attempt to stock replacement parts needed for repair.

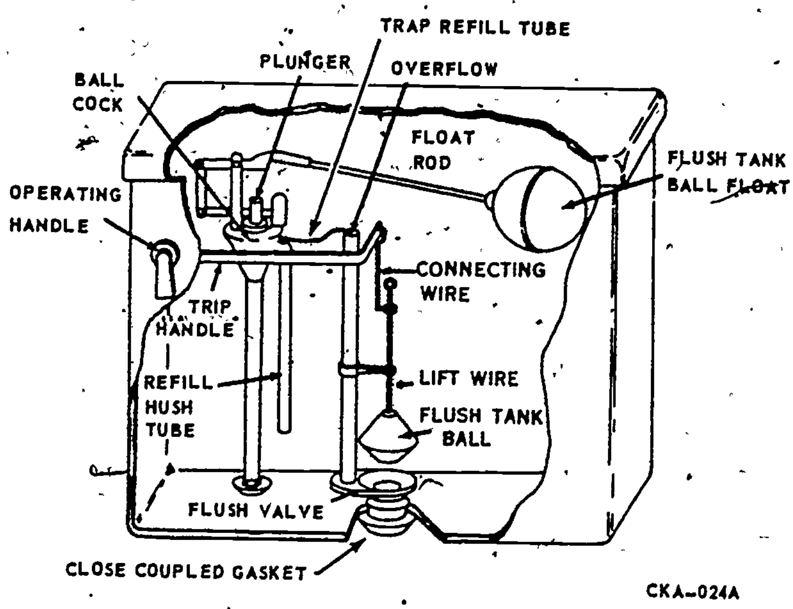


Figure 70. Flush Mechanisms for Tank-Type Water Closets

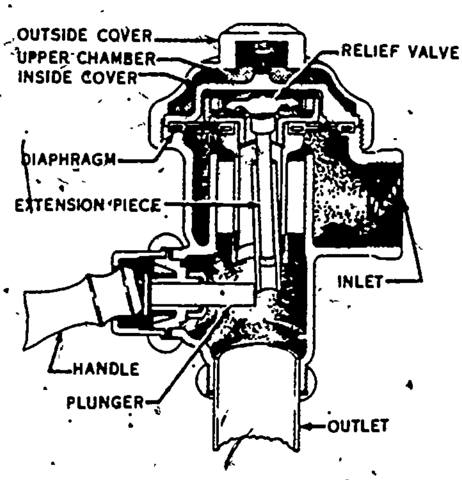
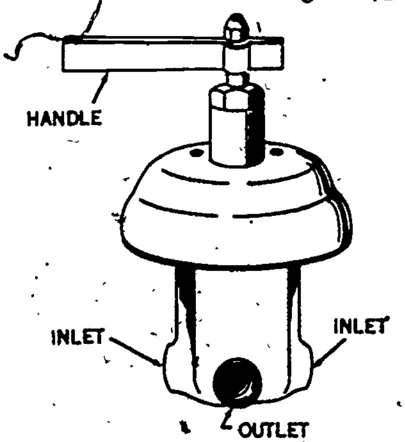
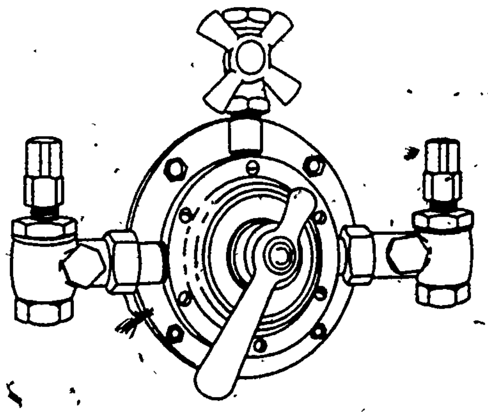


Figure 71. Diaphragm Type Flushometer



Pressure Controlled



Thermostatically Controlled

Figure 72. Mixing Valves

SUMMARY

Factors causing low pressure such as friction loss, obstruction, leaks, elevation, failure of pipe, valves, and pumps, should be considered when troubleshooting both main and service systems.

Some causes of system malfunctions are beyond the capacity of the plumber to correct. Regular inspection of the system often helps in discovering discrepancies. Timely correction of these discrepancies can prevent serious trouble from occurring.

Special techniques are required in locating leaks in buried pipe as well as exposed pipe.

Water or air may be used to test water systems for leaks. This includes new systems as well as established systems.

Testing techniques using air are also applied to pneumatic (air) and gas systems.

Some system failures are unpredictable and must be repaired when they occur.

Repairing leaking pipe systems requires a standard technique varied by the pipe composition and joint method. Timely repair in this instance not only returns satisfactory service but reduces damage to building structural members.

Repairing leaking valves and faucets is the most common corrective action a plumber may take in correcting system malfunctions.

QUESTIONS

1. What is the purpose of performing periodic inspections of plumbing systems?
2. What factors must be considered when troubleshooting a system for low pressure?
3. What is used to remedy low pressure to elevated locations?
4. A pressure velocity check at a fire hydrant is primarily performed for what purpose?
5. What two methods are used to locate leaks in buried pipe?
6. What methods are used to detect leaks in new or repaired systems?
7. What methods are used in locating leaks in air systems?
8. Would a soap and water solution be a satisfactory agent for application to gas piping joints for leak testing?
9. What are some of the causes for leaks developing in pipes, joints, and fittings?
10. How is water hammer reduced or eliminated in water systems?

REFERENCES

1. AFM 85-20, Plumbing
2. National Plumbing Code Workbook
3. AFM -88-8, Chapter 4, New Construction, Plumbing

RECOVERY AND RESTORATION

OBJECTIVE

The purpose of this study guide is to acquaint you with the procedures used in disassembly of water and waste system piping and reclaiming usable materials.

INTRODUCTION

You may be responsible for disassembling water service lines as well as waste lines to save reusable plumbing materials and equipment. It is important that you understand how to disassemble pipe connections without damaging the pipes, fittings, and fixtures. It is also important that you understand how to determine whether pipes, fittings, and fixtures can be reused in another installation. During this course of instruction you have learned to install a complete bathroom with the addition of a urinal. Since pipe and fittings used in plumbing are expensive, it is desirable to reuse as much of the material as possible from a dismantled system. This is especially true in this training course. The system you have worked on is installed and disassembled by more than one class. The amount of damage to the installation will depend upon your knowledge of assembly and disassembly of the system.

DISASSEMBLY PROCEDURES

In the disassembly of a plumbing system, it is important that you shut off the water and drain the piping system. You must do this to keep water from getting in the working area. A wet floor could be hazardous in a number of ways. One big danger is that water will cause hot lead to explode and possibly injure you or others working near. This can happen during disassembly procedures as well as assembly procedures. Therefore, be sure that hot lead is protected from water.

Draining System

Before a water or gas system is disassembled, it must be shut off from the water and gas supply to reduce the pressure. To drain a water supply system, the service valve where the service pipe enters the building should be closed. This service valve usually is equipped with a drain hole through which the water will drain from the building pipes after it is closed against the supply pressure. All the water may be allowed to drain through the drain hole in the valve if quick draining is not required. If quick draining is required, then the service valve should be closed as before and the highest faucet in the system should be opened to admit air into the system, while the lowest faucet should be opened to allow the water to escape from the system. After the water stops draining from the lower faucet, the rest of the water in the system will drain through the drain hole in the service valve.

In some cases, if the highest faucet is not opened, or unless the system is equipped with an automatic vacuum breaker, the closing of the service valve and opening of the lowest faucet is apt to draw water into the supply system. Water may be drawn from the water closets, whose valves are operated by water pressure and from fixtures having faucet openings below the upper edge of the bowl.

To completely drain a water supply system, the closet tanks and water heaters must be drained individually. Closet tanks may be drained by flushing the closet with the water in the tank. The remaining water in the tank below the outlet should be removed with a sponge or cloth. Closet traps may be emptied by forcing the water out of them with a force pump or a plunger cup. The remaining water may be removed with a sponge attached to a wire.

Hot water heaters and similar tanks may be drained only after all the fires are out. These tanks usually have a drain valve or plug at the bottom and an air valve at the top through which air enters the tank while the water flows out of it. If the tank is not equipped with an air valve, loosen part of the piping at the top of the tank to admit the air. To avoid running the drain water on the floor, connect a garden hose to the hot water tank drain valve to carry the water to the outside of the building.

Gaslines are not drained but the shutoff valve at the meter must be closed. After closing the valve, it is a good idea to disassemble the piping at this point and cap the meter outlet line. This precaution is taken just in case someone would turn on the gas while part of the pipes were disassembled. A situation of this kind could cause an explosion.

Serviceable fixtures should be disconnected and removed, then stored where they won't get damaged. Fixtures are a large percentage of the cost of a plumbing system. By saving serviceable fixtures that can be reused, the money saved will add to the salvage of the plumbing system.

Start disassembly of the water supply system after the fixtures are removed at the end of the pipeline and work back, or start at a union and disassemble both ways from the union. Both methods are used on the same system to save time.

Start disassembly of a waste system at the highest point of the system. Examine figure 73 and note where to start the teardown. It is also possible to start at the main soil and waste stack, but this would require breaking a section of the soil stack. When piping is disassembled within a building having finished walls and ceilings, care must be taken not to damage the finished surfaces. Figure 73 illustrates the disassembly of a typical waste piping system.

After the steel pipe for the urinal has been removed, then remove the steel pipe that makes up the lavatory assembly. To facilitate the removal of this pipe, cut the horizontal vent pipe two or more inches away from the 90 degree elbow, see figure 73. This will allow disconnecting the pipe at the threaded joints and will make disassembly of the leaded joints much easier. Up to this point the only tools needed have been a pipe cutter or hacksaw and two pipe wrenches.

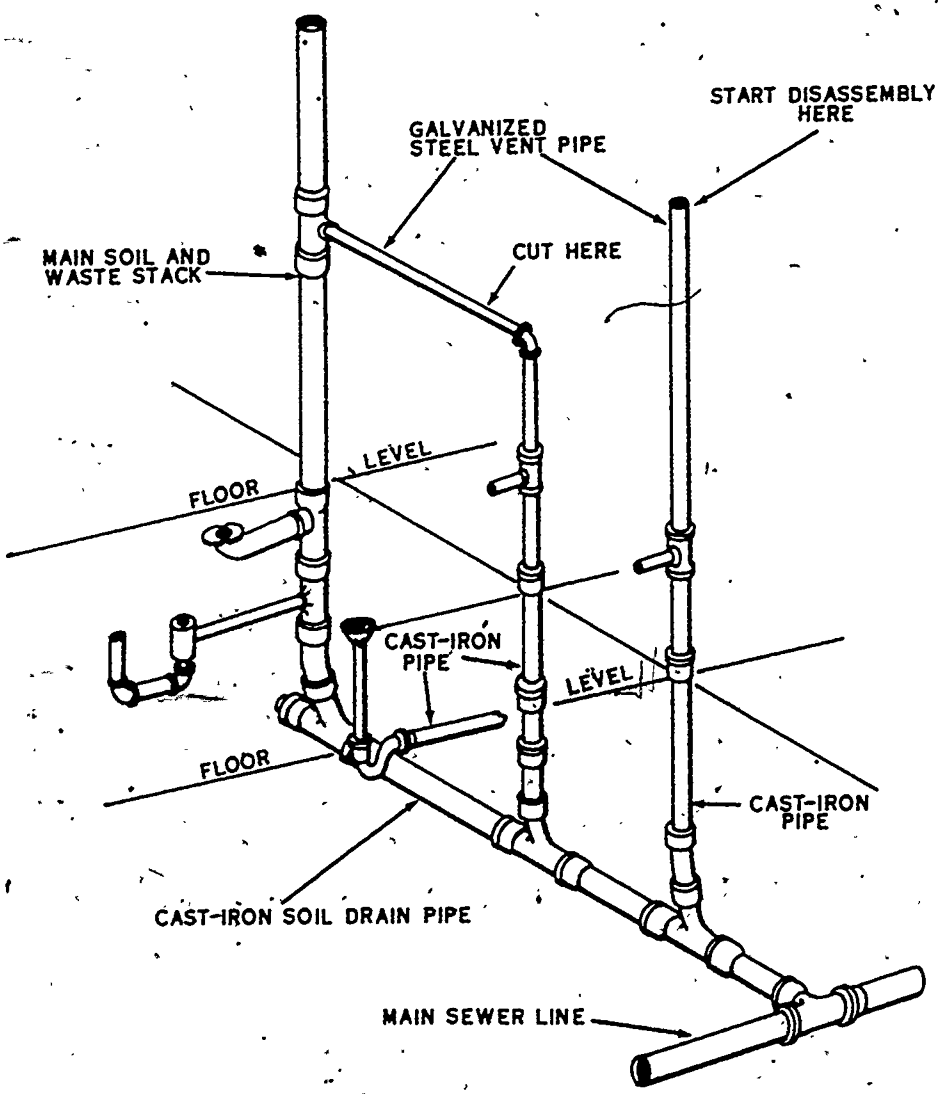


Figure 73. Typical Waste Piping System

Uncaulking Joint

The tools needed for uncaulking a joint depend on the location of the pipe. It may require the use of a lead pickout iron and a ball peen hammer, a sledge hammer, or oxyacetylene torch, and a metal pan to catch the melted lead from the joints. Before disassembly, determine which joint or joints should be separated first, then decide on the size of the sections to be taken out. The sections should not be so large that it is difficult to handle them. Referring to figure 73 again, the joints likely to be separated first might be where the two-inch cast-iron pipe in the lavatory wasteline joins the two-inch sanitary tee. Another point may be where the two-inch cast-iron pipe and 1/8 bend join the urinal wasteline, or at the four-inch cast-iron sanitary tee just below the floor. The final break will be at the connection to the main sewerline.

Where the work is near a wall or other similar construction and there is danger of fire if a torch is used, a lead pickout iron and a ball peen hammer should be used, see figure 74. This method of removing the lead from the joint is very slow and is not used more than necessary.

A sledge or similar heavy hammer is used to break pipe and fittings that you cannot remove by any other method. At times there is no advantage in saving a piece of pipe or fitting, because it would probably take a longer time to remove it, or probably the cost of labor plus the time would not make it worthwhile. But keep in mind if a heavy hammer or sledge is used, care must be taken to prevent injury to those working with or near you. Do not damage any of the surrounding area through careless use of the sledge.

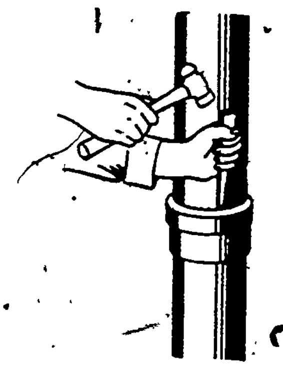


Figure 74. Using Lead Pickout Iron

In most cases, an oxyacetylene torch is used to melt the lead from caulked joints. see figure 75. The torch should be used as little as possible in and under the booth area to minimize the chance of causing a fire. A hand pump water extinguisher must be within easy reach since the water in the building will be shut off.

When taking joints apart in a building with a torch, be sure to provide adequate ventilation. The oxygen will be quickly removed from the room by these flames which could prove harmful to you and others in the building.

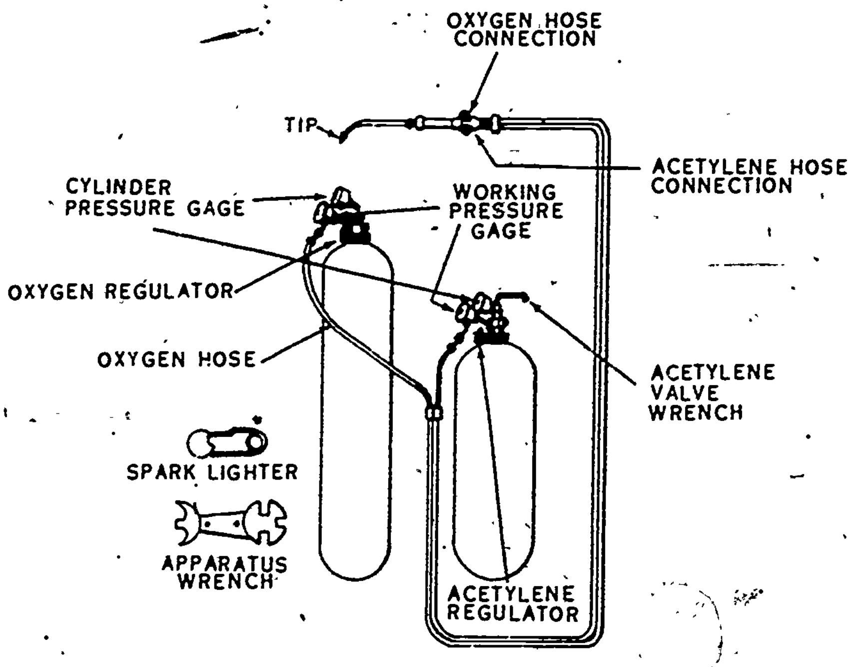


Figure 75. Oxyacetylene Welding Unit

After the drain and vent pipes are removed below the floor level, the hanger irons and tape can be detached from the floor joists and the pipe lowered to the floor. When moving the sections of piping to the outside area, make sure there are enough personnel carrying to prevent excess lifting and possible injury. Those assigned to carrying these sections of pipe must wear gloves to guard against cuts and burns.

Before melting the lead from the joints, have the pipe in a position so that molten lead will run out of the joint. Then place a sheetmetal catch pan under the joint to catch the lead. Later on, it is ladled into small pots to form easy-to-handle ingots for reuse. During this operation, both gloves and goggles must be worn. If you are unfamiliar with the heating torch, have your instructor show you now to light it and adjust the flame for best results. Start melting the lead by applying the flame at the top point of the lead ring and let it wash down to the bottom and into the pan, see figure 76. The hot lead as it washes down over the unmelted lead below greatly assists in melting it. Melt the lead down first on one side then the other. Caution and good judgment must be used while applying the flame from the torch to get best results. It is a very common tendency to crowd the tip of the torch too close to the melting lead and cause the flame to pop and go out. Remember the greatest amount of heat is at the tip of the inner cone of the flame. While using any type of torch, remember confine all attention to the work being done and not something else.

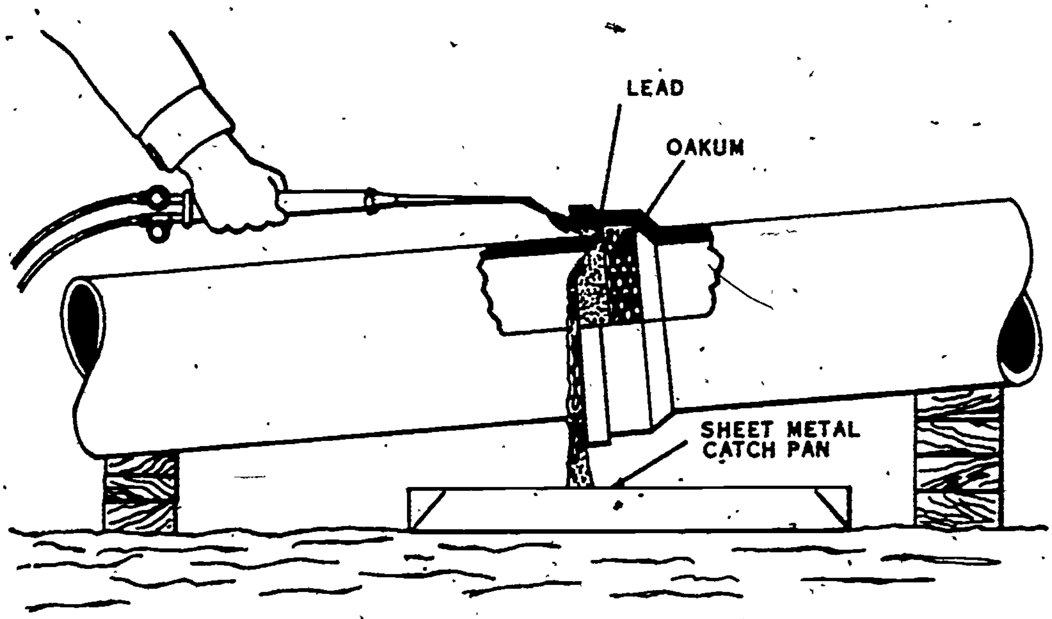


Figure 76 Melting Lead From Joint Using Oxyacetylene Torch

Removing Galvanized Pipes and Fittings

When fixtures are being removed, care should be taken not to break the vitreous china type or chip the enamel from the cast-iron type of fixture. Water supply and waste pipes should be removed carefully from a fixture since the connections are apt to be corroded. Use a strap or adjustable wrench to remove any kind of chromium, brass or copper pipes and fittings. After the pipes are disconnected from the fixture, remove it from the wall.

In some cases, the fixture may be removed by unscrewing the lag screws, or bolts while in others, it may be lifted from its hanger. This precaution is taken to assure proper bracket is available when the fixture is installed again. When the fixture is disconnected, carry it away a sufficient distance so that it will not get marred or broken during the disassembly procedure.

When the plumbing is to be taken out of a building that is to be renovated, care should be exercised not to damage the building unnecessarily.

When removing galvanized or black iron pipe, use two wrenches to unscrew each connection as shown in figure 77 Be sure to use an adjustable wrench on hexagonal pipe fittings. Sometimes, the connections may be rusted and corroded to the extent that they will not unscrew. In this case, it may be necessary to strike the surface of the fitting with a hammer to loosen it at the threads. Do not strike cast-iron fittings too hard, cracking may result. Cracked fittings are useless.

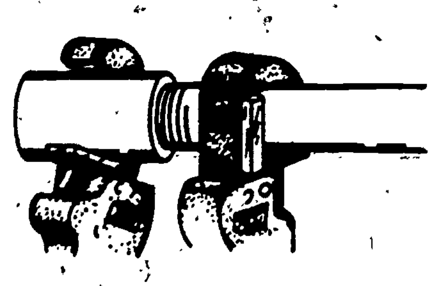


Figure 77 Use Two Wrenches to Disassemble Piping

When unscrewing threaded pipe and fittings, make sure not to damage the pipe. The pipe wrench will damage the pipe and fittings if it is allowed to slip. This procedure may mar the pipe causing the surface to become grooved. Marring the pipe in this way will weaken it, cause greater corrosion action at marred surfaces, and the sharp projections are apt to scratch and cut the hands of persons handling them.

Careless disassembly can bend the pipe or damage the threads. Even though the pipes and fittings are made of tough materials, they are very easily bent and dented.

Disassembly of Copper Tubing and Fittings

During the disassembly of copper tubing and fittings, apply heat from some type of torch to melt the solder in the joints. Every precaution must be taken to avoid starting a fire when heating the tubing and fittings that are located near flammable structural parts of the building. Before heating the tubing and fittings, be sure that the lines are drained. In the first place, the water in the lines, the tubing and fittings are hard to heat; furthermore, when the joint is disassembled, the heated water in the joint may run out and scald you.

DETERMINING USABLE MATERIAL

Determining whether the material disassembled is reusable depends almost entirely upon one's visual inspection and good judgment. For steel pipe, probably the first consideration would be whether it is long enough to make a nipple or other short length of pipe. Pipe that is bent, kinked, or twisted should be very carefully examined for fine cracks or other signs of rupture, see figure 78. Dents in pipe are caused by hard blows and these places should be inspected to determine the depth. If a dent is deep the steel may be exposed to the elements and will soon rust out if the galvanize on the inside is broken. When threads are cut on a pipe, it has been weakened considerably and cannot withstand strain like the unthreaded pipe. A slight excess of strain will then cause cracks or ruptures to develop. The threaded area should also be inspected to eliminate pipe with stripped, torn, flattened, crossed threading or any other injury to them which might make a defective connection, see figure 78. It is good practice also to check if more threads were cut on the pipe than were necessary. A fitting in this case will not turn far enough on the pipe to make a tight leakfree joint. Likewise if not enough threads or shallow threads were cut on the pipe, the plumber installing the piping had to force tighten the fitting, which in turn stretched the fittings out of size. These stretched fittings should not be saved when reclaiming materials.

When separating the fitting from the tubing, apply heat to the fitting and gradually twist the tubing from the fitting. Inspect the tubing and fittings and if any solder is found, remove with heat. When using a torch, precautions must be taken to avoid starting a fire. Store usable tubing and fittings in prepared storage bins and place unusable tubing and fittings in scrap containers. Do not mix copper with steel in the container. They must be separated at the salvage yard.

Most of the items mentioned in the preceding paragraphs also apply to fittings. They are also subject to being stretched by overtightening and will fail to make a watertight joint, if used in another installation. Cracked fittings are caused by overtightening. When fittings are used over and over, they become scarred by the pipe wrench and get unsightly and weaker each time they are used. The best way to determine if a fitting is usable is to screw it on the threads of a new nipple. If it fits loosely, discard it.

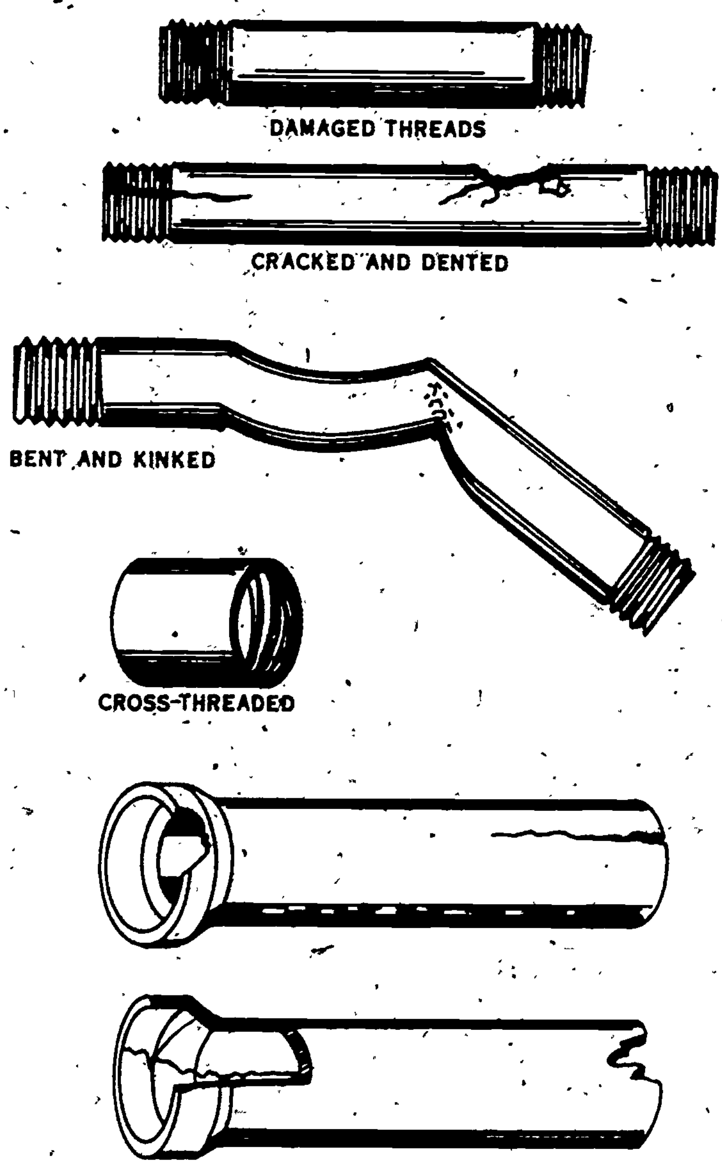


Figure 78. Damaged Pipe and Fitting

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Reclaiming cast-iron pipe and fittings depends on visual inspection and by the sounding-out method, see figure 78. Inspect them and if you do not see any defects or cracks, then check each joint by sounding. Use the same method as you did when installing the system. Remember, when tapping the pipe or fitting with a hammer, a clear ring indicates it is usable; a dull sound means it is cracked and should not be used. Usually, cast-iron pipe must have a hub and sufficient length to be usable. The extent of reusing pipe with or without a hub will depend upon the ~~job. Often~~ these short pieces can be used again. When the usable pipe and fittings have been inspected, clean and place them in the storage space provided. Clean tools and equipment and return them to their proper stogage. All materials that cannot be used should be placed in the dump contained for disposal. An ingot of lead weighs five pounds and is sometimes called a cake or bar of lead.

SUMMARY

From this study guide you have become familiar with the disassembly of a waste system and the materials that can be reused. It is just as important to save material when disassembling a system as well as economizing when installing it. To disassemble the system, the proper place to start is at the highest point in the system and work down to the lowest point. To prevent water damage and hazardous working conditions, the utilities are shut off before starting work. Since the water to the building is shut off, it is necessary to have a fire extinguisher available in case of a fire. While working on the job, safety precautions must be followed the same as at any other time. This means that goggles and gloves must be worn.

When steel pipe is to be removed, you should determine which starting place will prevent damage and waste of piping. Tools and equipment used in the removal of cast-iron pipe will vary according to the individual installation. While using a blow or oxyacetylene torch in a room or building, provide ample ventilation. Know the extent of damage to waste system materials so you can make the proper choice of pipe and fittings for reuse.

QUESTIONS

1. What is the purpose of turning off the water supply before disassembling the waste piping system.
2. When should you use a lead pickout iron?
3. What protective equipment should you use while melting out lead?
4. What is an ingot of lead?
5. What type of test is used to determine if cast-iron pipe is cracked?
6. How does damage to steel fittings differ from those to steel pipe?
7. Why is it necessary to reclaim piping material?
8. Where should the disassembly of a waste system start.

9. When should a pipe be broken in the system?

10. How could water in a working area be hazardous?

REFERENCES

AFM 85-20, Plumbing

229

PLANNING AND LAYOUT OF PLUMBING SYSTEMS

OBJECTIVE

This unit of instruction will give you practical experience planning and installing a typical plumbing system.

INTRODUCTION

The installation of a building plumbing system requires careful planning and lay-out. Without this planning the possibility of the completed system working correctly is very small. As a plumber, if you will observe the blueprints and specifications very closely and complete your work according to the code, the system will work perfectly when completed.

INFORMATION

BLUEPRINTS

Construction of a building is described by a set of drawings which give a thorough graphic description of each part of the operation. Usually, a set of plans begins by showing the boundaries, contours, and outstanding features of the construction site. Succeeding drawings give instructions for erecting the foundation and superstructure, as well as installation of lighting, heating, and plumbing fixtures.

Plot Plan

A plot plan (figure 79) shows the boundaries of the construction site and the location of the building in relation to the boundaries. It also shows roads and walks. It also indicates the location of utility lines, such as sewer, water, gas and electric lines. Each utility line is identified as to type of line and size. This plot plan also shows the ground contour. These plans are drawn to scale from sketches and notes based on a survey of the area. By locating the corners of the building at specific distances from established reference points, the plot plan gives the builder a definite starting point. Since it is a location plan, it must also have an arrow indicating the north direction.

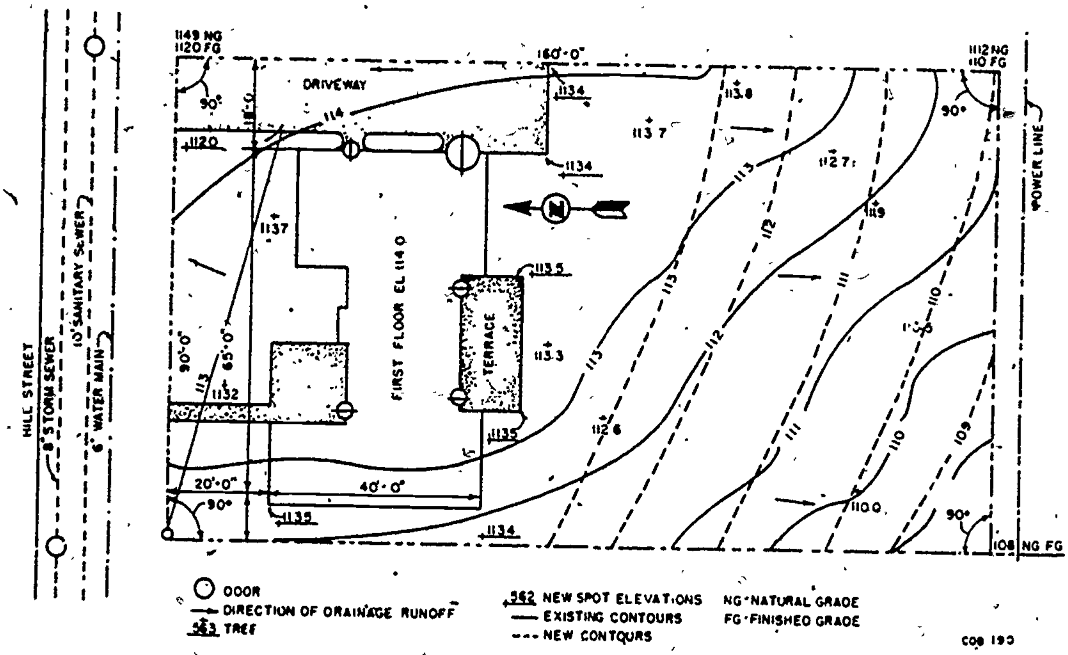

Figure 79. Plot Plan

Foundation Plan

The foundation plan (figure 80) is the starting point in the actual construction and a completely dimensioned plan is furnished except for very simple buildings. Information from foundation plans will aid the plumber in locating service entrances to the building.

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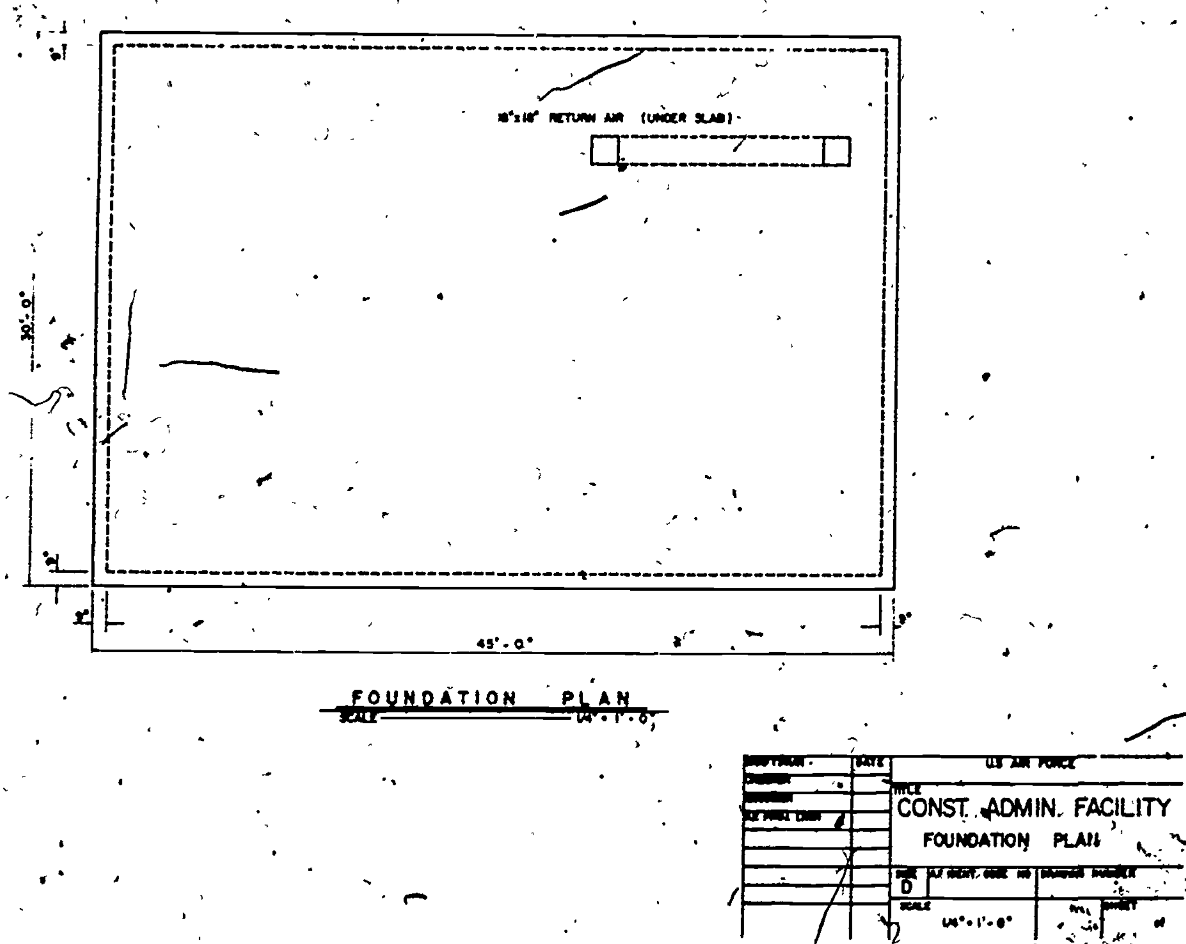

CB-045

Figure 80.

Floor Plan

A floor plan (figure 81) is a cross section view of the building. This view is obtained by assuming that a horizontal cutting plane is passed through the building in such a manner that it cuts through all walls, doors, and windows. If the building has more than one floor, a floor plan for each floor is drawn. The floor plan shows the outside shape of the building; the arrangement and size of rooms; the types of material and the type, size, and location of doors and windows. In addition, it may show heating, lighting, and plumbing fixtures.

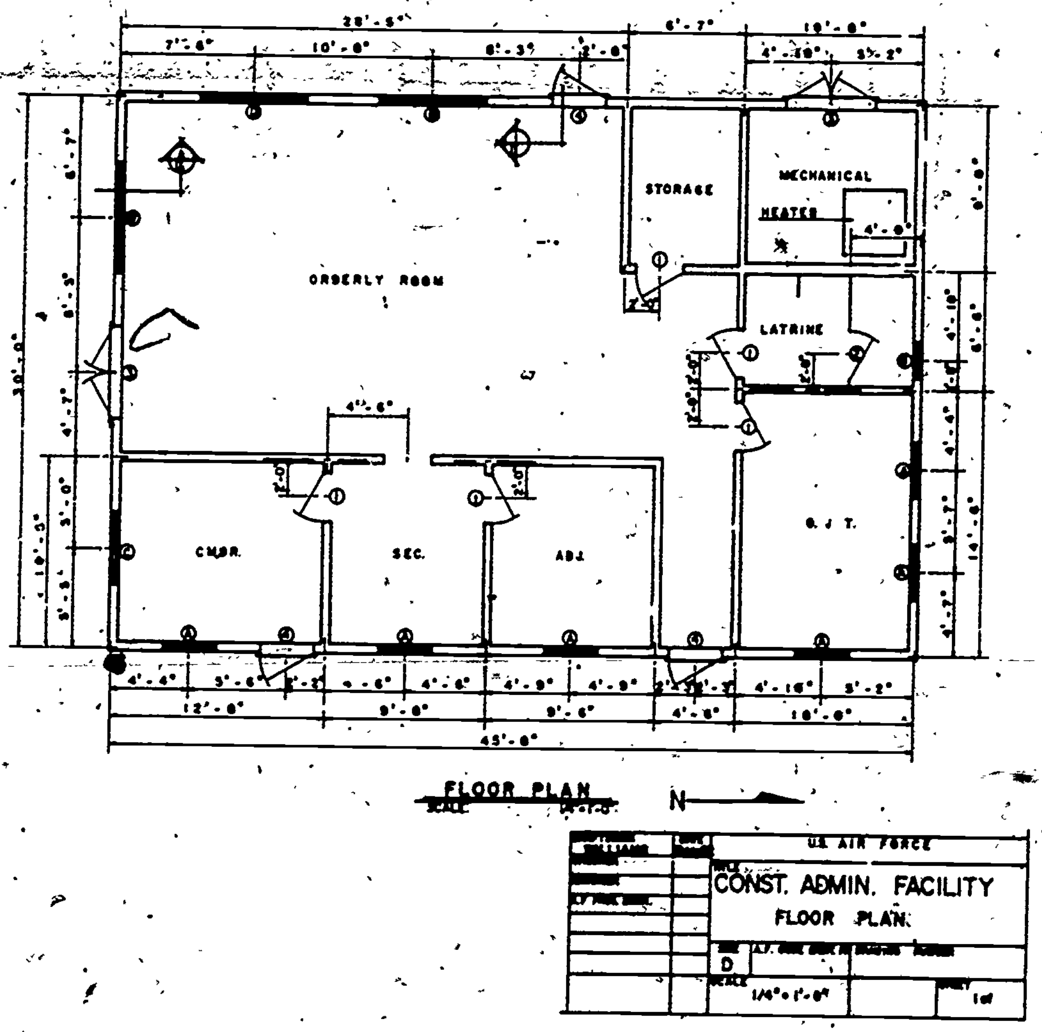

Figure 81

Framing Plans

Framing plans show the size, number, and location of structural members which form the building framework. Separate framing plans may be drawn for the floor, walls and roof. A roof framing plan (figure 82) shows the location of the rafters or trusses used to span the building and support the roof.

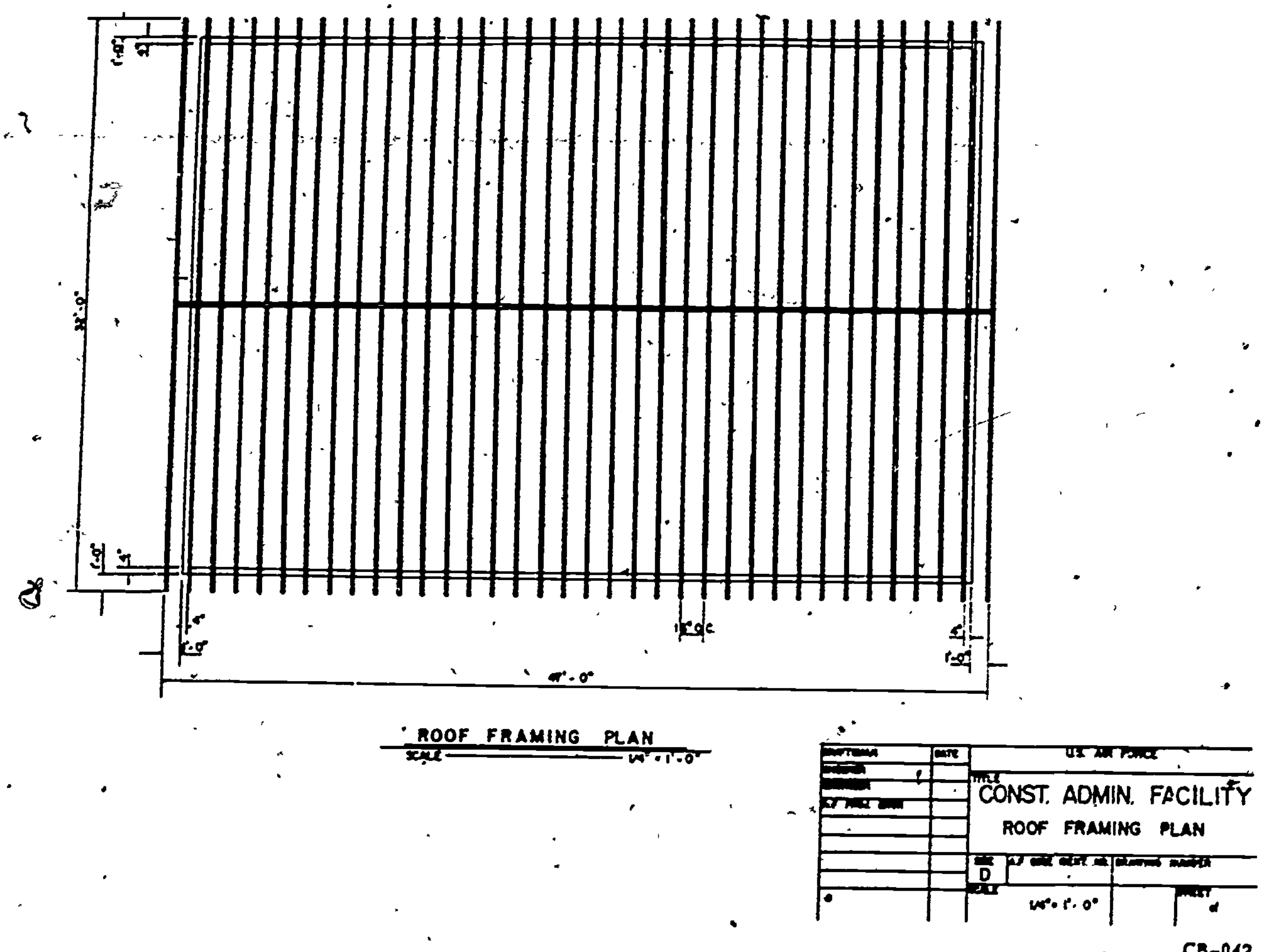

Figure 82

Floor framing plans specify the size and spacing of joists, girders, and columns used to support the floor. Detail views are usually added to show the methods of anchoring joists and girders to the foundation. Wall framing plans show the size and location of wall openings, ceiling height, and other details (see figures 83, 84, 85 and 86).

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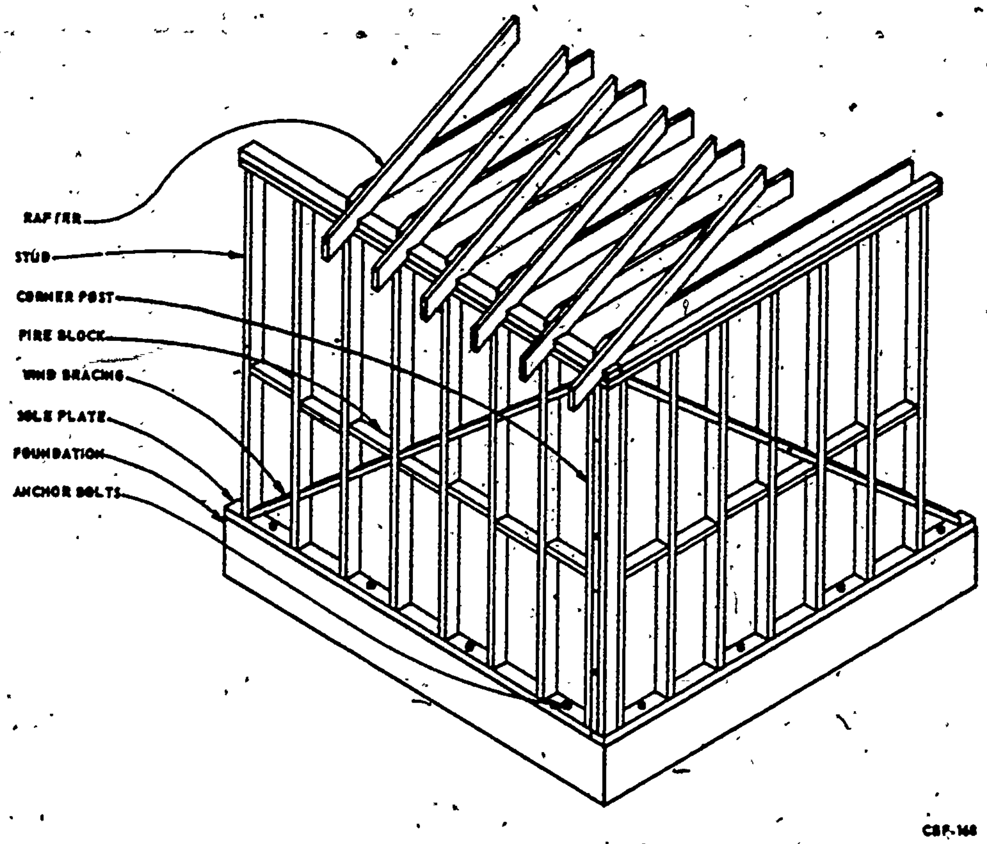

Figure 83. Wall Framing

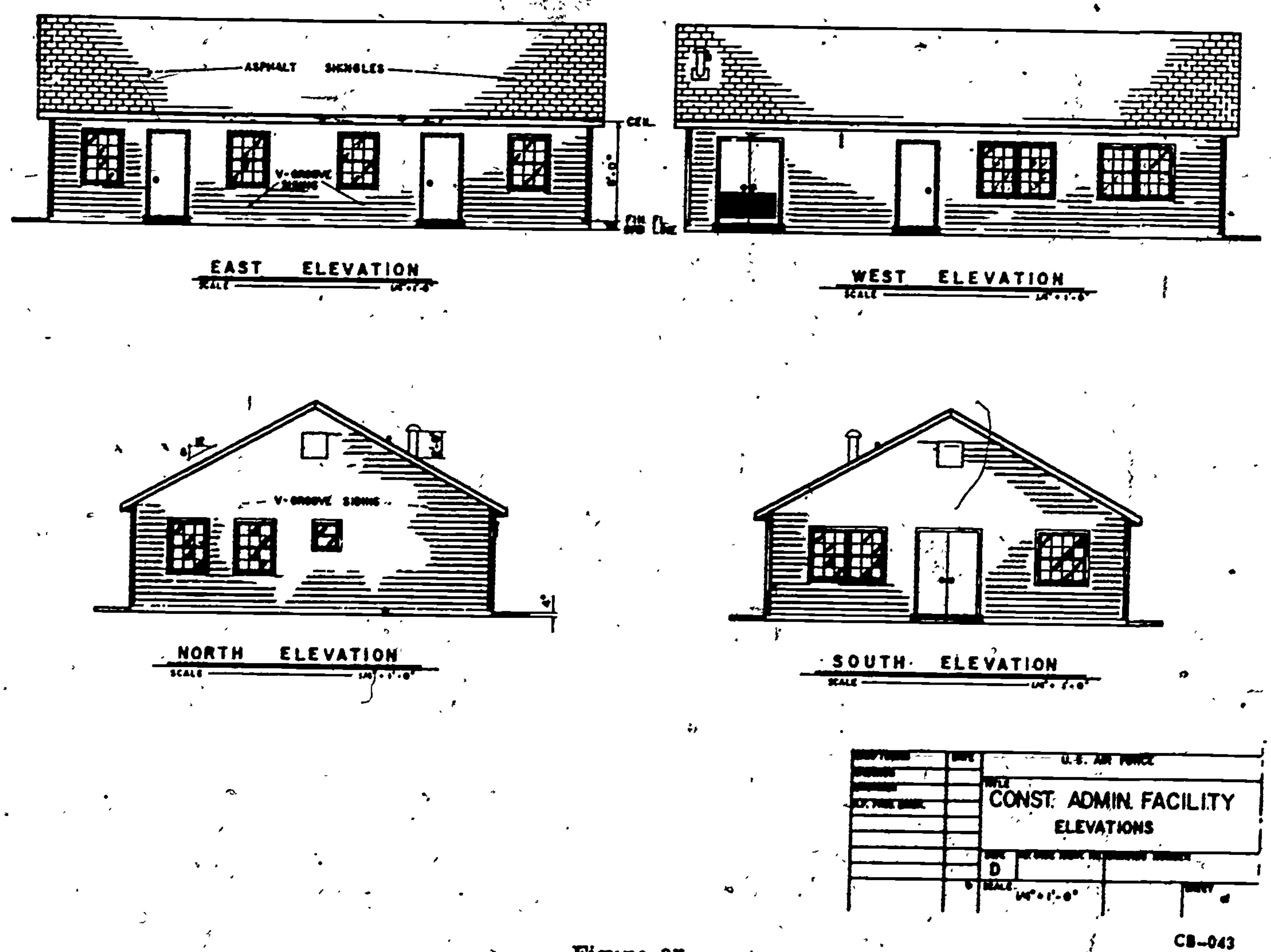
ASPHALT SHINGLES
CEIL.
V-GROOVE SIDING
EAST ELEVATION
WEST ELEVATION
V-GROOVE SIDING
NORTH ELEVATION
SOUTH ELEVATION
U.S. AIR FORCE
CONST. ADMIN. FACILITY
ELEVATIONS
D
CB-043

Figure 87

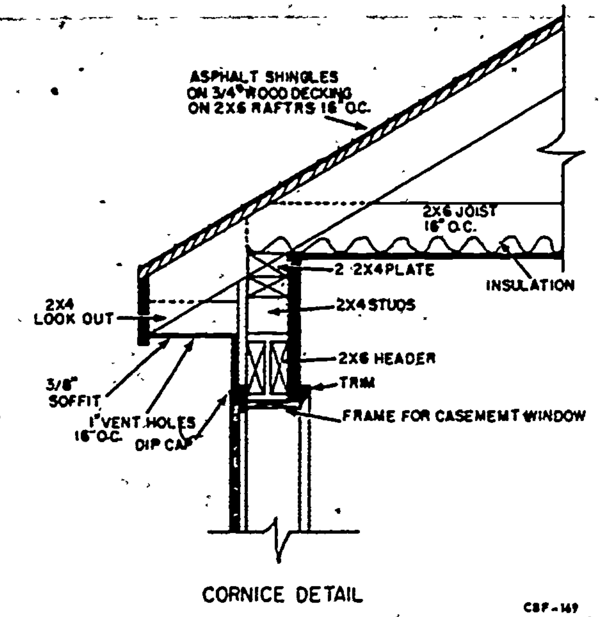

Figure 84

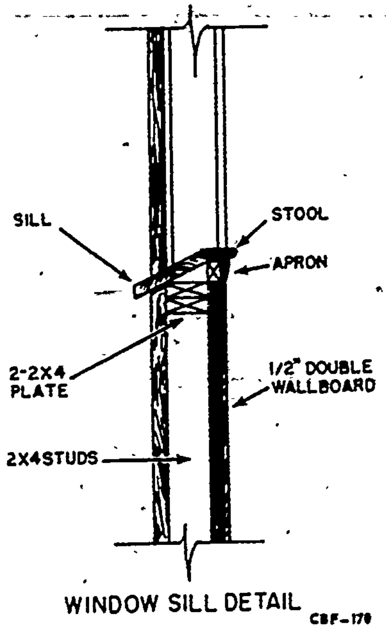

Figure 85

Elevations

Elevations are external views of a structure and may be drawn to show the front, rear, right or left side views. (See figure 87.) An elevation is a picture-like view of a building that shows exterior material and the height between finish floor and ceiling. It may also show the ground level surrounding the structure, called the grade.

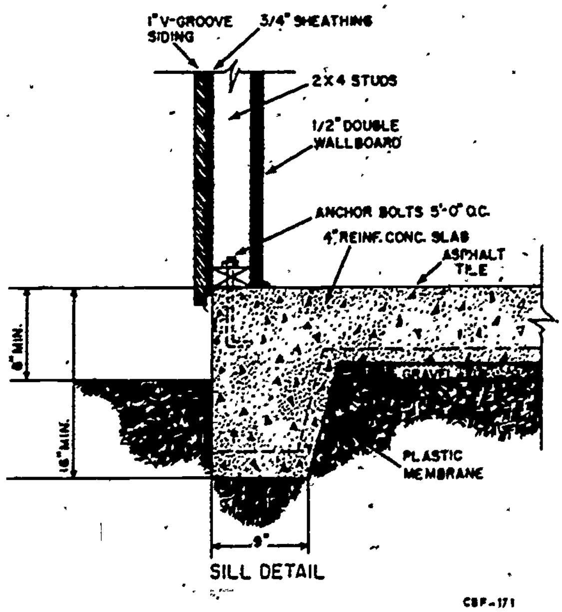

Figure 86

Specifications

The specification is a written document which supplements the building plans by explaining these points which are not readily explained by drawings. Specifications usually begin with a statement of the general conditions of the contract and then proceed to consider the various phases of construction. Each phase of construction is related to a particular operation or material. A separate specification is written for each phase of construction and these are compiled to parallel the job sequence of the phases. The specifications cover type and quality of material, kind and quality of labor to be used, methods of construction, standards of workmanship, kinds of equipment, delivery and storage of materials, inspection of work, protection of finished work, and many other points which could not be covered if drawings alone were used. See figure 88.

SPECIFICATIONS
FOR
PLUMBING
University of Nebraska
Lincoln, Nebr.

GENERAL CONDITIONS: The general arrangement of the plumbing shall be as indicated on the drawings. Detailed drawings of the proposed departures due to actual field conditions or other causes shall be submitted for approval. The contractor shall carefully examine the drawings and shall be responsible for the proper fitting of materials and equipment in each building as indicated, without substantial alteration.

UTILITIES: Water and drainage piping shall be extended to points 5 feet outside the building where the pipes shall be capped or plugged and left ready for future connections by others. Utilities shall be installed below the frostline. If trenches are closed or the pipes are otherwise covered before being connected to the street mains, the location of the end of each plumbing utility shall be marked with a stake.

Figure 88. Specification Sheet (Sample)

Plumbing Symbols

Plumbing symbols are used in the preparation of drawings of plumbing systems. They indicate what material and fixtures are installed and where they are installed.

Conventional plumbing symbols used on drawings are represented by figure 89. Since symbolic representation does not usually involve exact or scale layouts or the actual run or leads of piping, the same symbol may be used for all projections of the system (plan, elevation, sections, etc.)

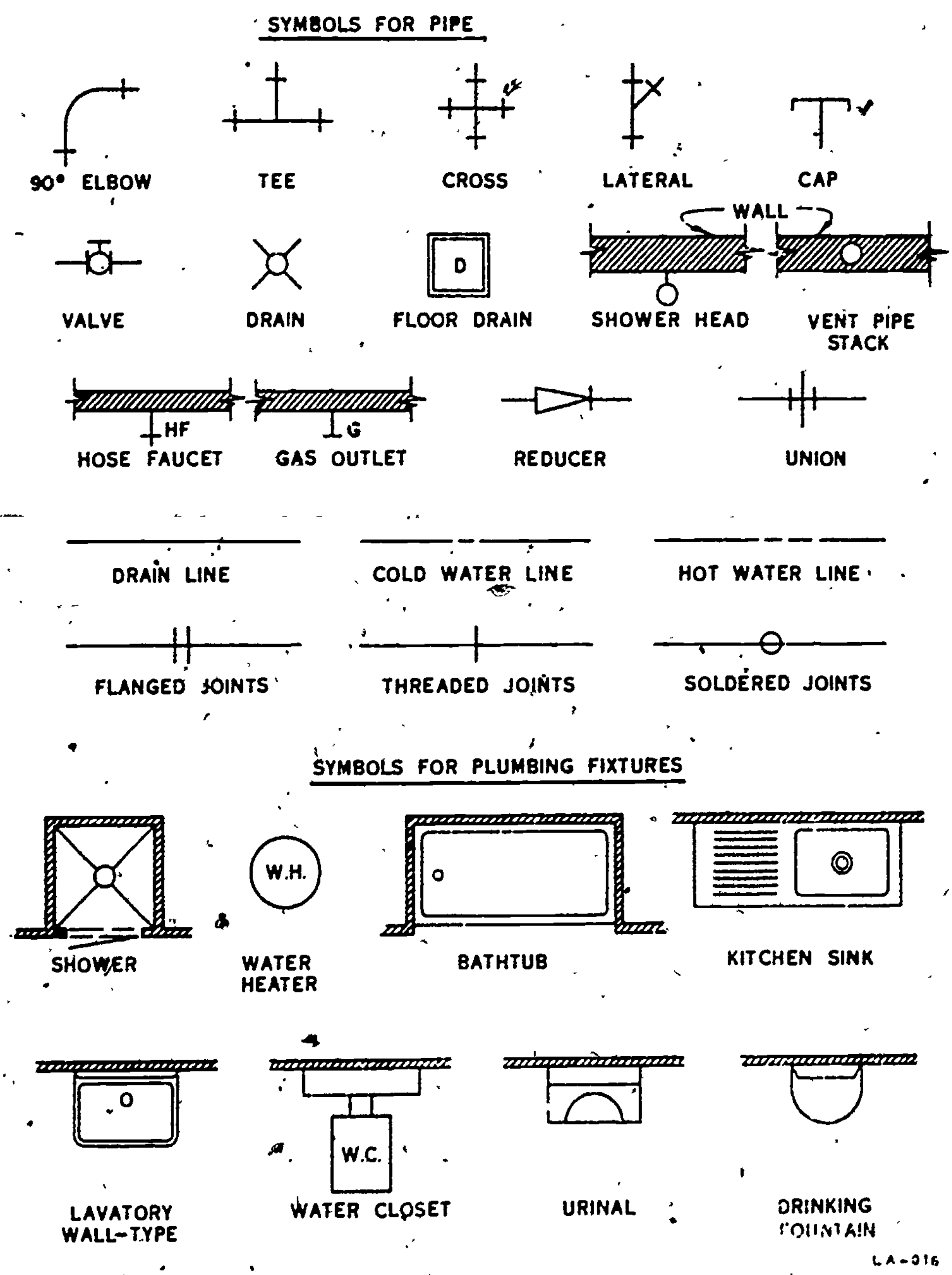

Figure 89. Plumbing Symbols

Working Drawings

Most blueprints of small structures will not include a complete plumbing plan. The plumber must plan and lay out the plumbing system using information from the available blueprints. A working drawing should be made of the plumbing systems. Since it is the purpose of working drawings to be exact about shape and size, most working drawings are drawn as top and side views. In some instances an isometric detail drawing may be included to show how parts look when they are assembled. (See figure 90.)

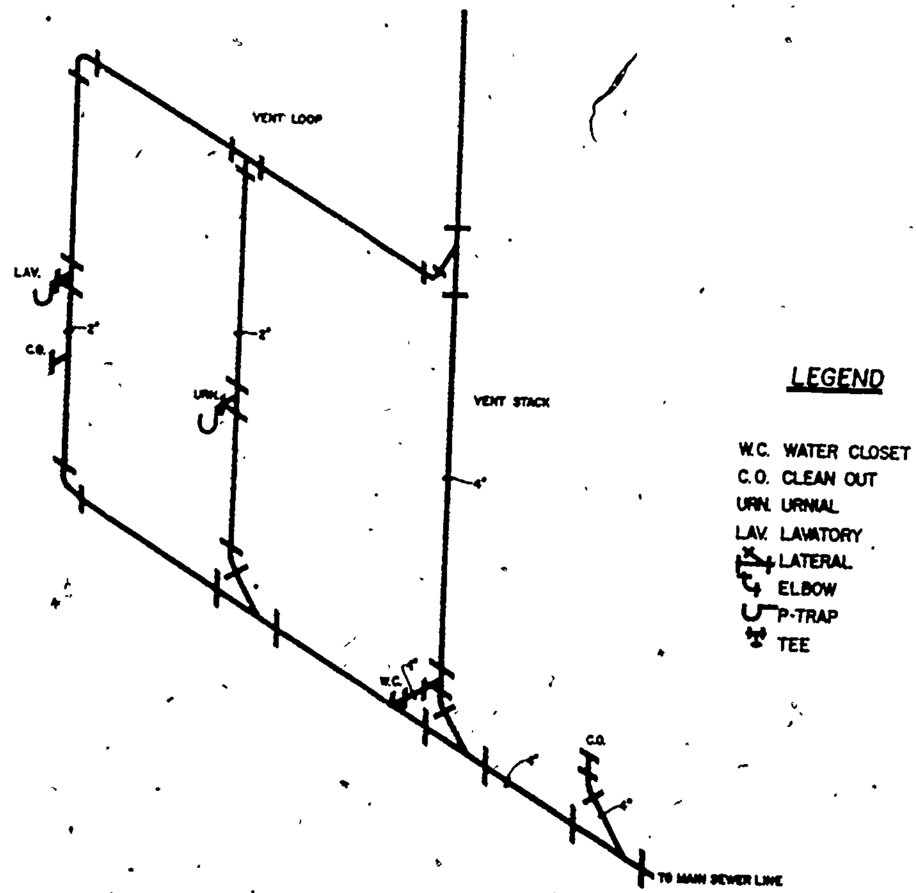

Figure 90

Scale

Due to the size of the building being represented the drawings cannot be drawn full size. This reduction in size is called scale. In general, plan views and elevations are drawn to a scale of 1/4" equal to 1'-0", however, they may be drawn either smaller or larger. When installing the plumbing in the model house you will be using 1/2" = 1'-0" for the blueprints, and the pipe, fittings and house are 1/5 scale.

Bill of Materials

A complete bill of materials is usually made by the draftsman at the time he prepares the blueprint. When a bill of materials does not accompany the blueprint, one must be prepared by the plumber. A bill of materials is a tabulated list of requirements for a job showing the name, description, quantity, stock number, size and sometimes the cost of the different items. Figure 91 shows a sample bill of materials. Quantities are taken from the plans or drawing by listing one item at a time, starting with the smallest size and progressing to the largest.

When special types of valves or fittings are required for a certain job, the item should be located in a commercial manual. The manufacturer's numbers and types should be shown to insure positive identification.

A bill of materials in which the cost must be listed will require that each item be researched in manufacturers' catalogs to obtain the unit cost.

A list of so-called "takeoff" items should also be included in the bill of materials. These are items which are known to be necessary to complete the job but are not included on the prints or drawings. They include such items as thread cutting oil, joint compounds and bolts or screws for attaching brackets.

ITEM	DESCRIPTION	PART NO.	QUANTITY	SIZE	COST
1	Valve, Gate-Brass with Wedge Disc, 100 Pound Pressure	Crane 410 or Equal	6	3/4"	4.10 each
2	Valve, Gate-Brass with Wedge Disc, 100 Pound Pressure	Crane 410 or Equal	2	1 1/4"	6.60 each
3	Valve, Globe-Brass with Composition Disc 150 Pounds Water Pressure at 200°F.	Crane 1250 or Equal	3	3/4"	3.40 each
4	Coupling, Pipe Reducer, Galvanized, 125 Pound Pressure	FSN 4730-277-2774	12	3/4" X 1/2"	.11 each

Figure 91. Sample Bill of Materials

INSTALLATION OF BUILDING WASTE SYSTEM

All plumbing installations must conform to a certain procedure called codes. The National Plumbing Code and local plumbing codes govern the installation of plumbing. The plumbing code derives its justification for police power because it is mandatory only insofar as it protects the people against harmful conditions concerning health and safety. Codes governing plumbing include the practice, materials and fixtures used in the installation, maintenance, extension and alteration of all piping, fixtures and appliances that are connected to a plumbing water and waste system. On a military installation, plumbing systems must also conform to installation procedures governed by the base engineer.

IDENTIFICATION OF TYPES OF PIPE

Cast-Iron-Soil Pipe

Cast-iron soil pipe is used for sanitary drainage pipe and stacks in waste disposal systems. It is lighter than cast-iron water main pipe and is available in two weights; service weight and extra heavy. The selection of service weight or extra heavy is determined by the specification in the job plan. For household drains, service weight is usually satisfactory.

Copper Tubing

Copper tubing has many advantages over cast-iron pipe. It is easier to transport and install and is more resistant to corrosion. Copper tubing is classified by its wall thickness and hardness. It is available in four wall thicknesses, Type K, L, M, and DWV. Types K and L are available in either hard (cold drawn) or soft (annealed) tubes. Types M and DWV are available only in hard temper. Types M and DWV are used in drainage lines and vents.

Hard copper tubing cannot be bent without annealing. When a change in direction is required, a fitting such as an elbow should be used.

Plastic Pipe

Plastic pipe is available in both durable and light weight. It can be cut with a tubing cutter, hacksaw, or a knife and will not rust, rot, or corrode. Plastic pipe is available in straight lengths or coils. It is also available in three degrees of hardness.

Sizing the Building Drain

Building drains must be of sufficient size to carry off all the water and waste materials which may be discharged into them at any one time.

Positioning and Blocking the Stack Base and Fittings

The building drain may be suspended from the floor joists of the lowest room in the building (or from the ceiling joist of a basement) or buried. In either case, it is usually a straight line from the building sewer to the main vent stack. (The building or house sewer extends from the main sewer to five feet outside the building. The building drain continues from that point and extends through the wall to the vent stack.

TYPES OF STACKS

Stacks

A stack is the vertical piping in a plumbing system. If a stack is used to carry sewage from the upper floor levels to the building drain, it is called a soil stack.

Stack Group

A stack group is a term applied to the location of fixtures in relation to the stack so that, by means of proper fittings, vents may be reduced to a minimum.

Main Stack

Every building in which plumbing is installed shall have at least one main stack, which shall run undiminished in size and as directly as possible from the building drain to fresh air above the roof. (See figure 92.)

Vent Stack

A vent stack is a vertical pipe which provides circulation of air through the drainage system. The vent stack is the extension of a soil or waste stack; but on the portion of the pipe which is above the highest fixture run or branch inlet. (See figure 92.)

Waste Stack

A waste stack is the vertical pipe which carries waste from any fixture, except water closets or urinals. (See figure 92.)

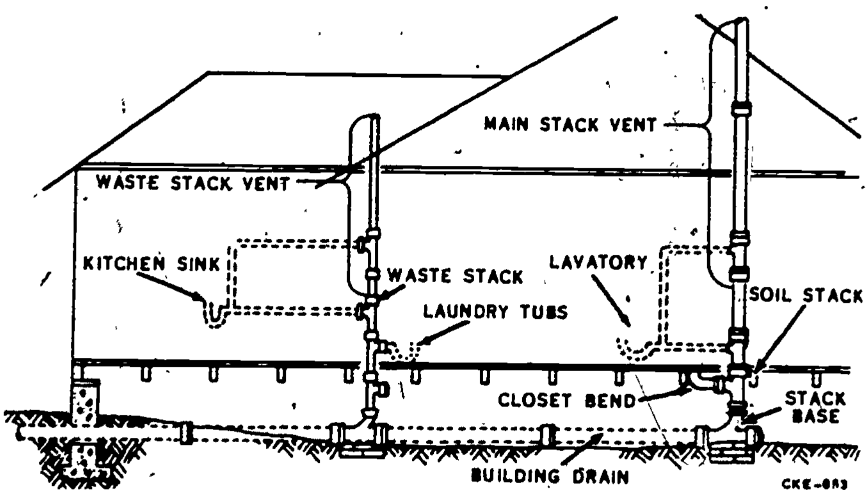

Figure 92. Identification of Stacks

Soil Stack

A soil stack is the vertical pipe which carries soil from water closets, urinals, and/or similar fixtures. (See figure 92.)

Soil and Waste Stack

A soil and waste stack is a vertical pipe which receives the discharge from soil and waste branches.

Materials

Stacks and waste pipes may be made of cast iron, steel, brass, plastic, or copper. Soil stacks are usually made of cast iron soil pipe. The principal objection to the use of copper for soil and waste pipes is its high initial cost; otherwise, it has proven very satisfactory.

OPERATION AND CONSTRUCTION OF A VENT SYSTEM

The layout and construction of the stack in a plumbing system requires as much knowledge and skill on the part of the plumber as any job he may perform. Accurate measurement is absolutely necessary to insure proper positioning of fittings in the stack for soil branches, waste branches, and vent pipes to the various fixtures. The fittings and pipe must be assembled in perfect alignment as most stacks are concealed in walls where space is limited.

Although plumbing codes vary, they carefully regulate the size of piping for a particular type of vent. First, the size of the piping used for a soil or waste stack vent must be not less than the diameter of the soil or waste stack piping. When a main vent is added to a stack, it must have a diameter of at least one-half the diameter of the stack it serves, but in no case can the main vent be less than 1 1/4 inches in diameter.

There are several approved methods for ventilating a plumbing system. The one which is used will be determined by the design of the building, the number of fixtures, and the manner in which they are grouped or located. On small single-story plumbing installations where the fixtures are grouped so that the fixture traps attach directly to the fittings in the stack, no additional venting is necessary other than the stack vent. In buildings where the fixtures are located away from the stacks and drainage piping is necessary, or in multistory buildings where fixtures are installed in the upper floors, additional venting will be necessary to insure adequate ventilation of the system.

Main Vent

The main vent is a vertical vent pipe which runs parallel to the soil or waste stack and serves as a terminal for the vent piping from the individual fixtures, as illustrated in figure 93. It is an integral part of the vent system and is constructed in conjunction with the main stack. The main vent connects full size at its base into the soil or waste stack through the Y fitting. This connection is made below the lowest fixture branch. It extends full size through and above the roof, or to a point of connection with the stack vent above the highest fixture branch. The fitting for this connection is referred to as the main vent tee and is also shown in figure 93. In most installations, the main vent is located within a few feet of the main stack but it may be offset where special problems exist.

Unit Vent

Fixtures which are mounted side-by-side or back-to-back, as shown in figure 94, are unit vented. A unit vent, sometimes called a dual vent, is a vent pipe installed to protect two fixture traps.

Individual or Back Vent

Figure 95 illustrates the installation of a single fixture when a main vent is used. Note the drainage through the waste pipe to the main stack. The vent pipe above the trap is connected to the main vent. This method of venting a fixture is referred to as an individual vent. The vent piping must rise vertically at least 6 inches above the fixture rim before changing direction for connection to the main vent. The fixture is said to be dry vented as there is no drainage flow through the vent piping in the system.

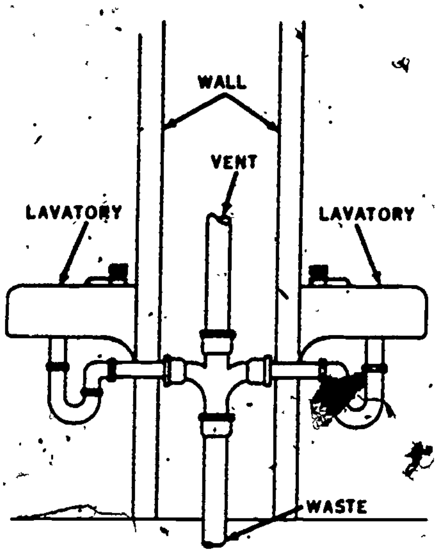

Figure 94. Pair of Fixtures Unit Vented

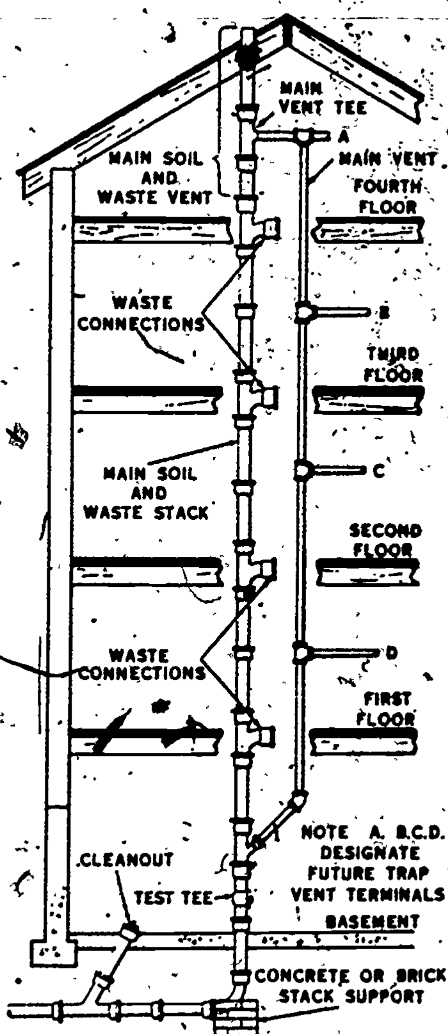

Figure 93. Stack and Vent Installation

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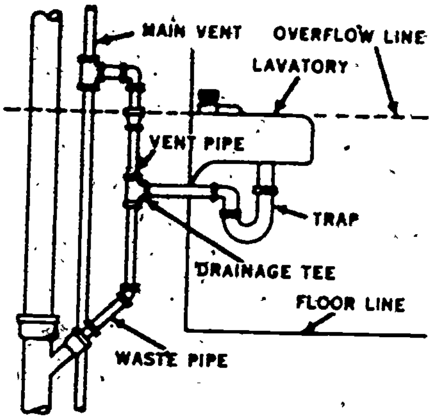


Figure 95. Single Fixture Individually Vented

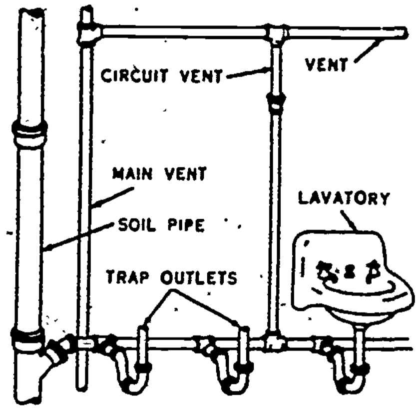


Figure 96. A Battery of Lavatories Circuit Vented

Circuit Vent

The circuit vent, illustrated in figure 96, is the vent from a horizontal branch taken between the first two fixtures and connecting into the main vent. There should be no more than eight fixtures on one circuit vent.

Loop Vent

The loop vent is similar to the circuit vent in figure 96 except that it ties to the soil or waste stack vents.

Wet Vent

A wet vent is a vent which receives the discharge from waste to other than water closets.

Assembling Vents

When assembling the building drain and vents, the plumber must determine if that portion of the work can be fabricated and then set in place, or if it must be done in place. There should be sufficient room near the joint for yarning, packing and pouring if the joint is assembled in place.

When aligning vertical and horizontal piping, a carpenter's level should be used. On vertical piping, this assures that the hubs will be encased within the wall.

Roof Flashing

The stack must be carried full size or larger through the roof to form a vent terminal. The stack must extend at least 6 inches above the roof. To make openings watertight, a roof flashing must be used. This is shown in figure 97.

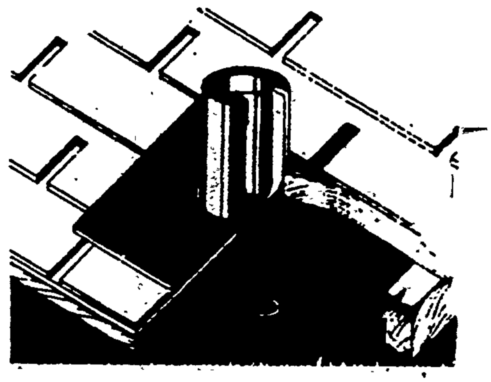


Figure 97. Roof Vent Flashing

MODEL HOUSE

The model house you will be working on is a scale model of a two-story house. The overall dimensions represent a house 30 feet by 20 feet. On each floor there will be two full baths and two kitchens. Your class will be split into four groups. Two groups will install minipipe and fittings for the first floor, and the other two groups will complete the other floor. Keep in mind that this is a two-story house, when installing the waste and vent system.

SUMMARY

Blueprints and specifications are important guides for the plumbers. Learn how to use them and you will find you'll do less tearing out and replacing of piping.

There are several approved methods for ventilating a plumbing system; be sure you use them. Without the proper type of vents the system will not work properly.

QUESTIONS

1. What are the two views which should be drawn to make a working drawing?
2. What information can be found in a set of blueprints?
3. What plan will give you the location of water and sewer mains?
4. What drawing will give you the height of the ceiling?
5. What is meant by scale?
6. What is a specification?
7. What must the plumber do if the blueprints do not contain a plumbing plan?
8. What is a takeoff item?

9. How large must the building drain be?

10. What is used to align vertical and horizontal piping?

REFERENCES

AFM 85-20, Plumbing

WORKBOOKS 3ABR55235-IV-1-P1 thru 8-P1

Department of Civil Engineering Training

Plumbing Specialist

FIXTURES AND APPURTENANCES

October 1974

SHEPPARD AIR FORCE BASE

Designed For ATC Course Use

DO NOT USE ON THE JOB

TABLE OF CONTENTS

This supersedes Workbooks 3ABR55235-IV-1-P1 through 7-P1, 28 June 1973.

Department of Civil Engineering Training
Sheppard Air Force Base, Texas

WB 3ABR55235-IV-1-P1
2 October 1974

INSTALLING MIXING FAUCETS AND SHOWERS

OBJECTIVE

This project will give you practical experience installing a shower and mixing faucets.

STANDARD OF PERFORMANCE

All measurements must be correct and the installed faucets must not leak.

EQUIPMENT AND SUPPLIES

	Basis of Issue
SG 3ABR55235-IV-1	1/student
WB 3ABR55235-IV-1-P1	1/student
Manufacturer's Specifications	1/2 students
Plumber's Tool Kit	1/2 students
Shop and Special Tools	1/2 students
Mock-up Trainer	1/6 students
Showers	1/4 students

Mission 1

INSTRUCTIONS

1. Install shower mixing valves.
   a. Remove hot and cold water caps.
   b. Install half union on risers using proper wrench (make sure union ______________ is on pipe).
   c. Set valve in position.
   d. Start union collars on valve.
   e. Use smooth jaw adjustable wrench and tighten.
2. Install riser from center of valve (see C, figure 1).
3. Install shower head using strap wrench.
4. Install shower base (see figure 2).
   a. Place putty around strainer.
   b. Screw in strainer.

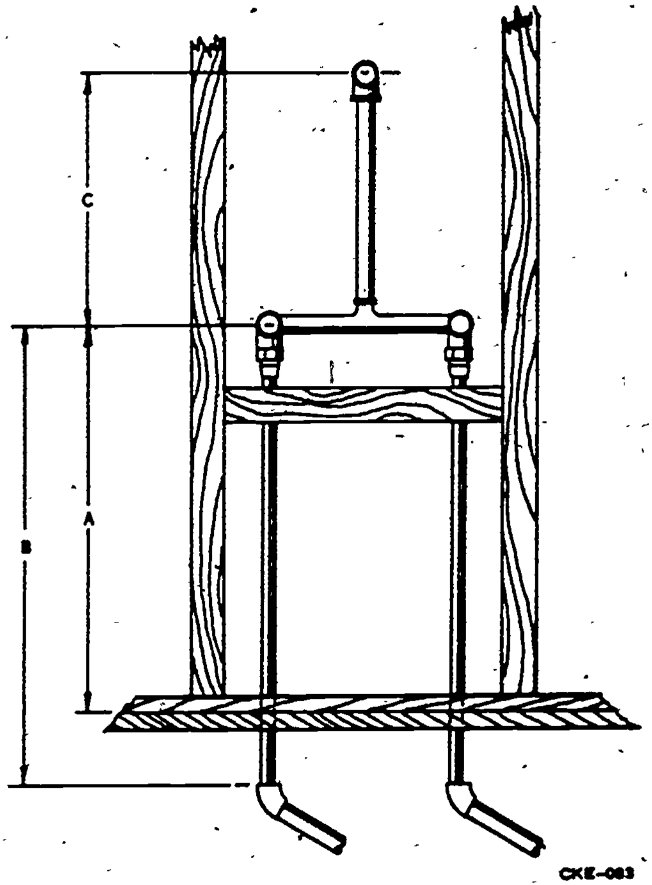


Figure 1

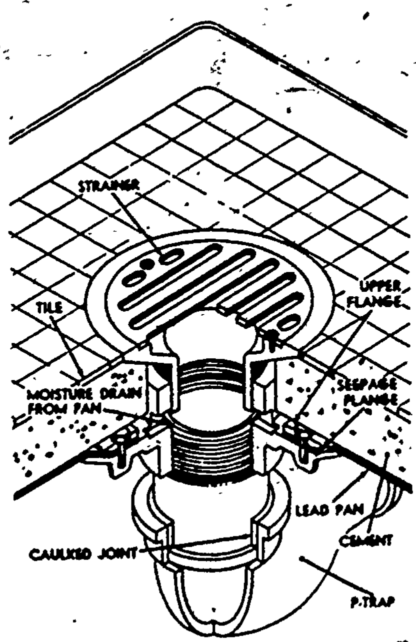


Figure 2. Cutaway View of a Shower Drain Installation

Mission 2

1. Figure 3 is a manufacturer's rough-in specification for a recess bath combination. Answer the following questions by writing the answers in the spaces provided.

Step 1. The measurement from the rough floor to the center of shower arm is

____________________.

Step 2. The measurements from the rough wall to the center of the drain are

____________________ and ____________________.

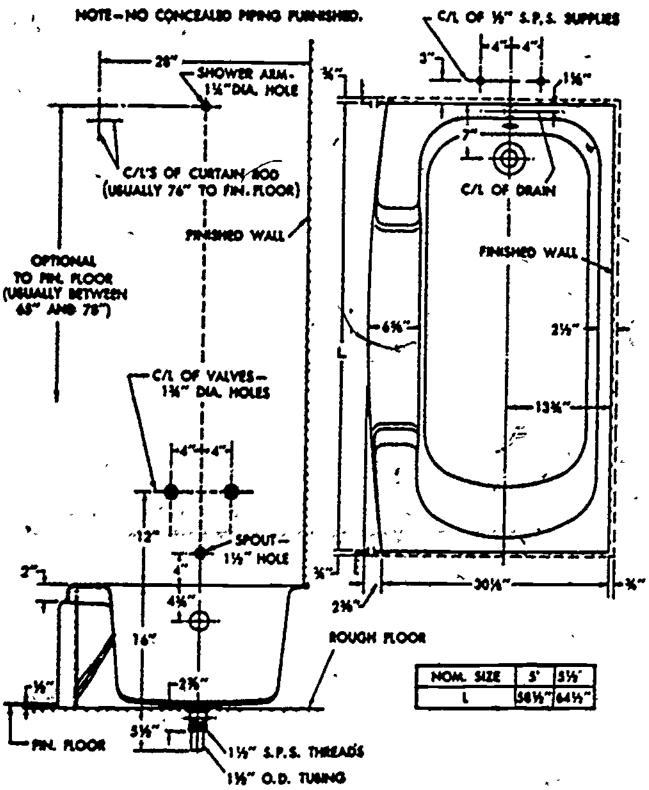
Step 3. This bathtub comes in what lengths? ______________ and ______________.

Step 4. The spread between the hot and cold water inlets of the mixing valve is

____________________.

Step 5. What is the measure from the finished floor to the center of the mixing faucet? ________________.

Enameled Recess Bath Combinations



NOM. SIZE	5'	5½'
L	58½"	64½"

CKA–062

Figure 3

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Mission 3

1. Figure 4 is a manufacturer's rough-in specification for a bathtub waste and overflow. Use design number 3 and answer the following questions.

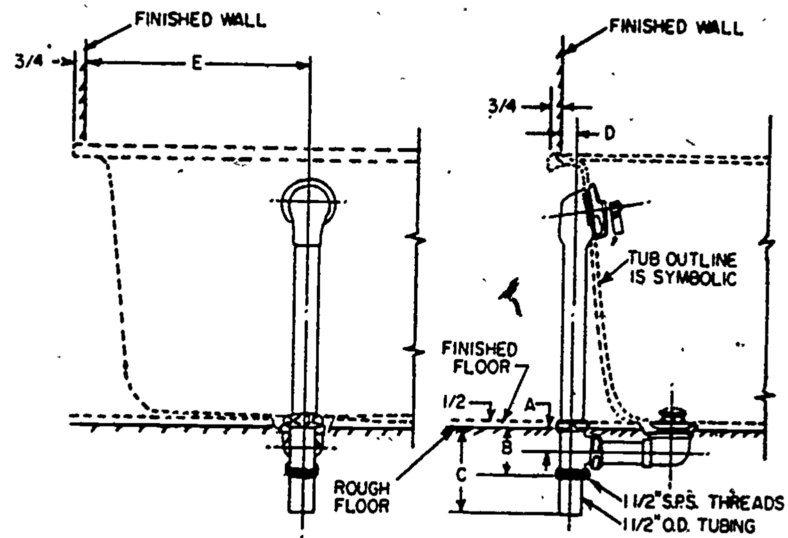
Step 1. This measurements from the center of the waste overflow and the finished walls are ____________________ and ____________________.

Step 2. What size is the tubing used for the waste and overflow?

Answer ____________________

Step 3. How thick is the finished flooring? Answer ____________________

Step 4. Is this drain a P.O. or pop-up type? Answer ____________________



DESIGN	A	B	C	D	E
1	1 1/4	2 7/8	5 1/2	7/8	13 3/4
2	1 1/4	2 7/8	5 1/2	7/8	13 3/4
3	1 1/4	2 7/8	5 1/2	7/8	12 3/4
4	1 1/4	2 7/8	5 1/2	1 1/8	13 3/4
5	3/8	2	5 3/8	1 5/8	13 3/4

CKA-868

Figure 4

Mission 4

1. Using figure 5 to identify items A through H. Write the name of the unit in the corresponding blank space.

A. ______________________________

B. ______________________________

C. ______________________________

D. ______________________________

E. ______________________________

F. ______________________________

G. ______________________________

H. ______________________________

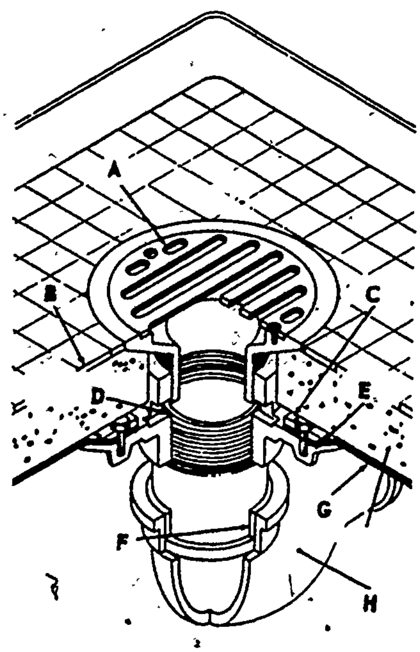
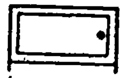


Figure 5

Mission 4

1. Identify the following symbols:

   a.  ____________________

   b.  ____________________

   c.  ____________________

2. What tools are required for setting a bathtub?

   a. ____________________
   b. ____________________
   c. ____________________
   d. ____________________
   e. ____________________
   f. ____________________
   g. ____________________
   h. ____________________
   i. ____________________
   j. ____________________

INSTALLATION OF WATER CLOSETS

OBJECTIVE

This project will give you practical experience installing a tank-type water closet and a flush tank.

STANDARD OF PERFORMANCE

All answers must be correct and all completed projects must work and not leak.

EQUIPMENT	BASIS OF ISSUE
SG 3ABR55235-IV-2	1/student
WB 3ABR55235-IV-2-P1	1/student
Manufacturer's Specifications	1/2 students
Plumber's Tool Kit	1/2 students
Shop and Special Tools	1/2 students
Water Closets	1/2 students
Flusk Tanks	1/2 students

Mission 1

INSTRUCTIONS

Fill in the blanks for the following guide on the installation of a water closet.

CAUTION: Observe safety precautions at all times.

1. Secure the tools, ____________ and equipment to the job.
2. Place two brass ____________ ____________ in the slots of the ____________________ with threaded ends up.
3. Turn water closet bottom side up, see figure 6,, and apply ________ ____________ to the outer portion of the bowl rim.
4. Install a doughnut-shaped preformed ____________ ____________ over the drainage opening of the bowl. Putty can be used in an emergency.

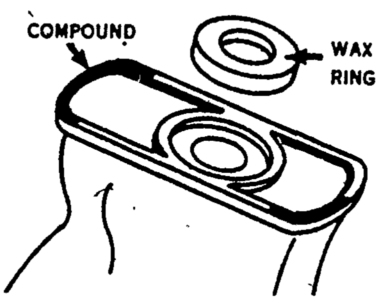


Figure 6

259

5. Turn water closet bowl right side up and set it down on the ______________ ______________ with the drainage opening (horn) projecting into the closet bend. Guide the two ______________ through the holes on either side of the base of the water closet. If four bolts are used, the front bolts must be previously installed.

6. Be sure closet bowl sits snugly to floor before ______________.
Install nuts on the closet bolts and alternately tighten them.
NOTE: The base of the water closet will crack if ______________ are overtightened.

7. Remove excess ______________ ______________ squeezed out around the base of the water closet.

Mission 2

INSTALLING A FLUSH TANK

1. Install ______________ on closet bowl, using special gasket and bolts.
NOTE: The closet bowl or tank will ______________ if nuts are ______________.

2. Measure, cut, thread (or flare), and assemble supply lines and fittings for connecting to the ______________ ______________.

3. Test installation for proper operation under line pressure.

4. Repair leaks if necessary.

5. Properly adjust level in ______________ and check flushing action.

6. Disassemble the installation.

7. Clean tools and materials, then return them to their proper storage.

8. Clean the work area.

INSTALLING A URINAL

OBJECTIVE

This project will give you practical experience installing a lavatory, faucet, and a lavatory trap.

STANDARD OF PERFORMANCE

All statements must be answered correctly and the installed unit must not leak.

EQUIPMENT	BASIS OF ISSUE
SG 3ABR55235-IV-3	1/student
WB 3ABR55235-IV-3-P1	1/student
Manufacturer's Specifications	1/student
Plumber's Tool Kit	1/2 students
Shop and Special Tools	1/2 students
Urinals	1/2 students
Flushmeter	1/2 students
Vacuum Break and Traps	1/2 students

Mission 1

INSTALLING A LAVATORY

1. List tools needed to install a urinal.

_______________ _______________

_______________ _______________

_______________ _______________

2. List material needed to install urinal.

_______________ _______________

_______________ _______________

_______________ _______________

Fill in the blanks in the following statements:

a. Secure fittings, urinal and ______________________________ needed to perform this task.

b. From the ______________ rough-in specifications,

determine the ____________________ of the urinal. NOTE: Use specifications for model that you will install in your booth.

c. Install __________________ and ____________________________ spuds on urinal.

d. Hang urinal with combination lag and stud ____________ or brass closet screws.

e. Connect the ___________________ piece to lower spud.

f. Install the _____________________________ trap.

NOTE: Never tighten chrome fittings with pliers or pipe wrench.

Why? ____

____

g. Install the _________________________ to the water supply and

_________________________.

h. Install _________________ _________________ between flushometer and tailpiece.

i. Turn on _________________________ supply.

j. Test for leaks.

k. Have the instructor check your work.

CHECKED BY ____________________
(Instructor)

2B-75-676

INSTALLING LAVATORIES

OBJECTIVE

This project will give you practical experience in:

1. using manufacturer's rough-in specifications.
2. installing a drain and trap.
3. installing a lavatory and faucets.

STANDARD OF PERFORMANCE

All statements must be answered correctly. All measurements must be within ± 1/2 inch and the installed unit must not leak.

EQUIPMENT

EQUIPMENT	BASIC OF ISSUE
SG 3ABR55235-IV-4	1/student
WB 3ABR55235-IV-4-P1	1/student
Manufacturer's Specifications	1/2 students
Plumber's Tool Kit	1/2 students
Shop and Special Tools	1/2 students
Faucets	1/2 students
Traps	1/2 students

Mission 1

1. Secure the tools, ________________ and equipment to do the job.
2. Obtain the manufacturer's ____ for the lavatory that you will be installing in your booth.
3. ____________________ a centerline from the waste inlet to a convenient height from the floor.
4. Locate ________________, and mark ________________ height.
5. Check fixture hanger spacing and ________________ position on the wall.
6. Locate anchor ________________ position for hanger bracket.
7. Mount lavatory on bracket and check for ______________________________.

Mission 2

1. Assemble ________________ plug and ____________________ in lavatory drain.
2. Remove ________________ nipple from waste line and replace with nipple of ________________ length.
3. Install escutcheon.
4. Install 1 1/4 inch ________________ trap.

Mission 3

1. Position lavatory faucets in place and ____________________________________.
2. Insure that water has been shut off; both hot and cold.
3. Remove hot and cold water test ______________________________ and install ____________________ nipples through finished wall.
4. Install escutcheon.
5. Make-up and install ______________ valve on end of chrome ______________.
6. Cut and fit chrome ________________ between angle valve and ______________ inlet. The ________________ wrench will be used to tighten jam nuts in hard to reach places.
7. Turn on water and check for leaks.

NOTE: Now that you have completed your tool and material list and answered all the blanks, use this information to install the lavatory in your booth.

Have the instructor check your work.

Checked by ______________________________
(Instructor)

INSULATING WATER LINES AND FITTINGS

OBJECTIVE

This project will give you practical experience insulating line and valves.

STANDARD OF PERFORMANCE

All the statements must be answered correctly and all completed work must comply to the standards in AFM 85-20.

EQUIPMENT	BASIS OF ISSUE
SG 3ABR55235-IV-5	1/student
WB 3ABR55235-IV-5-P1	1/student
Plumber's Tool Kit	1/2 students
Shop and Special Tools	1/2 students
Pipe Insulation Material	1/2 students

Mission 1

1. List the materials needed to insulate the pipe illustrated in figure 7.

_______________ _______________

_______________ _______________

_______________ _______________

2. List the tools needed to insulate the pipe illustrated in figure 56.

_______________ _______________

_______________ _______________

_______________ _______________

3. Fill in the blanks on the following statements:

a. Measure the pipe to be insulated between points "A" and "B".

b. Measure the lengths of__________ __________to cover the full length of the pipe run. Points "A" and "B".

c. Unwrap__________ __________and enclose pipe between the__________ halves of the preformed insulation.

d. Cut insulation with__________or__________.

e. Rewrap cheesecloth around section of insulation and secure with ____________ ____________ to flap.

f. Secure insulation sections in place with 3/4" metal ____________.

g. Cover fitting "C" (90° Ell) with cement and cover with ____________.

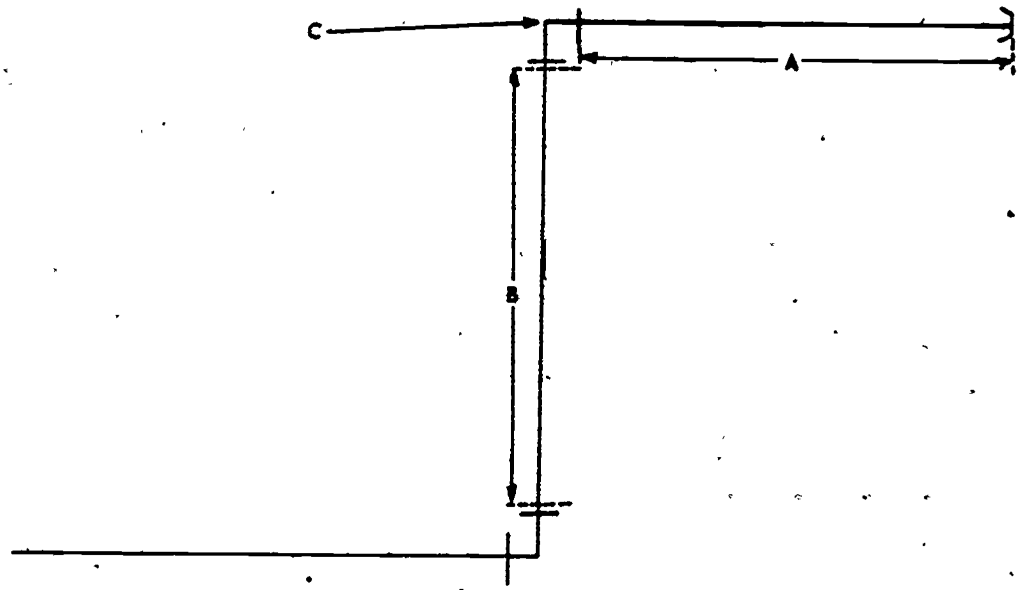


Figure 7. Pipe Insulation

Mission 2

1. Insulate the cold water line in your booth area.
2. What type of insulation did you use? ____________
3. Insulate the hot water line in your booth area.
4. What type of insulation did you use? ____________
5. Explain why you used a different type of insulation on the hot and cold water lines.

____

____

____

____

INSPECTION AND MAINTENANCE OF PLUMBING SYSTEMS

OBJECTIVE

Upon completion of this workbook, you will be able to:

1. Inspect plumbing systems
2. Maintain plumbing systems

STANDARD OF PERFORMANCE

All answers must be correct and all completed work must comply with the standards in AFM 85-20.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-IV-6	1/student
WB 3ABR55235-IV-6-P1	1/student
Manufacturer's Specifications	1/2 students
Plumber's Tool Kit	1/2 students
Shop and Special Tools	1/2 students
Tank Flush and Float Valves	1/2 students
Water Faucet	1/2 students
Flushometer	1/2 students

Mission 1

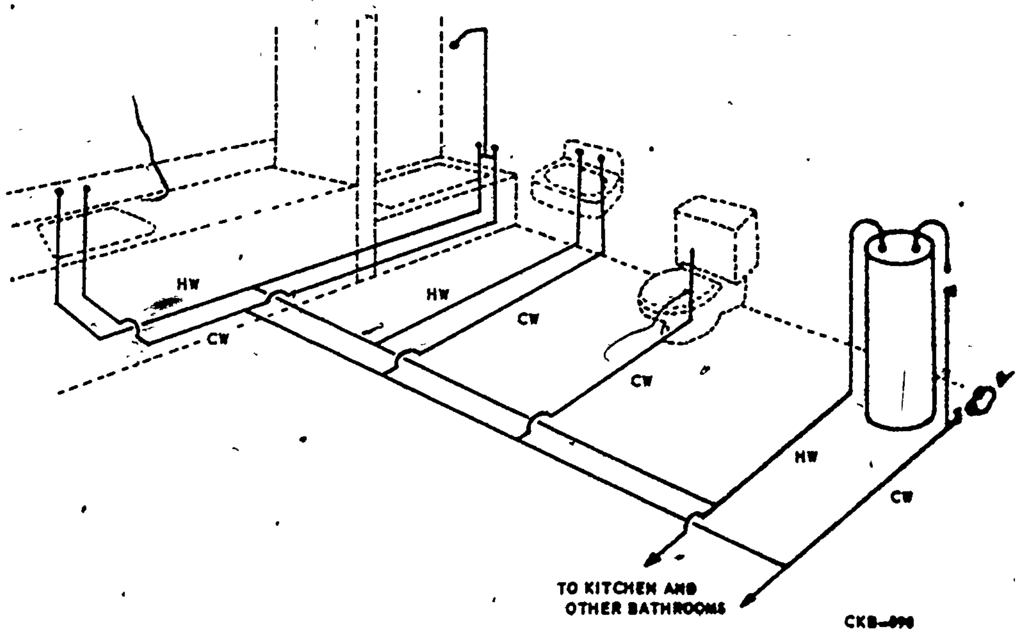
1. Describe the use of two instruments used to locate leaks in buried pipe.

a. ______________________, ______________________,
______________________, ______________________,
______________________, ______________________,
______________________, ______________________,

b. ______________________, ______________________,
______________________, ______________________,
______________________, ______________________,
______________________, ______________________.

Mission 2

1. From the drawing below, sketch in the locations where it is necessary to install air chambers.

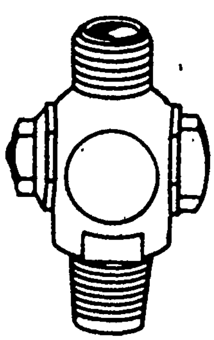


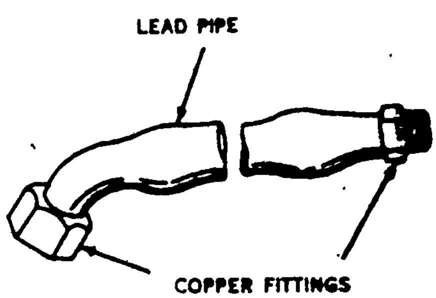
2. Explain the operating principle of an air chamber.

__________________________, __________________________,
__________________________, __________________________,
__________________________, __________________________.

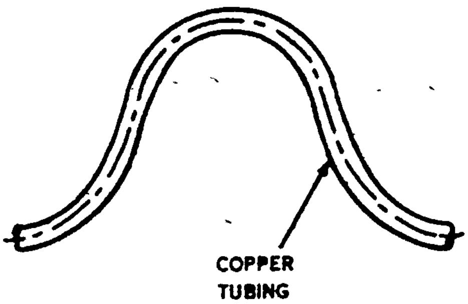
Mission 3

1. From the series of drawings, identify the units used for compensating for pipe expansion and contraction.

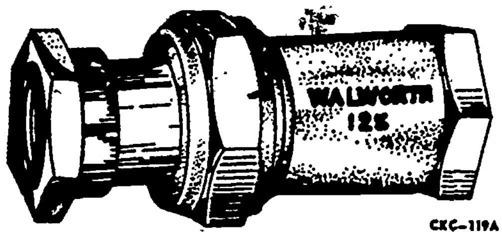




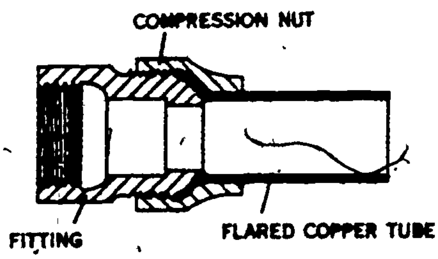
a. ____________________ b. ____________________


COPPER
TUBING

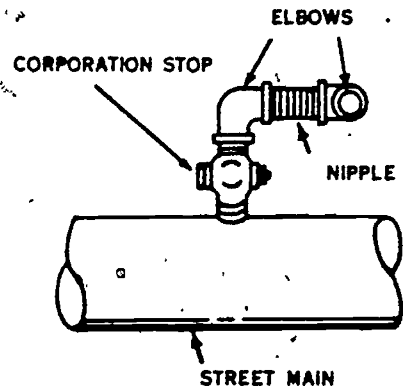
c. ______________


WALWORTH
125
CKC-119A

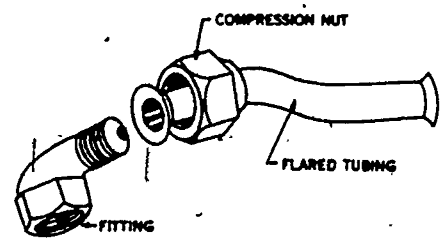
d. ______________


COMPRESSION NUT
FITTING
FLARED COPPER TUBE

e. ______________


ELBOWS
CORPORATION STOP
NIPPLE
STREET MAIN

f. ______________


COMPRESSION NUT
FLARED TUBING
FITTING

g. ______________

2. From part I, explain the principle of operation of each unit.

a. ______, ______,
______, ______.

b. ______, ______,
______, ______.

c. ______, ______,
______, ______.

d. ______, ______,
______, ______.

e. ______, ______,
______, ______.

Mission 4

1. Using an assigned fire hydrant determine the velocity and static pressure.

a. Velocity pressure______
b. Static pressure______

2. List the tools needed to perform this task.

______ ______ ______ ______

Mission 5

1. List all malfunctions or problems that must be corrected in your booth area.

______ ______ ______
______ ______ ______
______ ______ ______
______

2. List the materials that are required to repair all the malfunctions located.

______ ______ ______
______ ______ ______
______ ______ ______

Mission 6

1. List the tools necessary to repair your booth area.

______ ______ ______
______ ______ ______
______

2. List the procedures necessary to repair your booth area.

______________ ______________ ______________
______________ ______________ ______________
______________ ______________ ______________
____

Mission 7

1. Using this operational checklist of water closet flush valve and ball cock check the operation of your closet tank.

   a. Ball cock

      (1) Adjust float level and float valve operation.

      (2) Repair or replace damaged floats.

      (3) Repair or replace valve to provide a tight closure.

      (4) Inspect seat washer or bottom of plunger for wear and seat irregularity. (Repair or replace)

   b. Flush valve

      (1) Inspect and clean flush ball and machined seat. (Replace if necessary.)

      (2) Check list wires or linkage to flush handle. (Repair or replace.)

      (3) Check flush handle that it moves freely and that arm is properly set.

   c. Check refill tube.

2. List the malfunctions found on the closet tank in your booth area.

______________ ______________ ______________
______________ ______________ ______________
____

Mission 8

Check and repair the faucets in your lavatory using these procedures for maintenance on faucets.

1. Turn off water.

2. Turn valve stem to a partly open position.

3. Remove handle (if required).

4. Remove escutcheons (if required).

5. Unscrew bonnet nut (use smooth jaw wrench).

6. Remove stem from valve body.

7. Remove the disc from its holder (replace disc).

8. Inspect valve seat for pitting (If pitting is severe the entire valve should be replaced. If slightly pitted, reface seat.)

9. Assemble valve and check for leaks.

10. If leakage around stem tighten backing.

NOTE: If stick leaks, replace packing.

Mission 9

Do maintenance of a flushometer using this checklist.

1. Adjust for flush of 10 seconds.

2. If malfunctions, clean bypass to upper chamber.

3. Clean valve seat.

4. Replace gaskets or diaphram as required.

5. Assemble and check for leaks.

6. If still malfunctions, replace unit.

Mission 10

From the drawings below identify thermostatic and pressure control mixing valves.

RECOVERING AND RESTORING PIPING AND FIXTURES

OBJECTIVE

This project will give you practical experience removing, inspecting, and salvaging pipes and fittings from a water and waste system.

EQUIPMENT

EQUIPMENT	BASIS OF ISSUE
SG 3ABR55235-IV-7	1/student
WB 3ABR55235-IV-7-P1	1/student
Manufacturer's Specifications	1/2 students
Plumber's Tool Kit	1/2 students
Shop and Special Tools	1/2 students

Mission 1

PROCEDURE

Answer the following questions on the blank lines provided.

1. What is the first procedure required when disassembling a water system?

____

____

2. What two ways should a water system be disassembled?

____

____

3. Where should you start when disassembling a waste system?

____

____

4. What are the safety precautions that should be observed when using a torch on a waste system?

____

____

____

Mission 2

DISASSEMBLING WATER SUPPLY PIPING

1. List tools needed to perform this task.

____
____
____
____
____

2. Shut off _______________ and bleed (drain) off contents of lines to be assembled.

3. Begin disassembly by disconnecting the piping at a _______________ and work in both directions or start it at fixture and work back.

NOTE: DO NOT DAMAGE FIXTURES

4. Clean all pipe and fittings using _______________ brush or rags.

5. Clean and assemble all unions.

6. Inspect and dispose of _______________ pipe and fittings.

7. Return cleaned usable pipe and fittings to proper storage _______________.

Mission 3

DISASSEMBLING CAST-IRON PIPING

1. List tools needed to complete this task.

____
____
____
____

2. Disassemble cast-iron piping in convenient sections, starting at the highest point of connection. Pick out lead and oakum, if there is ____________________ in using a torch during disassembly.

   CAUTION: Avoid damage to floors, walls or ceilings.

3. After the sections have been removed, use ____________________ and melt out the lead in the joints.

4. Direct the flame of the torch on the joint until the lead will run out freely. Wear gloves, goggles, and have ____________________ when using flame torches. Do not overheat lead because it oxidizes and becomes useless.

5. Reclaim lead and store for future use.

6. Move the pipe back and forth to loosen it, then withdraw the pipe.

7. ____________________ out pipe and fittings and discard the ones that are cracked.

8. Clean ____________________ pipe and fittings and return them to storage.

Mission 4

DISASSEMBLING COPPER PIPE AND FITTINGS

1. List tools and equipment needed to complete this project.

   ____

   ____

   ____

   ____

   ____

2. Disassemble copper pipe, starting either at the fixture, or use tubing cutter to ____________________ pipe and work both ways.

3. Make sure water is drained from all pipe and fittings.
4. Apply heat to melt the ______________ in the joint.
5. Clean and inspect fittings for serviceability
6. Return usable fittings to the proper storage area.
7. Have the instructor check this workbook.

Checked by: ______________________
(Instructor)

PLANNING AND LAYOUT OF PLUMBING SYSTEM

OBJECTIVE

To give you practical experience planning and laying out a typical building plumbing system.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-IV-8	1/student
WB 3ABR55235-IV-8-P1	1/student
Floor Plan	1/12 students
Working Drawing	1/12 students
Miniature Pipe and Fitting	1/4 students

Mission 1

Procedures

1. Using the blueprints provided in this workbook, construct a working drawing of the model house. (Note: The instructor will divide class into four groups and assign each group a section of the blueprint.)

2. Using the working drawing in Part I, make a bill of materials including all takeoff items.

ITEM	DESCRIPTION	QUANTITY	SIZE

3. Using the blueprints in Part I and the materials from the bill of materials, draw the materials from supply and install the waste and vent systems in the model house.

MODIFICATIONS

Foldouts 1-3 of this publication has (have) been deleted in adapting this material for ~~inclusion~~ in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE: B.R. Errington TCETC 12Sep75	INSTRUCTOR
COURSE NUMBER: 3ABR55235	COURSE TITLE: Plumbing Specialist
BLOCK NUMBER: V	BLOCK TITLE: Utility Equipment

LESSON TITLE: Winterization of Piping (Day 38)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
2 Hrs	0	2 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
54	2 July 1975	1

STS/CTS REFERENCE

NUMBER	DATE
552X5	17 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools	None	None	SG V-1 WB V-1-P1 National Plumbing Code Slides: Winterization of a Building Plumbing System, Techniques in Thawing Pipe

CRITERION OBJECTIVES AND TEACHING STEPS

1a. Working as a member of a team, winterize the plumbing fixtures in the building latrine. All water must be removed from the fixture traps.

(1) Purpose
(2) Effects of frozen pipe
(3) Ways to prevent freezing of piping
(4) Procedure for closing up buildings that are not in use

1b. Working as a member of a team, and using either a propane torch or rags and hot water, thaw a frozen pipe (frozen pipe may be simulated). The pipe must be heated until it is warm when touched.

(1) Locating frozen area
(2) Theory of heat transfer
(3) Ways to thaw pipes

ATC FORM AUG 72 770

COURSE NO: 3ABR55235
DAY: 38

BRANCH APPOVAL: [signature]
Date: 17 September 1975

Part II

INTRODUCTION (15 minutes)

CHECK PREVIOUS DAYS STUDY ASSIGNMENT:

REVIEW: None

ATTENTION:

OVERVIEW:

MOTIVATION.

BODY (95 minutes)

PRESENTATION:

1a. Working as a member of a team winterize the plumbing fixtures in the building latrine. All water must be removed from the fixture traps.

(1) Purpose: To prevent water in the pipe from freezing

NOTE: Ice takes up 1/12 more space than water.

(2) Effects of frozen pipe

(a) Weakens pipe

(b) Bursting of pipe and connections causing leaks

(3) Ways to prevent freezing of piping

(a) Bury pipe below frost line

(b) Install wrapping

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3 Use sponge to remove remaining water from tank and bowl

(c) Draining water heater

1 Shut off source of heat

2 Open drain plug or valve

3 Allow air to enter tank

(d) Winterizing waste system

1 Fill traps with anti-freeze

a Types of anti-freeze used

(1) Glycol very effective because it will not evaporate

1 Materials used

a Insulation

b Rags

c Paper

(c) Use heat tapes

(4) Procedure for closing up building that are not in use

(a) Drain water system first.

1 Close supply valve

2 Open highest faucet

3 Open lowest faucet

4 Let lines drain

(b) Empty water closet

1 Flush water from tank

2 Use force plunger to remove water from bowl

3 Water flows at one fixture but no flow at next fixture down-stream-pipe is frozen between the two fixtures

(b) Drainage lines

1 Open valves at fixtures

2 If no drainage area is frozen

(2) Theory of heat transfer

(a) Apply heat to pipe

(b) Pipe transmits heat to ice

(c) Ice melts next to pipe allowing some water to flow

(d) Water flowing plus heat thaws pipe

(3) Ways to thaw pipes

(a) Hot water and rags (raises temperature of pipe)

(2) Glycerine and water

(3) Alcohol and water normally not used due to evaporation

(4) Calcium chloride and water - normally not used due to corrosive action

1b. Working as a member of a team and using either a propane torch or rags and hot water, thaw a frozen pipe (frozen pipe may be simulated). The pipe must be heated until it is warm when touched.

(1) Locating frozen area

(a) Water lines

1 Open valves at fixtures

2 Use process of elimination

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b Affixation

c Burns

(c) Electrical devices

(best methods)

1 Faster and safer

2 Most convenient Method

3 Used on pipes in ground or concealed in wall

4 Connecting electrical device to pipe

a Clean contact area with emery cloth

b Make sure connections are tight

c Use C clamps or Thawing clamps to make connections

1 Wrap rags around frozen are

2 Pour hot water on rags

3 Continue until thawed

4 Hazards

a Scalding personnel

b Slippery floors

c Damage to building

(b) Torches

1 Light torch and adjust flame

2 Move flame slowly across frozen area until water flows

3 Hazards

a Fire

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(3) Will produce at least 250 amps.

(4) May also be used for welding

c Heat tapes

(1) Composed of electrical heating element in wire form

(2) Plugs into 110 volt A.C. power source

(3) Wrap in spiral motion around frozen area

(4) Very slow in thawing

(d) Safety precautions when using electrical devices

1 Don't touch exposed terminals

5 Type of electrical devices used

a Low voltage transformers

(1) Plugs into 110 or 220 Power Source

(2) Transformer steps voltage down and current up

(3) High current flow through pipe will heat pipe and melt ice

b Electrical welding unit

(1) Portable self contained gas driven unit

(2) Some are plugged into 110 or 220 volt AC power source

~~b Pour into drain~~

c Heat from chemicals thaws pipes

3 Hazards

a Chemical burns

b Explosions

c Damage to pipe or building

NOTE: Do not use on pipes that are completely clogged

(f) Thawing drainage lines with hot water

1 Run hose down pipe to frozen area

2 Attach funnel to open end of hose

3 Pour hot water into funnel

2 Keep connections tight

3 Select contact location as close as possible to frozen area.

4 Remove ground wire from area to be thawed

5 Use copper jumpers on joints with gaskets or other insulation

(3) Chemical thawing of drainage lines

1 Chemicals used

a Lye

b Unslaked lime

2 Application

a Mix in container

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APPLICATION: Complete Exercise
1 and 2 of WB
WB 3 ABR55235-V-1-P1

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 minutes)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMET: None

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE: TCETC/5Sep75	INSTRUCTOR
COURSE NUMBER: 3ABR55235	COURSE TITLE: Plumbing Specialist
BLOCK NUMBER: V	BLOCK TITLE: Utility Equipment

LESSON TITLE: Maintenance of Valves (Day 38)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
4 Hrs	2 Hrs	6 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
55	2 July 1975	2

STS/CTS REFERENCE

NUMBER	DATE
552X5	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools Shop Tools Valve Repair Kit Plumbing Valves	None	None	SG V-2 WB V-2-P1 Slides: Valves Used in Plumbing Systems Training Film: FLC 16/118 Piping Painters

CRITERION OBJECTIVES AND TEACHING STEPS

2a. Given a globe valve, locate and name each of the major components. All components must be correctly named.

(1) Purpose of valves
(2) Types of valves
(3) Characteristics of valves

2b. Following given instructions, repair a globe valve. The completed valve must open and close easily but must not leak when closed.

(1) Gate valve
(2) Globe valve
(3) Angle valve
(4) Check valve
(5) Plug valve

ATC FORM AUG 72 770

Course No: 3ABR55235
Day 38

Branch Approval: Bobby G Littlejohn
Date: 8 September 1975

PART II

INTRODUCTION (45 Minutes)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (180 Minutes)

PRESENTATION:

2a. Given a globe valve, locate and name each of the major components. All components must be correctly named.

(1) Purpose of valves

(a) Isolates parts of plumbing system

(b) Controls rate of flow of liquids and gases

(c) Controls direction of flow

(d) Drains system

(2) Types of valves

(a) Gate

(b) Globe

(c) Angle

(d) Check

(e) Plug

(3) Characteristics of valves

(a) Gate valve

1 Can't be used to control rate of flow

2 Must be fully open or fully closed

3 When opening or closing back off 1/4 to 1/2 turn to prevent wedging

4 Construction

a Valve body

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b Bonnet

c Stuffing box

d Stem

e Seat ring

f Disc

(b) Globe valve

1 Can be used to throttle flow

2 Construction

a Valve body

b Seat

c Stem

299

d Disc stem ring

e Bonnet

f Packing

g Packing nut

h Disc

1 Types of disc

a Plug disc

b Conventional disc

c Composition disc

(c) Angle valve

1 Changes direction

2 Purpose and construction same as globe valve

(d) Check valves

1 Provides free flow in one direction only

2 Basic types of check valves

a Swing check

b Lift check

3 Construction

a Swing check

1 Body

2 Hinged disc

3 Body seat ring

b Lift check

1 Body

301

2 Body seat ring

3 Disc

(e) Plug valves

1 Opened and closed with 1/4 turn of handle

2 Places used

a Corporation stop

b Stop and waste valve

c Curb stop

d Meter stop

e Gas lines

370

3 Construction

a Tapered plug with passable way

b Tapered hole in valve body

4 Operation

a Unobstructed flow when passage in plug is aligned with piping

b When valve is closed close mating surface between tapered plug and tapered hole stops flow

2b. Following given instruction, repair a globe valve. The completed valve must open and close easily but must not leak when closed.

(1) Gate valve

303

(a) Leaks around stem

1 Tighten packing nut

2 Replace packing

(b) Internal leakage

1 Reface disc by using mixture of oil and lapping compound

2 Surface of disc and seat may be lapped true to each other by using figure eight motion

(c) Leaks at body bonnet joint

1 Tighten joint

2 Replace gasket

(2) Globe valve

(a) Leaks around stem

1 Tighten packing nut

2 Replace packing

(b) Internal leakage

1 Valves with plug or conventional disc

a Insert washer or coin under disc

b Lap disc to the seat using mixture of oil and lapping compound

2 Valves with composition disc

a Remove defective disc

b Install new disc

3 Damaged valve seats

a Reface valve seat with re-seating tool

b Remove and replace valve seat if replaceable type is used

4. Leaks at body - bonnet joint

a Tighten joint

b Replace gasket

(3) Angle valve - repaired same way as globe valve

(4) Check valves

(a) Replace hinge or hinge pin when necessary

(b) Tighten hinge disc bolt if loose

(c) Defective disc face and disc seats should be replaced reground or laprred

(5) Plug valves

(a) If valve leaks, clean and lubricate

(b) If valve seat is severly pitted, replace valve

APPLICATION:

Have students complete WB 3ABR55235-V12-P1

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (15 Minutes)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

Have students read SG 3ABR55235-V-3 and answer the questions at the end of chapter.

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE: TCETC/5Sep75	INSTRUCTOR
COURSE NUMBER: 3ABR55235	COURSE TITLE: Plumbing Specialist
BLOCK NUMBER: V	BLOCK TITLE: Utility Equipment

LESSON TITLE: Maintenance of Sewers and Grease Traps (Day 39)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
6 Hrs	2 Hrs	8 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
56	2 July 1975	3

STS/CTS REFERENCE

NUMBER	DATE
552X5	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools Shop Tools Grease Trap	Power Auger Pipe Detection Instrument and Devices	None	SG V-3 WB V-3-P1 and P2 Slides: Maintenance of Main Sewer and Maintenance of Grease Traps

CRITERION OBJECTIVES AND TEACHING STEPS

3a. Working as a member of a team and using an engine or electrically powered auger, steel tape or chemicals, clean a sewer line. Cleaned line must pass water readily.

(1) Checking for stoppages in sewer main
(2) Cleaning sewers
(3) Repairing sewer lines
(4) Hazards of manholes
(5) Hazards of equipment
(6) Maintenance of building sewers
(7) Maintenance of building drainage systems

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LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

3b. Using maps, probes, or electrical instruments, locate buried pipe. Two or more students must individually locate the same pipe.

(1) Maps
(2) Sighting from one manhole to another
(3) Probes
(4) Electronic equipment

3c. Following given procedures and working as a member of a team, inspect and clean a grease trap or septic tank. The cleaned grease trap or septic tank must operate correctly without leaking and without undue odor.

(1) Purpose of grease traps
(2) Operation
(3) Cleaning

Course No: 3ABR55235
Day: 39
Day

Branch Approval: [signature]
Date: 8 September 1975

PART II

INTRODUCTION (45 Minutes)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

3

BODY (5 Hours 5 Minutes)

PRESENTATION:

3a. Working as a member of a team and using an engine or electrically powered auger, steel tape or chemicals; clean a sewer line. Cleaned line must pass water readily.

(1) Checking for stappages in sewer main

(a) Observe flow at man holes

1 Plug off section of sewer main at man holes with sand bag or pneumatic ball

2 Fill section and man hole with water

3 Remove plug

(b) Observe rate of flow at next man hole

312

1 Fast flow, no stoppage

2 Slow flow indicates stoppage

(2) Cleaning sewers

(a) Fire hose

(b) Pneumatic ball

1 Inflate ball and insert in line

2 Fill man hole with water

3 When water force becomes great enough, ball will move

4 Water will spurt around ball forcing sand and grit forward to the next man hole

(c) Sewer hoe

1 Use on large sewers (30 inches or more)

2 Similiar action to pneumatic ball,

3 Flexible belting cleans side of piping

4 Hoe moves over fixed objects because of flexibility of belting

5 Sewage moves sewer hoe forward

(d) Power driven sewer auger

1 Components

a J tube

b Rod

c Rodding heads

d Gasoline engine

e Trailer

2 Operation of power driven sewer auger

a J tube guides rod into sewer (must insert cable through "J" tube)

b Rodding heads punch or cuts through stoppage

c Gasoline engine drives cutting head

d Rods come in 3' lengths

e Takes three people to operate

f Oil after each use

3 Use of chemicals

a Use after rodding

b Never use chemical if sewer is completely stopped up

c Copper sulphate

1 Effective in root removal

316

2 Use where obstruction is not severe

3 May take from one to three weeks before roots die and break free

4 Use every 30 days

(3) Repairing sewer lines

(a) Isolate defective section from one man hole to another with sand bags

(b) Pump sewage to another man hole.

(c) Repair defective section

285

(4) Hazards of man holes

(a) Sewer gases are greatest hazard

(b) Sewer gas is explosvie, toxic and will explode

(c) Remove man hole covers and air before entering

(d) Use buddy system

(e) Tie rope around waist of person entering man hole

(f) Worker should wear portable respirator when working in man hole

(5) Hazards of equipment

(a) Avoid clothes catching in rods

313

(b) Wear gloves to prevent cutting of hands

(c) Have all electrical devices grounded

(d) Use proper shoring methods when replacing sewer main sections

(e) Handle heavy piping and equipment correctly to prevent personnel injury

(f) Guard against whipping of snakes

---

(6) Maintenance of building sewers

(a) Removing stoppages

1 Snakes

a Ribbon snake made of coiled tempered wire

2 Power driven sewer auger

a Cutting head

b Flexible steel cable

c Electric motor

(b) Use of chemicals if line is not completely stopped

(7) Maintenance of building drainage system

(a) Check drains for

1 Leaks

320

200

2 Clogged traps

3 Trap syphonage

4 Clogged vents

5 Clogged drains

6 Grading of lines

7 Excessive directional changes

(b) Unstopping sinks, lavatories tubs, shop sinks

1 Vacuum plunger

a Used on flat surfaces

289

b Operation

1 Plug over-
flow

2 Center dup
over drain

3 Push down and
pull up on
handle

4 Alternate
pressure and
suction strokes
works
obstruction
loose

2 Clean trap

a Remove cleanout
plug and remove
stoppage with
wire

b Remove trap if
no clean out plug
is available

322

3 Sink auger

a Flexible coiled steel

b Remove trap and insert

c Rotate and push in

d After unstopped chemicals can be used

e Never use chemicals if drain is completely stopped up

(c) Unstopping water closets

1 Force cup

a Used on cone shaped surface

b First tool used

c Operate same as vacuum plunger

2 Closet auger

3 Remove water closet and use sink or sewer auger

3b. Using maps, probes, or electrical instruments, locate a buried pipe. Two or more students must individually locate the same pipe.

(1) Maps

(a) Information shown on maps

1 Location of sewer piping

2 Location of man holes

3 Elevations - depth of buried pipe

4 Type and size of pipe

5 Locations of buildings

(b) Interpretation of maps

(2) Sighting from one man hole to another (easiest)

(3) Probes

(a) Used on shallow lines

(b) First find general location by sight

(c) Push probe in soil until pipe is located

(d) Probe is used when several pipes are in same area

(4) Electronic equipment

(a) Types

1 Metal detector

2 Sound detector

(b) Operation

3c. Following given procedures and working as a member of a team, inspect and clean a grease trap or septic tank. The cleaned grease trap or septic tank must operate correctly without leaking and without undue odor.

(1) Purpose of grease traps

(a) Catch and remove grease from waste

(b) Serves as a trap

(2) Operation

(a) Baffle chambers slows up movement of waste and cools grease

(b) Grease being lighter than water rises to the top (inlet on large traps near the top)

(c) Grease is trapped in baffle chambers

(d) Water free of grease is drawn from bottom of trap and passed on to sanitary sewer

(3) Cleaning

(a) Must be cleaned according to use

1 Check liquid level

2 Grease accumulation

3 Check solids retained

(b) Procedures

1 Remove cover

2 Skim off grease with perforated scoop

3 Remove putrid material from trap with perforated scoop

(4) Installation

(a) Close to fixture

(b) Outside building (near building drain)

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APPLICATION:

Complete WB 3ABR55235-V-3-P1 and P2

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 Minutes)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

Read and answer questions in SG 3ABR55235-V-4

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE	INSTRUCTOR
TCETC/9Sep75	
COURSE NUMBER	**COURSE TITLE**
3ABR55235	Plumbing Specialist
BLOCK NUMBER	**BLOCK TITLE**
V	Utility Equipment

LESSON TITLE
Emergency Maintenance of Exterior Piping (Day 40)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
6 Hrs	2 Hrs	8 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
58	2 July 1975	4

STS/CTS REFERENCE

NUMBER	DATE
552X5	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools Shop Tools	None	None	SG V-4 WB V-4-P1 Slides: Emergency Maintenance of Exterior Piping

CRITERION OBJECTIVES AND TEACHING STEPS

4a. Given specific tools, equipment and instructions, make a temporary repair to a line by installing a clamp-on repair device. Completed repair must withstand base water pressure without leaking.

(1) Purpose of temporary repair
(2) Type repair clamps and saddles

4b. Using given instructions, grooved pipe and necessary fittings, assemble a grooved pipe connection. Completed connection must withstand base water pressure without leaking.

(1) Purpose
(2) Type materials

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LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

(3) Components of mechanical grooved coupling
(4) Assembly of mechanical grooved coupling
(5) Procedures for using grooving tool
(6) Cutting pipe for grooving

Course No: 3ABR55235
Day: 40

Branch Approval: Robert R. Heworth
Date: 10 September 1975

PART II

INTRODUCTION (45 Min)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (5 Hrs 5 Min)

PRESENTATION:

4a. Given specific tools, equipment and instructions, make a temporary repair to a line by installing a clamp-on repair device. Completed repair must withstand base water pressure without leaking.

(1) Purpose of temporary repair

(a) Prevents unnecessary loss of water

(b) Minimum time without water

(2) Type repair clamps and saddles

(a) Adjustable bell joint clamps-repair leaks in bell and spigot joints

(b) Collar clamps-stop leaks through threads of screw collars

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(c) Band and saddle clamps repair pit holes and small splits

(d) Split repair clamps- repair pit holes longitudinal splits in pipe

(e) Compression clamps- repair leaks in asbestos cement and cast iron pipe

(f) Compression coupling-

1 Repair damaged section of pipe

2 Use small galvanized pipes

3 Can be used on temporary mains

4 Easier to install than mechanical grooved

4b. Using given instructions, grooved pipe and necessary fittings, assemble a grooved pipe connection. Completed connection must withstand base water pressure without leaking.

(1) Purpose

(a) Temporary water mains (steel grooved piping)

(b) Permanent installations where ground is unstable

(2) Type materials

(a) Steel

(b) Cast aluminum

(c) Plastic

(3) Components of mechanical grooved coupling

(a) Upper housing

(b) Lower housing

(c) Rubber gasket

(d) Retaining nuts and bolts

(4) Assembly of mechanical grooved coupling

(a) Usually assembled on top of ground

(b) Apply grease to grooved ends and inner face of gasket

(c) Slide gasket on one end of pipe

(d) Bring pipe ends to within 1/4 inch of each other

(e) Center gasket over each end of pipe

(f) Install housings of mechanical grooved coupling

(g) Insert bolts and tighten evenly

NOTE: Upper and lower housing ends must meet to be tight

(5) Procedures for using grooving tool

(a) Slide tool over end of pipe until stop hits end of pipe

(b) Tighten clamp screws (holds machine in position)

(c) Loosen wing nuts and set spring fed blade in position

(d) Rotate with ratchet handle

(e) Cutting blade automatically disengages

(6) Cutting pipe for grooving

APPLICATION:

Complete WB 3ABR55235-V-P1

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 Min)

SUMMARY:

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REMOTIVATION:

STUDY ASSIGNMENT:

Read and answer questions at end of text.

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LESSON PLAN (Part I, General)

1C ... 9Sep75	INSTRUCTOR
	TITLE: Plumbing Specialist
	Utility Equipment

Fire Hydrants and Sprinkler Systems (Days 41 and 42)

LESSON LENGTH

	SUPPLEMENTARY	TOTAL
12 Hrs	0	12 Hrs

POI REFERENCE

	PAGE DATE	PARAGRAPH
60	2 July 1975	5

STS REFERENCE

552X5	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools Shop Tools	Fire Hydrant Plastic Pipe	None	SG V-5 WBs V-5-P1; P2; and P3 Slides: Maintenance of Fire Hydrants and Maintenance of Sprinkler Systems

CRITERION OBJECTIVES AND TEACHING STEPS

5a. Disassemble, check, repair (if necessary), and reassemble a fire hydrant. Completed fire hydrant must be assembled correctly.

(1) Models of fire hydrants
(2) Location of fire hydrants
(3) Components of fire hydrants
(4) Installation of fire hydrants
(5) Inspection and maintenance of fire hydrants
(6) Fire protection sprinkler systems

5b. Measure, cut, and assemble plastic pipe to install a portion of a lawn and sprinkler system. All measurements must be within $\pm$ 1/8 inch of given specifications.

(1) Characteristics
(2) Effects of temperature

ATC FORM AUG 72 770

(3) Advantages of plastic
(4) Types of plastic
(5) Assembly of plastic pipe
(6) Laying plastic pipe in trench
(7) Types of lawn sprinkler systems

5c. Using given instruction and working as a member of a team, inspect a pneumatic system for operation and identify the major components. All components must be identified correctly.

(1) Purpose and application of a pneumatic system
(2) Major components

Course No: 3ABR56235
Days 41 and 42

Branch Approval: [illegible]
Date: 10 September 1975

PART II

INTRODUCTION (45 Min)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

3

BODY (11 Hrs 5 Min)

PRESENTATION:

5a. Disassemble, check, repair (if necessary), and reassemble a fire hydrant. Completed fire hydrant must be assembled correctly.

(1) Models of fire hydrants

(a) Flush model

1 Located in manholes below ground level

2 Used in heavy traffic areas

(b) Traffic model

1 Designed to prevent serious damage when hit by traffic

2 Has break away feature

a Safety flange, bolts or ring protects barrel

b Water pressure holds main valve closed to prevent loss of water

(c) Standard model

1 Similar to traffic model except for break away feature

2 Internal parts same as flush model

(2) Location of fire hydrants

(a) Placed at least two feet and not more than six feet from a paved street

(b) Placed at least 3 feet from any fixed object doorway or traffic lane

(c) Should be accessible for immediate use

(3) Components of fire hydrants

(a) Operating nut

(b) Oil filler plug

(c) Bonnet

(d) Stem packing

(e) Pumper nozzle

(f) Hose nozzles

(g) Upper barrel

(h) Upper stem

(i) Safety stem coupling

(j) Safety flange

315

(k) Lower stem

(l) Lower barrel

(m) Drain valve

(n) Main valve

(4) Installation of fire hydrants

(a) Height

1 Lowest outlet at least 18 inches above surface of ground

2 Operating nut not more than 48 inches above ground surface

(b) Water supply line

1 Six inch connecting line to water main

2 Isolation valve in connecting line to shut off water to hydrant

3 Bury connecting line below frost line

(c) Mounting of fire hydrant

1 Set hydrant on concrete base at least 16 inches square and 4 inches thick to prevent settling

2 Brace side of hydrant opposite water entrance with brick to prevent blow off

3 Use briddle rods and clamps to secure hydrants to water main if soil is unstable

4 Pack at least 7 cubic feet of crushed rock around base of hydrant

5 Replace dirt around hydrant in layers and tamp each layer

(d) Facing of nozzles

1 Remove all barrel flange bolts and nuts

2 Turn operating nut slightly in opening direction to relieve compression between barrel sections

3 Rotate upper barrel section as desired

4 Turn operating nut in closing direction

5 Replace all barrel flange bolts and nuts and tighten

NOTE: On some hydrants the barrel can be rotated after loosening flange bolts

(e) Extending height of hydrant

1 Purpose: Compensates for changes in ground level

2 Extension sections

a Length-6" through 4' in 6" increments

b Installed between upper and lower barrels

3 Stem extension-extends length of stem

4 Installing extension sections

349

a Remove cap and cover plate assembly

b Unbolt standpipe top section from standpipe bottom section

c Screw stem extension piece to original stem

d Drill and pin stem extension piece to original stem

e Bolt extension to standpipe bottom section, using new gasket

f Bolt stadpipe top section to spool using new gaskets

g Replace cover plate assembly and cap

(5) Inspection and maintenance of fire hydrants

(a) Leakage at hose outlet

1 Defective main valve or seat

2 Replace main valve and seat

(b) Leakage at top of hydrant

1 Tighten packing gland

2 Replace packing

(c) Leakage through drain valve

1 Indication water comes up around hydrant when main valve is fully open

351

2 Correct by replacing valve facing or gasket

(d) Leakage past gaskets under caps

1 Open main valve

2 Check for leakage around caps

3 Replace defective gaskets

(e) Check operation of drain valve

1 Close main valve

2 Observe lowering of water in barrel

NOTE: Slow lowering of water in barrel can be caused by leakage past main valve or drain valve clogged

(f) Clearing clogged drain parts

1 Tighten all nozzle caps

2 Open main valve two complete turns and force flush drain parts

3 Close main valve

4 Remove nozzle cap and check lowering of water level in barrel

CAUTION: Remove nozzle cap slowly and let trapped air escape

(g) Lubrication of operating nut

1 Remove screw in top of operation nut

353

2 Apply lubricant recommended by manufacturer

(h) Inspect nozzle threads - replace nozzle if threads are badly damaged

(i) Inspect operating nut (replace nut if rounded by use of improper wrench)

(j) Check for cracks in barrel

1 Install new barrel if cracked

2 Replace hydrant when required

(k) Check static pressure

1 Connect pressure guage to hose outlet

2 Open hydrant valve

3 Record reading-
pressure guage

4 Close hydrant

(l) Check residual pressure

1 Remove second
hydrant nozzle cap

2 Open hydrant valve
slowly until wide
open

3 Record residual
pressure while
hydrant is discharging
maximum stream

(m) Removal of main valve

1 Remove hold down nut

2 Remove operating nut

3 Unbolt and remove hydrant bonnet

4 Insert seat wrench over top of valve stem and into hydrant barrel

5 Fasten seat wrench down to seat ring by screwing operating nut down on threaded portion of hydrant

6 Close isolation valve

7 Break bond between seat ring and shoe by striking top of seat wrench

8 Unscrew seat ring by turning seat wrench counter clockwise

9 Replace worn and damaged parts

10 Screw seat ring in place by turning seat wrench

11 Open isolation valve

12 Reassemble bonnet to hydrant by reversing steps used in removal

(6) Fire protection sprinkler system

(a) Purpose-prevents fires from spreading and sends the alarm to the fire department

(b) Types of sprinkler systems

1 Dry

2 Wet

3 Deluge

357

(c) Wet pipe system

1 Piping filled with water under pressure at all times

2 Heating sensing element integral part of sprinkler head

3 Heat from fire melts heat sensing element in affected area

4 Water flow long sends alarm to fire department

(d) Dry pipe system

1 Used where there is danger of freezing

2 Distribution piping contains air under pressure

3 When sprinkler head opens air escapes

4 Dry pipe valve operates admitting water to system

(e) Deluge system

1 Automatic dry pipe system

2 Has open sprinkler heads

3 Operation

a Deluge valve opens automatically by heat actuated device

b When deluge valve opens system is completely charged with water

c Water escapes through all open sprinkler heads over entire area

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APPLICATION:

Complete WB 3ABR55235-V-P1

CONCLUSION (Day 14)

SUMMARY:

STUDY ASSIGNMENT:

SG 3ABR55235-V-5 Pages 64 thru 73

INTRODUCTION (Day 42)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT

REVIEW:

OVERVIEW:

PRESENTATION:

5b. Measure, cut, and assemble plastic pipe to install a portion of a lawn and sprinkler system. All measurements must be within ± 1/8 inch of given specifications.

(1) Characteristics

(a) Rust proof and will not rot

(b) Smooth interior walls

(c) Light weight

(d) Non-electrolytic

(2) Effects of temperature

(a) Expands and contracts

(b) Allowable pressure decreases as temperature increases

(3) Advantages of plastic piping

(a) Excellent chemical resistance

(b) No galvanic action

(c) Low internal friction

(d) Low tendencies to collect crystalline deposits

(e) Low installation and maintenance cost

(f) Easy to install

(4) Types of plastic pipes

(a) Acrylonitrile-butadeine and styrene (ABS)

(b) Polyvinyl chloride (PVC)

(c) Polyethylene

(5) Assembly of plastic pipe

(a) Cutting

1 Hacksaw

2 Handsaw

3 Tubing cutter

4 Pipe cutter

5 Knife

(b) Types of connections

1 Solvent weld
(PVC and ABS)

a Assembly procedures

b Safety precautions

363

(7) Types of lawn sprinkler systems

(a) Movable

1 Constructed of light-weight material

a Aluminum

b Plastic

2 Easily maintained

3 Easy to couple and disconnect

4 Adaptable to most water supplies

a Fire hydrant

b Household water supply

2 Insert fittings and clamps

a Assembly procedures

b Safety precautions

3 Threaded joints

a Thick wall plastic pipes

b Types of threaders usable

c Assembly procedures

d Safety precautions

(6) Laying plastic pipe in trenches

a Pump

b Piping

c Control valves

d Sprinkler heads

5c. Using given instructions and working as a member of a team, inspect a pneumatic system for operation and identify the major components. All components must be identified correctly.

(1) Purpose and application of a pneumatic system

(a) Fire sprinkler system

(b) Pneumatic tools

(c) Paint spray units

(2) Major components

(a) Compressor-provides volume and pressure

1 Electric motor driven

2 Gasoline engine driven

3 Diesel engine driven

(b) Accumulator - provides storage of compressed air

(c) Valves

1 Check-prevents backflow of air from reservoir to pump

2 Opens and closes air passages to distribution lines

3 Opens moisture drains

4 Relieves excess pressure (automatic)

(d) Switches

1 Starts and stops driving source manually

2 Starts and stops driving source upon demand (automatic)

(e) Pressure regulator- controls pressure

(f) Gages- indicate pressure

(g) Moisture separator

1 Collects moisture from discharge side of reservoir

2 Collects moisture at discharge side of pressure manifold

(h) Piping-black iron

APPLICATION:

Complete WB 3ABR55235-V-5-P1, WB 3ABR55235-V-5-P2, and WB 3ABR55235-V-5-P3.

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

SG 3ABR55235-V-7 and SG AFS 55, 56

LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE	INSTRUCTOR
TCETC/9Sep75	
COURSE NUMBER 3ABR55235	COURSE TITLE Plumbing Specialist
BLOCK NUMBER V	BLOCK TITLE Utility Equipment

LESSON TITLE
Utility Equipment (Day 43)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
6 Hrs	0	6 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
61	2 July 1975	6

STS/CTS REFERENCE

NUMBER	DATE
552X5	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Hand Tools Shop Tools Water Coolers	None	None	SG V-6 WB V-6-P1 and P2 TO 32-1-101 Slides: Utility Equipment and Utility Equipment Water and Drain Systems

CRITERION OBJECTIVES AND TEACHING STEPS

6a. Working as a member of a group, install and maintain the water supply and drain system for utility equipment such as electric water fountains. The water supply line must withstand base water pressure without leaking, and drain system must not leak when used.

(1) Types of utility equipment
(2) Types of water fountains
(3) Major components
(4) Maintenance of water fountains
(5) Types of sinks
(6) Domestic washing machines
(7) Stoves (gas)
(8) Dishwasher (domestic)
(9) Steam kettles
(10) Steam tables
(11) Ice makers

ATC FORM AUG 72 770

Course No: 3ABR55235 Branch Approval: [signature]
Day: 43 Date: 10 September 1975

PART II

INTRODUCTION (40 Minutes)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (5 Hrs 15 Min)

PRESENTATION:

6a. Working as a member of a group, install and maintain the water supply and drain system for utility equipment such as electric water fountains. The water supply line must withstand base water pressure without leaking, and drain system must not leak when used.

(1) Types of utility equipment

(a) Domestic

1 Dish washer

2 Stove

3 Kitchen sinks

4 Washing machine

(b) Commercial

373

1 Steam kettles

a Steam

b Electric

c Gas

2 Steam tables

3 Coffee urns

a Steam

b Electric

c Gas

4 Dish washers

5 Ice makers

342

6 Sterilizers

7 Walk-in refers

8 Water fountains

(2) Types of water fountains

(a) Self contain floor model (refrigerated)

(b) Wall hung refrigerated

(c) Wall hung non-refrigerated

(3) Major components

(a) Bubble head

375

1 Height

2 Prevents water from falling back into system

(b) Automatic stream regulator

1 Uniform flow

2 Set screw for adjustment

(c) Installation

1 Use manufacturer's installation procedures

2 Hanger brackets like lavatory (for wall hung)

3 3/8 minimum water supply

4 1-1/4 minimum drain

5 Spring loaded control valve

6 30" to 40" rough-in (normal)

(4) Maintenance of water fountains

(a) Replacing valve and bubbler head

(b) Adjusting automatic stream regulator

(c) Unstopping drain

(d) Refer shop pulls most maintenance

(5) Types of sinks

377

(a) Kitchen sinks

1 Wall mounted

2 Counter top

3 Many varieties (single, double compartment, left hand, right hand drain board etc.)

4 Stainless stell, cast iron porcelain finish, enameled steel

5 Mfg's rough-in

6 1-1/2" minimum waste

7 Installed similar to lavatory

8 Garbage disposal unit

9 Faucets

a One hole automatic faucet

b Two hole deck type faucet

c Three hole valve body underneath sink

d Four hole with spray hose attachment

10 Basket or flat strainers

11 Continuous waste

(b) Utility sink (service)

1 Slop sink or mop sink

2 For washing mops, dumping wash water, and filling buckets

3 Both floor and wall mounted

a Hanging bracket (like lav.)

b Stand trap, (supports most of sink weight)

4 Mixing or single faucets

5 3" drain

6 Installation (mfg's rough-in)

7 Constructed of cast iron, procelain finish

(c) Laundry tubs

1 Installation (mfg's rough-in)

2 Utility room or basement

3 Constructed of:

a Concrete

b Plastic

c Fiberglass

d Stainless steel

e Cast iron porcelain finish

4 Mounted on stand

5 Single, double or triple compartment

6 Some have over flow similar to bathtubs

(d) Scullery sinks

1 Installation (mfg's rough-in)

2 Constructed of:

a Galvanized steel

b Stainless steel

3 Floor mounted, with or without wall brackets

4 Single, double, or triple compartment

5 Can have waste grinder or disposal unit

6 Used to wash pots and pan

7 Used to prepare vegetables

8 Installed in commercial kitchens

(6) Domestic washing machines

(a) Water rough-in 30" (local codes)

(b) Drain rough-in 30" (local codes)

(7) Stoves (gas)

(a) Mfg's rough-in specifications

(b) Black pipe

(c) Flexible connectors

(8) Dishwasher (domestic)

(a) Mfg's rough-in specifications

(b) Connects to kitchen drain

(9) Steam kettles

(a) Indirect drain

(b) Air gap (faucet)

(c) Locate near floor drain

(d) Mfg's specifications

(10) Steam tables

(a) Air gap (faucet)

(b) Indirect drain

(c) Mfg's specifications

(11) Ice makers

(a) Mfg's specifications

(b) Indirect drain

(12) Walk-in refrigeration

(a) Locate near floor drain

(b) Indirect drain

(c) Mfg's specifications

(13) Dishwasher (commercial) (clipper)

(a) Well vented area

(b) Near floor drain

(c) Discharge through grease trap

(d) Rough-in mfg's specifications

(e) Must be level

(f) Booster heaters

1 Gas

2 Steam

3 Electric

(g) Regular wash 140^0
final rinse 180^0

6b. Clean, lubricate and maintain plumbing hand tools and plumbing shop equipment according to the specifications in TO 32-1-101.

(1) Tools

(a) Remove foreign matter

(b) Lubricate moving parts

(c) Storage of tools (recurring)

(d) Individual tool kit

(e) Shop tool room

(2) Equipment

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(a) Check electrical components

(b) Removal of foreign matter

(c) Lubrication of moving parts

(d) Securing tools

1 Hand tools

2 Shop equipment

APPLICATION: Complete WB 3ABR55235-V-6-P1 and P2.

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during the lesson for increased effectiveness.

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CONCLUSION (5 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT: Read and answer the question in SG 3ABR55235-V-7 and SG AFS 55, Project and Resources management.

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LESSON PLAN (Part I, General)

APPROVAL OFFICE AND DATE: TCETC/9Sep75	INSTRUCTOR
COURSE NUMBER: 3ABR55235	COURSE TITLE: Plumbing Specialist
BLOCK NUMBER: V	BLOCK TITLE: Utility Equipment

LESSON TITLE
Corrosion Control (Day 44)

LESSON DURATION

CLASSROOM/LABORATORY	COMPLEMENTARY	TOTAL
3 Hrs	0	3 Hrs

POI REFERENCE

PAGE NUMBER	PAGE DATE	PARAGRAPH
62	2 July 197[illegible]	7

STS/CTS REFERENCE

NUMBER	DATE
552X5	15 February 1973, Chg 1, 25 Feb 1974

SUPERVISOR APPROVAL

SIGNATURE	DATE	SIGNATURE	DATE

PRECLASS PREPARATION

EQUIPMENT LOCATED IN LABORATORY	EQUIPMENT FROM SUPPLY	CLASSIFIED MATERIAL	GRAPHIC AIDS AND UNCLASSIFIED MATERIAL
Corroded Pipe Samples	None	None	SG V-7 WB V-7-P1 Slides: Corrosion Control

CRITERION OBJECTIVES AND TEACHING STEPS

7a. Inspect a plumbing piping system for evidence of corrosion and list the type of corrosion found. All students must find the same type of corrosion.

(1) Definition
(2) Causes
(3) Types

7b. Using given information, list two types of protective coating or wrappings that are used to prevent pipe corrosion. The coatings or wrappings listed must be those most often used by plumbers.

(1) Types of coatings used to protect pipe from corrosion
(2) Application of coatings

ATC FORM AUG 72 770

LESSON PLAN (Part I, General) CONTINUATION SHEET

CRITERION OBJECTIVES AND TEACHING STEPS (Continued)

7c. Identify two impressed current cathodic protection devices from their physical characteristics. Both devices must be identified correctly.

(1) Galvanic action
(2) Impressed current systems

Course No: 3ABR55235
Day: 44

Branch Approval: Robert S. Harper
Date: 11 September 1975

PART II

INTRODUCTION (45 Min)

CHECK PREVIOUS DAY'S STUDY ASSIGNMENT:

REVIEW:

ATTENTION:

OVERVIEW:

MOTIVATION:

BODY (2 Hrs 5 Min)

PRESENTATION:

7a. Inspect a plumbing piping system for evidence of corrosion and list the type of corrosion found. All students must find the same type of corrosion.

(1) Definition: Corrosion is the electrochemical reaction in which metal deteriorates or is destroyed (Conversion of metal back to its natural state)

(2) Causes

(a) Galvanic action

(b) Uniform corrosion

NOTE: (Explain galvanic cell)

(3) Types (uniformed, compositional, and localized)

(a) Uniformed corrosion

1 Direct chemical attack

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2 Entire surface corrodes

3 Uniformed pitting

(b) Localized corrosion (most common)

1 Caused by galvanic action

2 Difference of E.M.F. potential

NOTE: Explain E.M.F.

3 Forms pits, pockets or cavities

(c) Compositional corrosion

1 Caused by galvanic action

2 Changes the metal itself

3 Two types

a Dezincification

1 Occurs on copper and zinc (green tarnish)

2 Removes iron and leaves carbon

3 Iron goes into solution

(d) Effects of corrosion

1 Leaky pipes

2 Damage to equipment

3 More maintenance

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7b. Using given information list two types of protective coating or wrappings that are used to prevent pipe corrosion. The coatings or wrappings listed must be those most often used by plumbers.

(1) Types of coatings used to protect pipe from corrosion

(a) Zinc

(b) Plastic wrapping

(c) Bituminous compounds

(d) Vinyl paints

(e) Wrappings

(f) Mastics

(2) Application of coatings

(a) Zinc coatings applied at factory by hot dip method (metalic coating)

NOTE: Explain dip method

(b) Plastic sprayed or dipped at factory

(c) Bituminous compounds, hot coal tar is the most common used

(d) Vinyl paint sometimes called epoxy (very hard to apply)

(e) Wrappings of many kinds, mostly tar paper with hot tar, also vinyl wrappings most generally accomplished at factory

(f) Mastics, most mastics have a polyvinyl base or coal tar base, these are used on connections to mains and services

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7c. Identify two impressed current cathodic protection devices from their physical characteristics. Both devices must be identified correctly.

(1) Galvanic system

(a) Magnesium annode buried in ground and connected to pipe by means of welds or clamps

(b) The anode will corrode and protect the structure or pipe

(c) This method is the same as was discussed in E.M.F.

(d) Easiest system to install

(2) Impressed current system

(a) Uses outside source or power

(b) Converts AC to DC through a rectifier

(c) The anode bed is constructed of many anodes to a long line of pipe.

(d) Anode will not corrode without a DC flow

NOTE: This system is difficult to maintain and costly to install

APPLICATION:

Students will accomplish WB 3ABR55235-V-7-P1

EVALUATION:

Evaluate by oral, written questions, and/or observation of student's performance during lesson. This may be accomplished at any time during lesson for increased effectiveness.

CONCLUSION (10 Min)

SUMMARY:

REMOTIVATION:

STUDY ASSIGNMENT:

None

3-23 368

Department of Civil Engineering Training

Plumbing Specialist

UTILITY EQUIPMENT

14 December 1974

SHEPPARD AIR FORCE BASE

Designed For ATC Course Use

DO NOT USE ON THE JOB

TABLE OF CONTENTS

This supersedes SW 3ABR55235-V-1 thru V-7-P1; WB 3ABR55235-V-8-P1, 14 December 1973
(Copies of the superseded publication may be used until the supply is exhausted.)

Department of Civil Engineering Training
Sheppard Air Force Base, Texas

SG 3ABR55235-V-1
14 December 1974

WINTERIZATION OF PIPING

OBJECTIVE

This study guide will acquaint you with the methods of winterizing plumbing systems and the procedures for thawing frozen pipe.

INTRODUCTION

Sometimes, the Air Force has buildings that are vacant for one reason or another. In locations where freezing temperatures occur, it will be your job to winterize the plumbing system to prevent damage to the piping and fixtures. In cases where a building's plumbing system has frozen, you will have to thaw out the frozen system.

INFORMATION

WINTERIZING PLUMBING SYSTEMS

When a building's heating system is cut off and freezing temperatures may occur, you will need to winterize that particular building's plumbing system. Winterization of the system entails draining both the water and sewer system.

If a building water and drainage system is exposed to freezing temperatures (during normal use) measures must be taken to prevent the lines from freezing. The water service line can be buried below the frostline. Other lines (that are not protected by the building's heating system) can be wrapped with such things as insulation, rags, burlap, or paper. However, the best way to protect a line from freezing is to wrap it with an electrical heating tape.

Draining the Water System

To winterize the water system, you will need to accomplish the following:

a. Close the supply valve.

b. Open the highest faucet.

c. Open the lowest faucet.

d. Empty the water closet tank by flushing the water closet and sponging out the remaining water.

e. Remove water from the bowl with a force cup plunger.

f. Drain the hot water tank. First, turn off the source of heat, then open the drain plug or valve.

Draining the Waste System

The traps must be drained of waste water to prevent them from freezing. However, these traps must be refilled with an antifreeze solution to keep sewer gas from entering the building. Antifreeze used in automobile radiators is suitable for filling traps. Any of the glycol antifreeze preparations are highly effective, as is a mixture of glycerin and water. Alcohol and water or calcium chloride and water may also be used. An alcohol mixture can be used for temporary protection. If alcohol is used it should be replenished frequently, because the alcohol will evaporate after a short time and leave the traps unprotected. For this reason, it is better to use glycerin or glycol, since neither evaporates when in solution.

Traps fitted with cleanout plugs are easily drained by removing the plug. Traps without cleanout plugs may be emptied with a suction pump or by siphoning the water with a small rubber hose. To siphon a trap, fill the hose with water and pinch both ends shut while taking the hose to the trap. Insert one end of the hose into the trap before the water runs out of the hose. Hold the other end as far as possible below the water level in the trap and when you release the pressure, the water in the trap will be siphoned out.

THAWING FROZEN PIPE

Freezing of piping inside the building occurs when a building is left unheated or when lines are located in unheated spaces. Measures to prevent piping from freezing should have been taken when the pipes were installed. When freezing does occur, the method used to thaw out the frozen section depends on its location and accessibility.

First, locate the frozen pipe. On waterlines, start by opening the fixture valves. If water does not flow when the water is turned on, that area is frozen. Using the process of elimination, you can determine how much of the area is frozen.

When thawing a water pipe, start on the faucet or outlet side and work toward the supply.

When thawing a waste or sewer pipe, work upward from the lower end to permit the water to drain away.

No matter which method is used to thaw frozen pipe, apply heat to the pipe. The pipe then transmits heat to the ice. The ice next to the pipe will melt causing some flow of water. This flow, plus the heat, will thaw out the pipe.

Hot Water and Rags

One of the methods of applying heat is with hot water and rags. Wrap rags or burlap around the outside of the pipe to a suitable thickness and then keep the wrapping saturated with boiling hot water, as shown in figure 1.

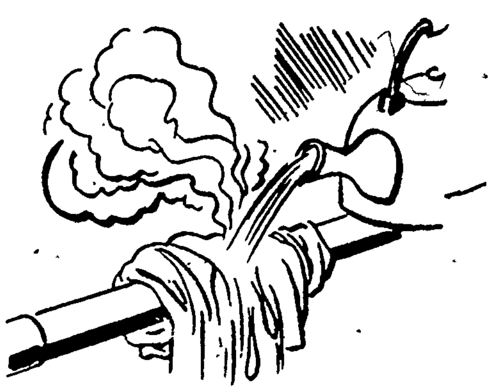

Figure 1. Hot Water Applied to Outside of Frozen Pipe

The hazards of using hot water are as follows:

a. Scalding personnel.

b. Slippery floors.

c. Damage to the building.

Torches

Another method, but considered a dangerous one due to the risk of starting a fire, is the use of torches. Adjust the torch air to gas ratio to obtain a blue flame. Apply the flame to the piping, moving it slowly along the frozen part of the pipe starting at the faucet or outlet side and working toward the supply. If the pipe is frozen behind a partition, or is otherwise inaccessible, apply the flame at the nearest exposed point. Water heated in the pipes circulates and may clear the obstruction. Take precautions when working next to wooden structures by isolating the area with asbestos sheeting. Also, be sure there is adequate ventilation to prevent asphyxiation.

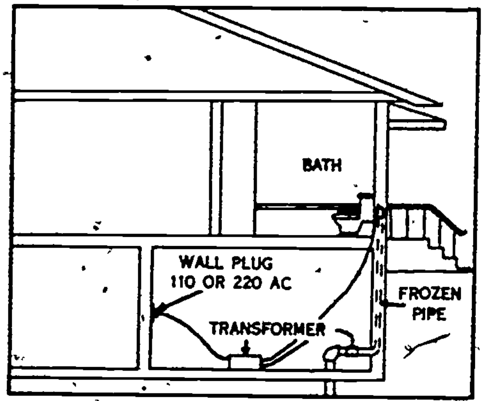

Figure 2. Transformer Type Thawer

Electrical Thawing

Thawing frozen water pipes with low voltage electricity is by far the best method. It is not only the most convenient method but is faster and safer, and costs less. This method works with steel or copper pipe, even when the pipe is buried in the ground or concealed in walls, see figure 2. This unit plugs into the house current, and it is used on short lengths of piping up to 1 1/2" in diameter.

When using electricity to thaw frozen pipe, good electrical connections are necessary. The point where the cables are attached to the pipe must be thoroughly cleaned, by sanding the pipe with coarse emery cloth. Make sure all connections are tight to prevent arcing and burning a hole in the pipe. Either special pipe thawing clamps or ordinary C-clamps are excellent for connecting the cables to the pipes, see figure 3.

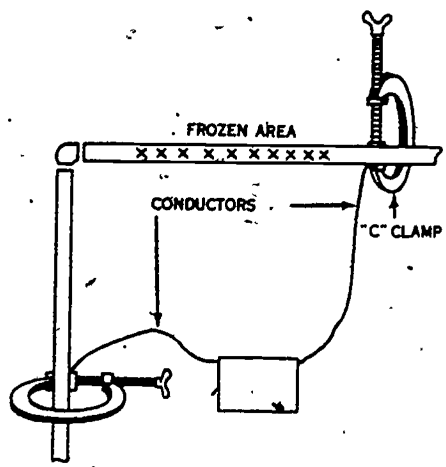

Figure 3. Low Voltage Connections

A gas engine-driven welder of at least 250 amps is better for thawing larger and longer pipe runs, because it will supply the higher current required and it can be used where electric power is not readily accessible. It can also be used for welding, as well as pipe thawing, which makes it useful year around, see figure 4.

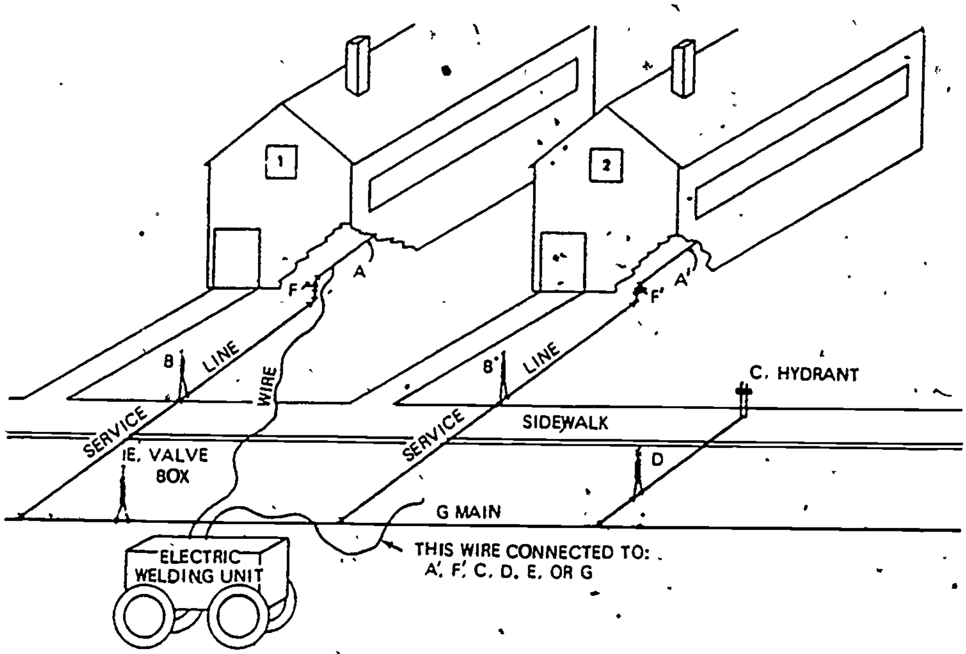

Figure 4. Connection Points for Thawing Service Lines

Operating Safety Suggestions

The following safety suggestions should be observed when using high amperage thawing equipment.

a. Do not touch electrical connections while machine is in operation.

b. Keep all connections tight. Loose connections get hot and reduce current flow.

c. Select contact points on pipe as close as possible to the frozen section.

d. Remove ground wires from system to be thawed.

e. If pipe joints have gaskets or other insulation at pipe joints, thaw pipe in sections, or use copper jumpers to close circuit across insulated joints.

SUMMARY

Piping exposed to freezing temperatures must be protected. This is accomplished by wrapping or burying the water service below the frost line.

When a building is deactivated, it must be winterized to prevent freezing. If freezing should occur, the pipe must be thawed by either hot water and rags, torches, or electrical devices.

QUESTIONS

1. When is it necessary to winterize the plumbing system?
2. What type of antifreeze is most suitable for winterizing traps?
3. What different ways can heat be applied to thaw pipe?
4. Why is it important that electrical connections be tight when thawing pipe?
5. How is the water service line protected against freezing?
6. What type of wrappings can be used to prevent freezing?
7. What are the steps for winterizing the water system?
8. What are the procedures for winterizing the waste system?
9. What are the hazards of using torches to thaw pipe?
10. What is used to attach the cables when thawing with electricity?

REFERENCE

AFM 85-20, Plumbing

MAINTENANCE OF VALVES

OBJECTIVE

The purpose of this study guide is to help you identify and maintain valves found in the plumbing systems.

INTRODUCTION

The use of valves to control the flow of liquids and gases into, through, and out of plumbing systems makes the knowledge of valve repair a necessity. In order to repair valves you must be familiar with their construction and operation. You must also be able to inspect valves in order to determine what repairs are needed. Inspection of any valve consists of close examination for visible wear and breakage.

TYPES OF VALVES AND THEIR MAINTENANCE

Gate Valve

A gate valve is one of the most used valves in a plumbing system. A gate valve, as illustrated in figure 5, contains a sliding disc which moves vertically and seats between and against two seats to shut off the flow of liquid.

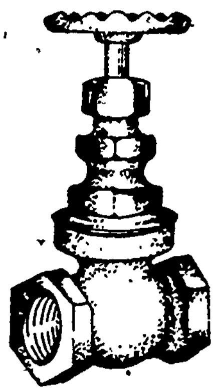

Figure 5. Gate Valve.

A threaded stem is used to lift or lower the disc, to open or close the valve. The volume of flow through the valve, however, is not in direct relation to the number of turns of the handwheel. Gate valves have either a single or double solid wedge-shaped disc, and the valves may be provided with either rising or nonrising stems, as shown in figures 6 and 7. Valves with nonrising stems are ideal for installations where headroom is limited.

Gate valves are used for services requiring infrequent valve operation and where the valve disc is kept either fully opened or fully closed. When fully opened, the seating design of a gate valve permits the fluid to move through the valve in a straight line with a minimum restriction of flow and a minimum loss of pressure at the valve. This type of valve is not suitable for a throttling operation (where the valve is kept only partly open) since the velocity of flow against the partly opened valve disc may cause vibration and damage to the disc and seating surfaces. To prevent binding, this type of valve should be closed one-quarter to one-half turn from the fully opened position and opened one-quarter to one-half turn from a fully closed position.

Gate valve leaks may occur at the valve seat, around the stuffing box, or at the body-bonnet joint. Repairs should be made at the first sign of a leak. Tightening a leaking joint will often correct the condition. Other remedies are the replacement of gaskets or renewable parts; repacking stuffing boxes; and regrinding valve seats.

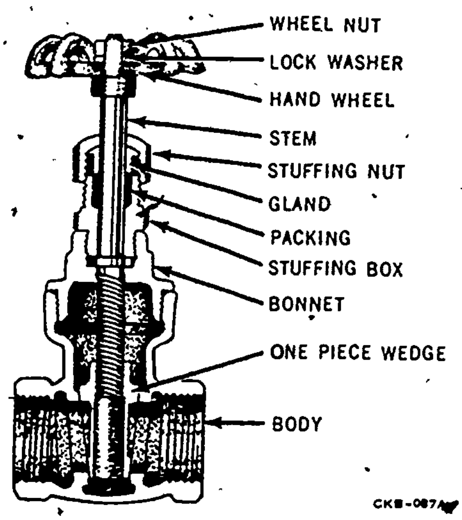

Figure 6. Nonrising Stem Wedge Disc Gate Valve.

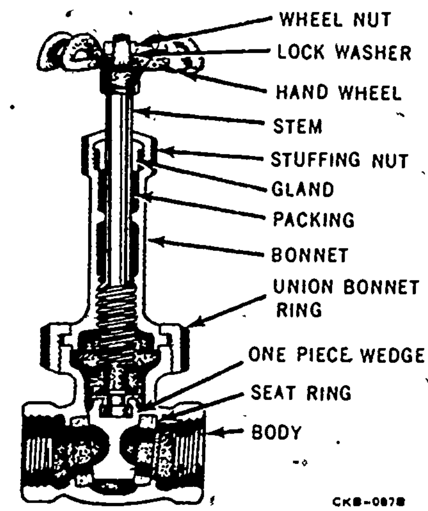

Figure 7. Rising Stem Wedge Disc Gate Valve.

The stuffing box holds the packing which seals the bonnet against leaks around the stem, see figures 6 and 7. Pressure is applied on the packing by a packing nut or gland flange which bears on a gland in the stuffing box. Packing wears in direct relation to service condition. It loses life with age, but wear is mainly due to rising and turning motion of the valve stem. Generally, packing lasts a long time and needs little attention. Stuffing box leaks can usually be stopped by tightening down on the packing nut or gland of the valve. On bolted glands, care must be exercised to tighten the bolts evenly, since cocking will bind the stem. If a stuffing box leak cannot be remedied by tightening the packing nut, the packing must be replaced.

Inability to close a valve tightly is an indication of a valve seat leak. Trouble of this sort is usually caused by scale, metal particles or other foreign matter. Occasionally, it comes from a cut in the seat or disc caused by high velocity fluid flow through the limited area when the valve is not fully closed. When valve seat leaks occur, the seat and disc may be repaired provided the damage is not too extensive. If the disc is made of soft metal it may be refaced (lapped) by using a mixture of oil and lapping compound on the machined surface. By using a figure eight motion, the two surfaces are lapped true to each other.

Gate valves are available in many styles and sizes. They are designed to meet all needs from low pressures to high pressures. They are manufactured to receive screwed, welded, sweated and flanged piping, and have either rising or nonrising stem.

The larger the valve, the more complex the repair will become.

Globe Valves

A globe valve, as illustrated in figure 8, has a horizontal interior partition which shuts off the inlet from the outlet, except through an opening in the partition, as shown in figures 8 and 9. The lower end of the valve stem holds a replacement fiber rubber or metal disc shaped and fitted to close the hole in the horizontal partition. The valve is closed by turning the handwheel clockwise until the disc presses firmly on the opening. The volume of flow through globe valves is roughly proportionate to the number of turns of the handwheel. Globe valves may be provided with either flat or beveled discs, depending upon the type of disc.

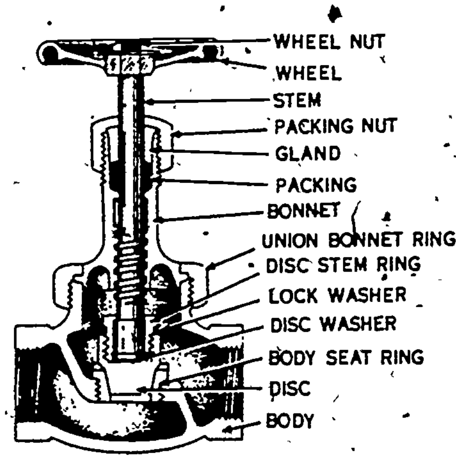

Figure 8. Globe Valve With a Plug Disc.

A plug-type disc, illustrated in figure 8, consists of a tapered plug which provides a wide area of seating contact. This type of valve seating provides a very effective means of flow control and offers high resistance to the cutting effects of dirt, scale, and other foreign matter.

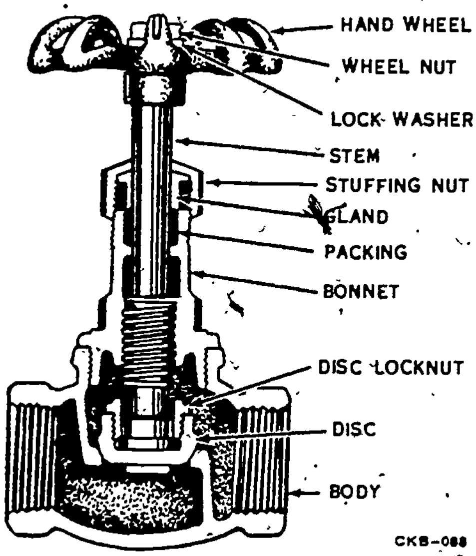

Figure 9. Globe Valve Conventional Disc.

A conventional disc, illustrated in figure 9, forms a relatively narrow contact with the valve seat, provides a more positive and higher pressure contact than a wide seat. The thin line contact breaks down hard deposits that form on valve seats and ensures a pressure-tight closure. The conventional disc is made in several seating styles, such as flat seating, ball seating, and with seating surfaces having varying degrees of taper.

A composition disc, illustrated in figure 10, operates on the principle of a cap. Its face seats against or into the valve opening. Most composition discs consist of three parts; a metal disc holder, the disc itself, and a retainer nut. The main advantage of a composition disc is the variety of disc materials available for different types of individual services, such as air, hot and cold water, gas, oil, gasoline, and other applications. The disc can be changed for different types of services and can be quickly renewed in case of valve leakage.

Globe valves are used for services requiring frequent operation and where the valve may be used to throttle and regulate flows. The seating design of this type of valve causes a change in direction of flow through the valve body, thereby increasing resistance to flow at the valve. The fluid flow through globe valves can be closely regulated and the disc and seats which are liable to be worn or damaged in throttling service can be conveniently reground or replaced. Globe valves can be fitted with fiber discs that are suitable for almost any type of service except steam lines, a metal disc globe valve should be used.

Globe valve leaks occur around the valve stem and the valve seat.

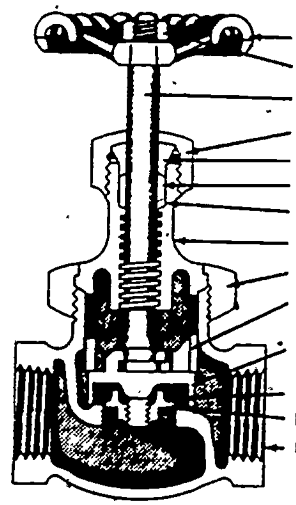

Figure 10. Globe Vlave Composition Disc.

When valve seat leaks are found in plug type or conventional discs, the valves can be repaired by removing the disc, inserting a washer under it, then lapping to make a snug fit.

Valve seat leaks in composition disc globe valves are corrected by replacement of the discs. If the seat is severely pitted, the entire valve should be replaced.

Stuffing box leaks can usually be corrected by tightening the packing nut. If tightening the packing nut does not stop the leak, replace the packing.

Angle Valves

Angle valves, as illustrated in figure 11, are similar in construction and operation to globe valves, except that the valve outlet is at an angle of 90 degrees to the inlet. Angle valves are used to control fluid flow and to change the direction of flow thus eliminating the use of elbows. The resistance to flow through an angle valve is less than if an elbow and a straight globe valve were used. Maintenance on angle valves is the same as for globe valves.

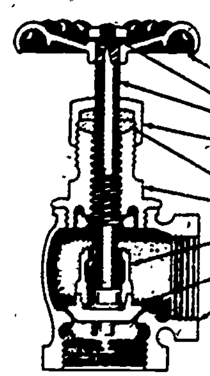

Figure 11. Angle Valve.

Check Valves

A check valve, as illustrated in figure 12, is used when it is necessary to control the flow in one direction only. Fluid flowing in the proper direction keeps the valves open and reversing the flow closes them automatically, as shown in figures 13 and 14. For installation purposes, most check valves are marked to indicate the inlet opening or direction of flow. There are two basic types of check valves (1) swing check valves, and (2) lift check valves. Each type has several variations that make them suitable for specific plumbing installations. A swing check valve should be used in conjunction with a gate valve and a lift check valve with a globe valve.

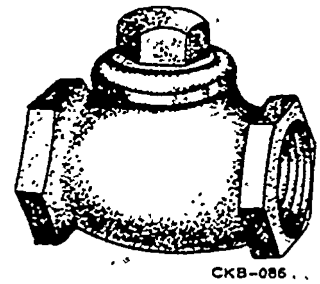

Figure 12. Check Valve.

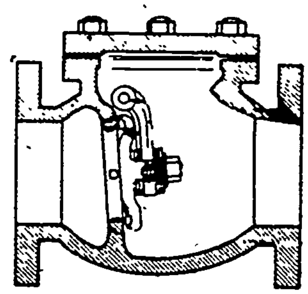
Figure 13. Swing Check Valve with Brass Disc.

Swing check valves contain a hinged disc which seats against a machined seat in the tilted bridge wall opening of the valve body, as shown in figure 13. The disc swings freely on its hinge pin in an arc from a fully closed position to one parallel with the flow. The fluid or gas in the pipeline enters below the disc. Line pressure overcomes the weight of the disc and raises it, permitting a continuous flow. If the flow is reversed or back pressure builds up, this pressure is exerted against the disc, forcing it to close and stop the flow.

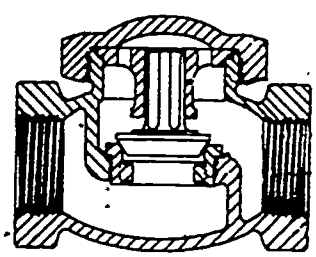
Figure 14. Lift Check Valve

Lift check valves contain a disc which seats on a horizontal bridge wall in the valve body, as shown in figure 14. The disc is raised from its seat by the pressure of the fluid flow and moves vertically to open. To insure proper seating and rising, the disc is provided with short guides, which are usually above and below the disc. The valve is closed by backflow, or by gravity when there is no flow.

Check valve leaks occur due to sticking parts or pitted valve seats. To operate properly the valve disc must fit firmly in its seat. Valve seats can be reground with a reseating tool or by lapping.

Plug Valves

Plug valves have a circular, tapered, ground plug fitting, a tapered hole or seat, as shown in figure 15. An opening through the plug permits the passage of fluid through the valve when the opening is aligned with the pipeline. Plug valves may be completely and quickly opened by a one-quarter turn of the handle and do not have soft packing which tends to wear.

Leaks in plug valves can usually be corrected by tightening the bottom nut if a leak occurs on the outside, or by cleaning and adding a special lubricant if a leak occurs on the inside.

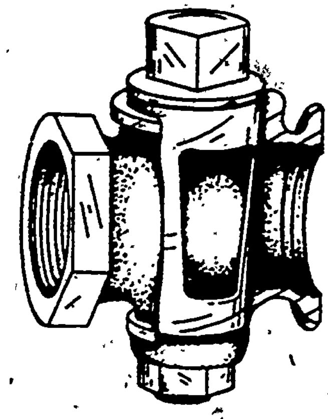

Figure 15. Plug Valve

Compression Faucets

A compression faucet is one in which the flow of water is controlled by a washer which is compressed against a seat by turning a threaded spindle to which the washer is attached. There are two types of compression faucets. In one type, the body of the faucet is threaded to receive a threaded stem that carries the washer to the seat; in the second type, the threaded stem actuates a square plug which moves vertically inside a body squared to match the plug. The faucets, shown in figures 16 and 17, are typical compression faucets.

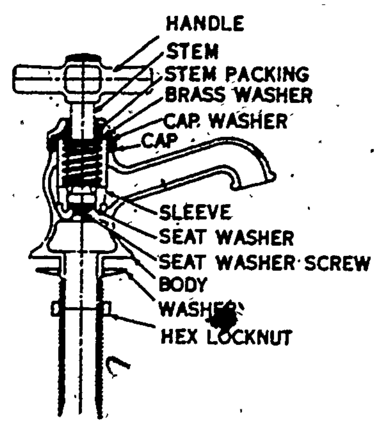

Figure 16. Cross Section of a Typical Compression Faucet

Leaks are the major maintenance problems of faucets and are usually caused by insufficient packing around the faucet stem or by improper seating of the washer on the valve seat. Continual leaking of water after a faucet has been closed tightly by hand usually indicates a worn washer. To repair the faucet, remove the screw in the center of the washer at the end of the stem and remove and replace the washer. Be sure you use the proper type of washer, because washers for hot water service are usually made of a different material from washers for cold water service. If the surface of the faucet seat which the washer compresses against is rough or damaged, the seat must be repaired with a reseating kit or the complete faucet must be removed and replaced.

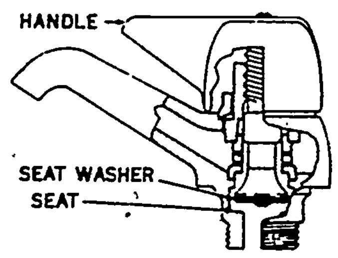

Figure 17. Cross Section of a Typical Lavatory Faucet

REFACING AND RESEATING TOOLS

Refacing and reseating tools are used to repair valve seats on nearly all types of valves, as shown in figure 18.

The tools act as a rotary file which machines the seat so that the washer or disc will fit properly when the valve is closed. Many attachments are available to fit various sizes and types of valves.

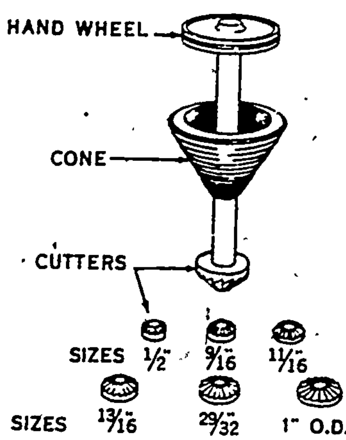

Figure 18. Reseating Tool

SUMMARY

Valves are used to control the flow of gases and liquids. There are various types of valves such as the gate, globe, plug, check, flush, mixing, etc. Gate valves are used for services where they are kept either fully open or fully closed. Globe valves are used to throttle the flow. Check valves allow the flow in one direction only.

1. What is the advantage of valves with nonrising stems over valves with rising stems?
2. Where are gate valves used?
3. What is the main advantage of gate valves?
4. Where are globe valves used?
5. What is the main disadvantage of using globe valves instead of gate valves?
6. What is the main advantage of the wide area of seating contact that is provided by the tapered plug on a globe valve that has a plug type disc?
7. What is the main advantage of the relatively narrow contact area between the disc and valve seat on a globe valve that has a conventional type disc?
8. What is the main advantage of the composition disc type globe valve?
9. If a globe or gate valve leaks around the stem, what maintenance should be performed?
10. What should be done when valve seat leaks are found in the plug type or conventional disc type globe valve?
11. What should be done if valve seat leaks are found in composition disc type globe valves?
12. Name the main purpose of angle valves.
13. Maintenance on an angle valve is the same as maintenance on what other type of valve?
14. Explain the purpose of a check valve.
15. Name two types of check valves.
16. Swing check valves should be used in conjunction with ________________ valves.
17. Lift check valves should be used in conjunction with ________________ valves.
18. How far must the handle be turned to completely open a plug type valve?
19. How are external leaks on plug type valves corrected?
20. How are internal leaks on plug type valves corrected?
21. What is the most probable cause of leaks out of the spout of a compression faucet?
22. Name the tool that is used to reface the seat of a compression faucet.

MAINTENANCE OF SEWERS AND GREASE TRAPS

OBJECTIVE

The purpose of this study guide is to furnish introductory information concerning the inspection, maintenance and repair of main sewer, building sewers, drain systems and grease traps.

INTRODUCTION

Like water systems, waste and drain systems must be inspected constantly to insure continued satisfactory service. Small discrepancies, if corrected, will prevent major system failures later. When a failure occurs, however, its cause must be determined and corrected.

INFORMATION

MAINTENANCE OF EXTERIOR SEWERS

Locating Buried Pipe

Main sewer systems must be inspected periodically for condition and operation. Locating the sewer pipe is an operation accomplished for inspection as well as later maintenance and repair.

Visual sighting between manhole for the most part is a reliable method of locating buried sewer mains. Obstruction may prevent visual sighting. Maps must be consulted in such cases to determine pipe location.

This is especially important if repair is required. Other piping systems may cross the sewerline or run parallel nearby. The map generally has a legend which identifies the symbols used for each piping system.

Electrical instruments are sometimes used to locate buried sewer pipe. One instrument may detect pipe by magnetism. Such instruments are reliable only when sewer-lines are of a metallic composition and no other piping systems are nearby.

Sound detecting instruments can be used to locate buried pipe that conveys liquids. Sound detection instruments operate on the principle of listening to liquids moving through the pipe. Sound detection instruments are reliable only when no other piping conveying liquids is nearby.

Probing for the exact location of buried pipe is probably the most reliable method. Not only its location, but depth can be determined, see figure 19.

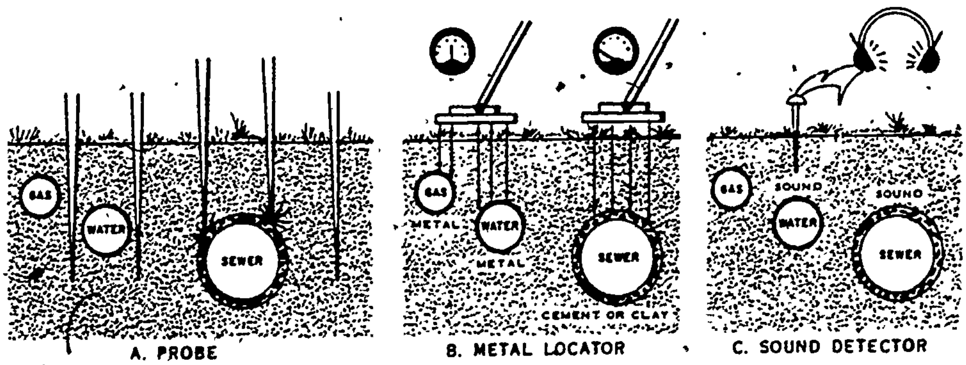

Figure 19.

Inspecting Main Sewers

Sewer mains are constructed with manholes which are provided at intervals of 300 feet. These are used to gain entrance to a sewer main. Manholes are usually located in the center of a street and covered with a round iron door. All the work done when cleaning or repairing a main sewer is done through a manhole. Before entering a manhole remove the cover and allow the sewer gas to escape. This gas is dangerous if ignited and will burn or explode causing injury to personnel. Breathing the gas is also dangerous to personnel.

CAUTION: Never enter a sewer manhole without someone standing by to go for help in case the one entering the manhole is overcome with gas. A rope tied around the body and under the arms of the man entering the manhole is recommended so that he may be pulled out if he is overcome by gas.

After it has been determined that the sewer is safe, inspection and maintenance operations may begin.

Inspection of a Main Sewer

Obstructions in the main sewer can be detected by observing flow at manholes. Checking for obstructions between manholes can be done by performing the following steps:

1. Plug off section of sewer main at manholes with sandbags or pneumatic ball.

2. Fill section of sewer line and manhole with water.

3. Remove plug and observe rate of flow at next manhole. Slow rate of flow at the next manhole indicates an obstruction in the line between the two manholes. Fast rate of flow at the next manhole indicates no obstruction in the line between the two manholes.

Another way of detecting restrictions between manholes is by comparing the level of sewage at one manhole with the level of sewage at the next manhole downstream. If the level of sewage at the upstream manhole is greater than the level of sewage at the downstream manhole then there is restriction in the line between the two manholes provided the line is the same size.

Maintenance of Main Sewer

Once the restriction is located it is removed by a power-driven sewer auger, as shown in figure 20. The auger consists of a J-tube, rod, rodding heads, a gasoline engine and trailer.

The J-tube is used as a guide when inserting the cable into the sewer main. The rod is extended to the obstruction. The rodding head, depending on type, is used to punch or cut through the obstruction permitting water to flow downstream. The obstruction could also be entangled in the auger head permitting the obstruction to be withdrawn from the sewer pipe.

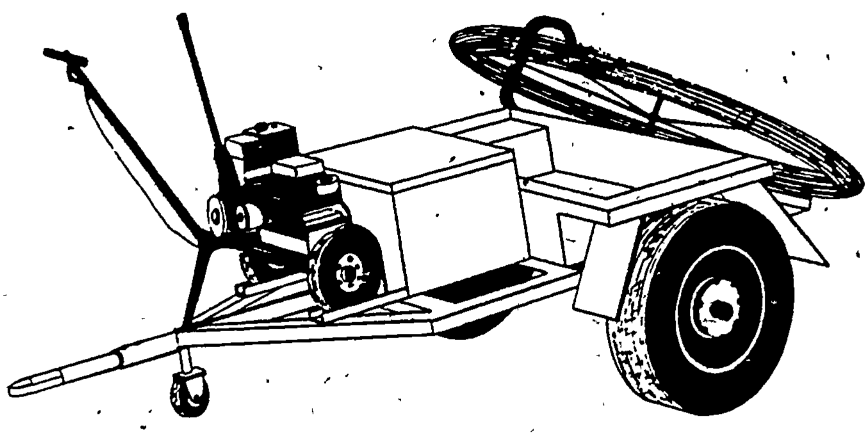

Figure 20. Power-Driven Sewer Auger with Attachments

Rodding a main, as shown in figure 21, is only temporary and will have to be accomplished where tree roots are a problem. Treating the sewer with chemicals often lengthens periods between rodding.

A word of caution when performing inspection and maintenance on main sewers. Sewer gases are highly flammable and toxic. Even though manhole covers provide some venting, gases will continue to be emitted from the sewer mains. If work is to be performed inside the manhole the worker should be wearing a portable respirator. A rope should also be attached to his waist and monitored by a fellow worker topside. If repair to the main itself is required, additional safety precautions are necessary. Proper shoring methods must be used to prevent cave-ins when replacing sewer main sections. Tools, equipment and piping are heavy and must be handled correctly to prevent personnel injury.

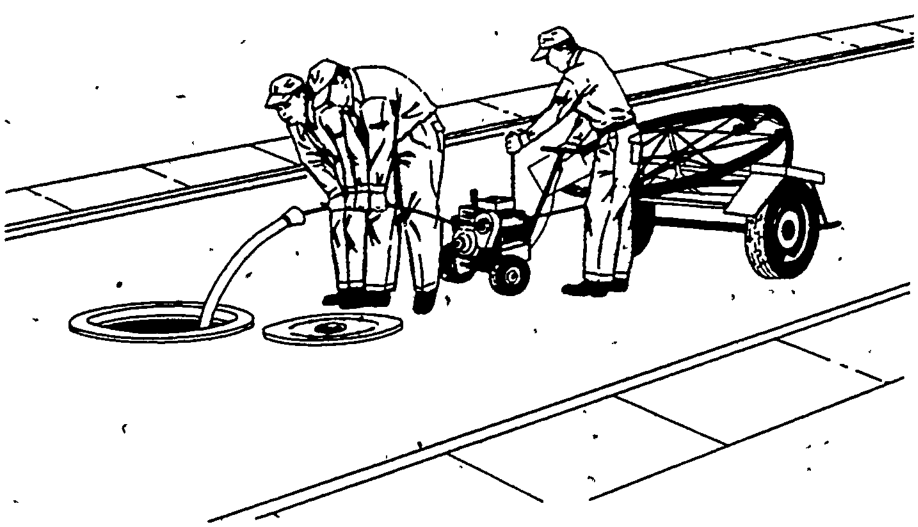

Figure 21. Using Power-Driven Sewer Auger

MAINTENANCE OF BUILDING SEWER

The building sewer often has the same problems as the main sewer. Periodic inspection, however, is not performed. The plumber is usually called after the sewer is clogged.

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Unclogging Building Sewer

The same technique used in clearing the sewer main is also used to clear building sewer mains. Flat steel tapes, as shown in figure 22, are inserted through the clean-out plug to the point of obstruction. The tape is used as a battering ram to either punch a hole through the obstruction or push it into the sewer main.

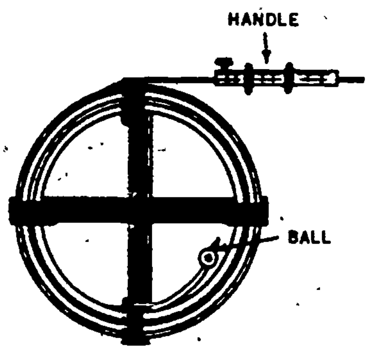

Figure 22. Coiled Ribbon Snake

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INSTALLATION AND MAINTENANCE OF GREASE TRAPS

Removing grease from greasy wastes is essential to the proper functioning of a sewer system in large military or commercial kitchens. In such kitchens, if large quantities of grease are allowed to pass into the waste system, it will solidify and clog the waste pipes. To prevent this condition some means must be used to collect the grease before it enters the waste system. Grease traps are used for this purpose.

Construction and Operation of Grease Traps

Grease traps may be constructed of concrete, brick or metal in various sizes. A number of different types of grease traps are available but they all work in accordance with the principle that grease is lighter than water and therefore will rise to the top of water. In the common air-cooled grease trap, like the one shown in figure 23, the incoming water passes through a series of baffle chambers where the grease is cooled and rises to the top of the water. Clear water, free from grease, is drawn from the bottom of the trap and passed into the sanitary sewer system. From a study of figure 23, it can be seen that the unit is only as efficient as the service which it receives. In a very short period of time the grease trap fills and ceases to remove grease. When this happens, the unit must be cleaned.

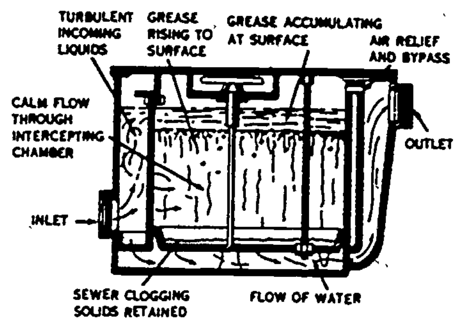

Figure 23. A Typical Grease Trap

Installation of Grease Traps

A grease trap should be installed as close to its fixture as possible, preferably in a location where the odor will not get into the kitchen when it is opened to be cleaned. The ideal place is outside the building. Since grease traps must be cleaned periodically they must have a removable cover. Some grease traps are connected to a hot and cold water supply for flushing after the accumulated grease has been removed.

Maintenance of Grease Traps

Periodie cleaning is all that is necessary for the proper maintenance of a grease trap. To clean a small grease trap, remove the cover and dip the grease out of the trap with a ladle. In cases of sewer and waste stoppages at large military or commercial kitchens, the first step is to see that the grease traps are clear.

Plumbing personnel usually clean the grease traps that are located outside the building. They normally use an ordinary perforated scoop to skim the grease from the surface of the trap and place it in suitable containers for salvage. The next procedure is to remove as much of the putrid material as possible with the same scoop, and treat it as refuse material to be destroyed. If necessary, pump out the liquid contents from the traps every three months and scrape all the sediment from the sidewalls and bottom. Finish the operation by flushing the trap with clear water.

MAINTENANCE OF BUILDING DRAINS

Inspection

Periodic inspection of interior piping systems prevents undesirable conditions and costly repairs.

Loose, broken or missing pipe supports permit waste pipe to sag, causing undue stress on joints. Leaks in waste systems inside a building are not acceptable. Sagging pipe alters the pipe grade which in turn changes the drainage flow. Solids will settle in the low area and eventually cause slow drainage or clogging.

Leaks caused by defective joints, pipe, and fittings must of course be corrected for health reasons.

Clogged vents often cause fixture drains to operate slowly. Water may be siphoned from the trap due to vent-stoppage. This allows sewer odors and gases to be vented through the fixture drain. Vents may be clogged from debris backed up from a previous line clogging. Birds attempting to nest in the roof outlet may also cause poor venting. The vent pipe itself may have been damaged to restrict its venting capability.

Maintenance and Repair

Sink, lavatory, urinal, bathtub, shower, floor and utility drains as well as the water closet are all subject to lint, hair, fats, food particles, and other objects being flushed down them. Lint, hair and similar materials may get caught in strainers or even settle in the traps. Fats congeal and in time may reduce the pipe size. Objects of metal, plastic, and cloth may become wedged in the system piping. All have to be removed to maintain system operation.

A vacuum plunger, as shown in figure 24, applied to the fixture drain is often sufficient to clear the drain. The cup is centered over the drain. Alternate pushing and pulling of the handle creates alternate pressure and suction cycles. The obstruction is worked loose and flushed down the drain.

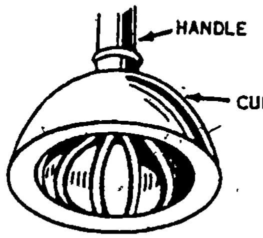

Figure 24. Vacuum Plunger (Screw Handle)

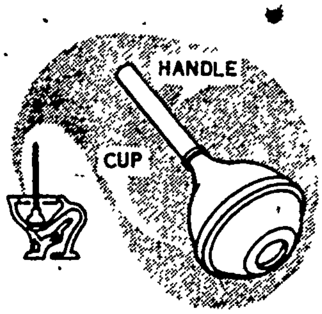

Figure 25. Force Cup

The vacuum plunger is designed to clear drains of fixtures such as kitchen sinks, lavatories, and bathtubs. These fixtures have flat areas in the bottom around the drain.

A similar tool called a force cup, see figure 25, is used on fixtures such as water closet bowls and wall-hung urinals that have integral traps. These fixtures have cone-shaped bottoms that enable the force cup plunger to be more effective than the vacuum plunger. To achieve the best results with a force cup, insert it down into the outlet of the fixture with the fixture filled with water as near the top as possible. Alternate pushing and pulling strokes of the handle should work the obstruction loose and flush it down the drain. Do not use this method of clearing a stoppage when it is suspected that a large or irregular-shaped object is the cause of the stoppage. Forcing such an object into the sewer may cause an underground stoppage which could be more difficult to clear than the stoppage of the fixture.

The closet auger, shown in figure 26, may be used if the obstruction cannot be forced through the trap by plunging. Insert the end of the flexible cable in the trap, forcing it through the trap while rotating the handle, see figure 26. Rotate the handle continuously until the auger reaches the obstruction and then turn the handle slowly until the obstruction is caught on the coiled hook of the auger. Continue rotating the handle in the same direction (clockwise) and slowly withdraw the auger from the bowl, removing the obstructing object if possible rather than forcing it through to the soil piping.

If the obstruction cannot be removed from the water closet trap with the force cup or the closet auger, the closet bowl must be removed and the obstruction forced out from the other end of the trap.

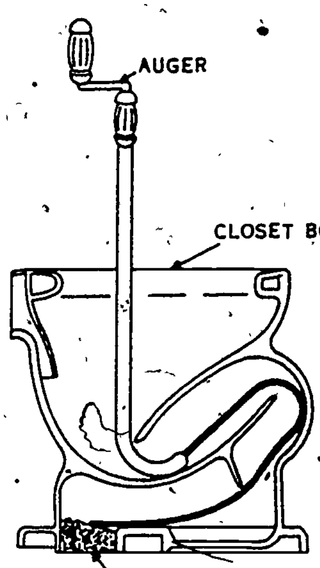

Figure 26. Using a closet auger to clear a water closet trap.

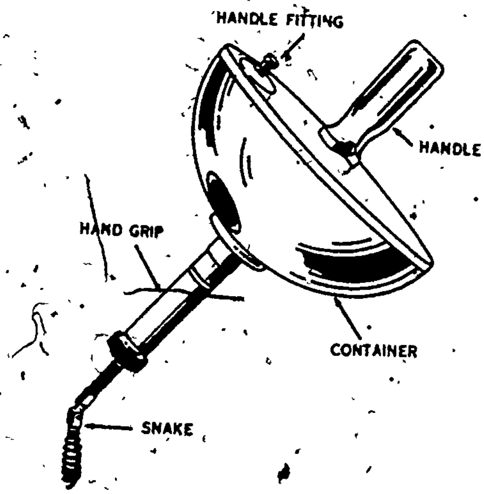

Figure 27. Sink Auger

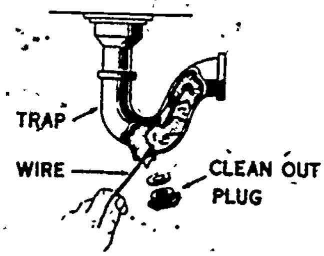

Figure 28. Removing Stoppage from a Pipe

A sink auger, shown in figure 27, may be used when the vacuum plunger or force cup is unsuccessful. Some types of augers are hand operated while others are operated by attaching a small drill motor.

Opening Clogged Traps

As shown in figure 28, traps fitted with cleanout plugs are easily opened. To open the trap, remove the cleanout plug, and pull the contents through the cleanout hole with a bent wire. Flush the trap with hot water before you replace the cleanout plug. Traps that do not have a cleanout plug are a little more difficult to open. Often chemicals, force-cups, or sink snakes are required to remove the more stubborn types of stoppages. If all the above operations fail, you may have to remove the trap and reverse-flush it with water to remove the stoppage.

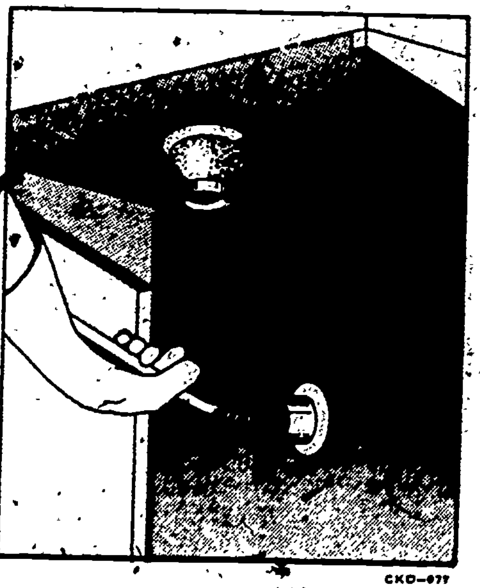

Figure 29. Using Sink Auger

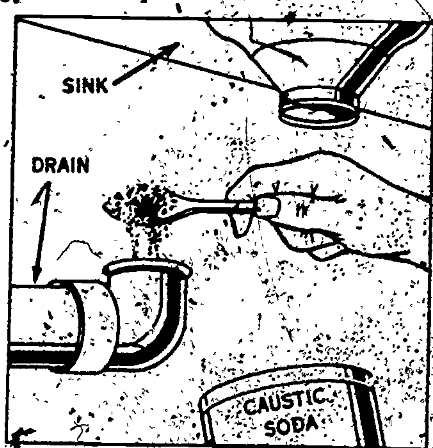

Figure 30. Placing a Chemical into a Waste Pipe

Some drain stoppages may require removal of the fixture trap in order to get at the obstruction, figure 29.

A caustic agent, shown in figure 30, is sometimes used to unclog drains. However, the use of caustic agents is not generally recommended. They can be used to open small stoppages, as a temporary repair measure, and where other cleaning methods will not work.

CAUTION: Since these drain cleaning chemicals are extremely caustic, they must be handled with care to avoid getting the solution on your hands, arms and face. Also avoid splashing the chemical on clothes, wood, painted surfaces or aluminum. If this happens accidentally, flush the affected part with cold water, then immediately apply vinegar and finally rinse with cold water.

A chemical cleaner should not be used in drain pipes that are completely clogged. It is necessary to have a slight flow to carry the chemical down to the point of obstruction since it must be in contact with the stoppage to be effective. Pouring the chemical into a sink drain merely lets most of it settle in the trap. The best method is to remove the trap and insert the chemical in the pipe beyond the trap.

SUMMARY

The drainage system consists of all the pipe and fittings required to carry waste, sewage, or other drainage from the building to the street sewer or other place of disposal.

Some of the chief causes of sewage stoppages are grease, lint, hair, cigarette butts, chewing gum, and tree roots. All of these materials cause the plumber much trouble in trying to keep the drainage systems open.

There are several methods used to open clogged drains, such as chemical cleaners, force cups, and snakes. Chemicals will often open the drain and remove grease from the system. A force cup will open the drain or trap if the stoppage is not too solid. If the chemical or force cup fails, then a snake and hot water should be tried.

Chemical cleaners which are used to open clogged drains must be handled with care to avoid getting the solution on the hands, arms, and face. If you accidentally get a chemical on the skin, immediately wash the affected part with cold water. Then, apply vinegar to the skin and finally rinse it with cold water.

Traps fitted with cleanouts are the easiest to open. Traps that do not have cleanouts must be opened with chemicals, force cups, or sink snakes.

Snakes and other equipment used for opening the drainage system should be cleaned after each use for sanitary precautions as well as protecting the equipment.

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QUESTIONS

1. What methods are used to locate sewer mains?
2. What are the hazards of working in a manhole?
3. What precautions are necessary when working in manholes?
4. What safety precautions are required when replacing segments of main sewer piping?
5. What should a plumber look for when inspecting interior waste system for condition and operation?
6. What are some of the causes for unsatisfactory drain system operation?
7. How is grease removed from waste water?
8. Why should the tools and equipment that have been used to clear a sewer be thoroughly cleaned after use?
9. List three methods of cleaning an obstruction from a lavatory drain and trap.
10. The drain is cleared of obstruction but drainage is still unsatisfactory. What is a possible cause?

REFERENCES

1. AFM 85-20, Plumbing
2. National Plumbing Code
3. AFR 127-101, Ground Accident Prevention Handbook

EMERGENCY MAINTENANCE OF EXTERIOR PIPING

OBJECTIVE

To help you better understand factors governing emergency water main repairing, and the procedures to follow when laying a temporary waterline.

INTRODUCTION

Breaks in water mains must be repaired as rapidly as possible to prevent unnecessary loss of water and to keep out-of-service periods in the affected areas to a minimum. Personnel must be trained and repair plans must be made in advance for prompt repair work. Digging tools, trench-shoring material, and a self-priming centrifugal portable pump should be readily available at all times. Adequate pipe repair supplies and materials should be kept on hand.

INFORMATION

FABRICATING TEMPORARY WATER MAINS

In emergencies, any materials available may be used to construct temporary water mains. For example, galvanized iron pipe is normally used for lines up to 1 1/2 or 2 inches in diameter, whereas, cast-iron pipe may also be used. The size of the main determines, to some extent, the type of pipe to be used. A mechanical type compression sleeve coupling can be used to assemble glavanized or cast-iron pipe sections in less time than would be required for conventional threaded joints.

The repair of broken lines is one of the most frequent jobs in a distribution system. Many of these are emergency jobs and must be done regardless of the time of day or weather conditions. The equipment necessary to make line repairs should be kept readily accessible, and an ample supply of emergency repair parts should be available at all times. Emergency clamps and sleeves for all sizes of pipe in the system should be available. Records of valve locations should be kept for handy reference. This will enable the men to shut off the area in which the repair is to be made quickly.

Temporary water mains are usually installed on top of the ground unless they are exposed to freezing weather. Portions of a main may be buried underground at street crossings or in areas where damage to the main might occur. Compression couplings are used on steel pipes when speed of installation is necessary and when the main will be in use for only a short period of time. Mains which must handle high water pressures must be secured at intervals along the run of the line, and at all turns when compression couplings are used. This prevents whipping of the pipe under pressure and separation at the couplings.

There are many types of pipe that can be used for temporary fabrication of piping systems. Such as steel, plastic, hose, and aluminum. The connections can vary depending on the types of pipe. In an emergency situation, steel pipe can be assembled using screwed, grooved, or compression connections.

Grooved Joints

When using the victualic couplings, all pipe ends must be grooved to accept the victualic coupling. No reenforcement of the pipe ends is required.

The victualic coupling has three parts: a single gasket, two housing clamps, plus two bolts and nuts as shown in figure 31. These clamps are entirely self centered over the pipe ends which are grooved by using a grooving tool.

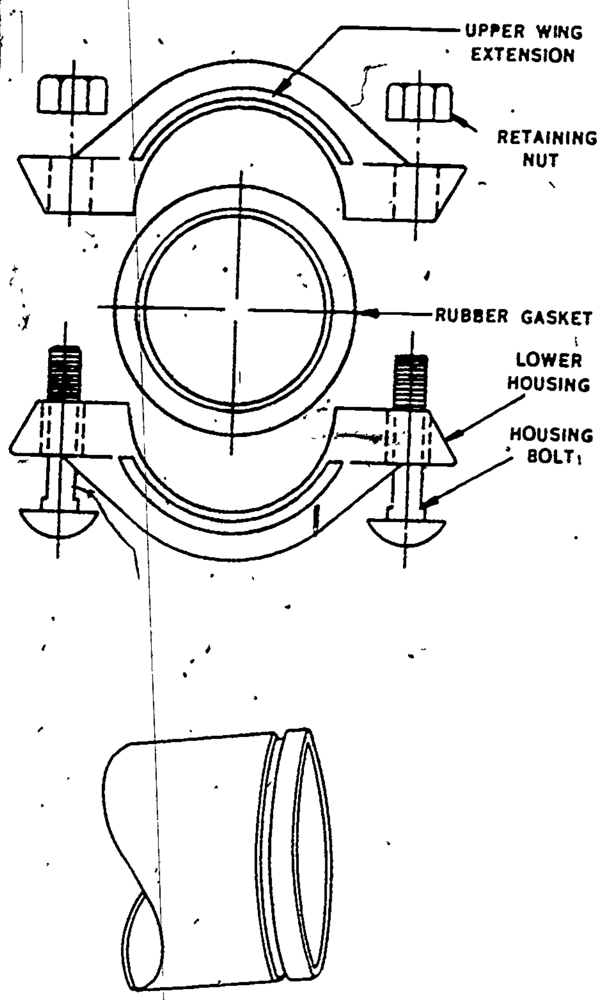

Figure 31. Groove Pipe and Mechanical Groove Coupling

To use the grooving tool, shown in figure 32, slide it over the pipe end until it is against the pipe stop of the front of the tool, then handtighten the clamping screw. Thus, the grooving knife is automatically positioned, and the knife is put in spring fed cutting tension by simply loosening the wing handle. Stroke the ratchet handle and when proper groove depth is reached, the grooving knife automatically disengages and the tool spins freely. Grooving tools are simple to operate and cut accurate grooves with little effort.

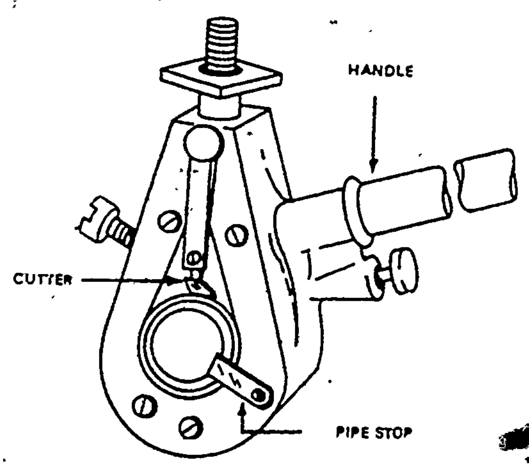

Figure 32. Pipe Grooving Tool

The coupling engages the adjacent pipe grooves around their entire circumference and securely locks the pipes together in a positive yet flexible grip allowing for up to 3° of angular deflection and 1/4" linear movement, as shown in figure 33. The housing maintains the sealing position of the O-shaped gasket and, at the same time, provides a strong metal backup for the gasket.

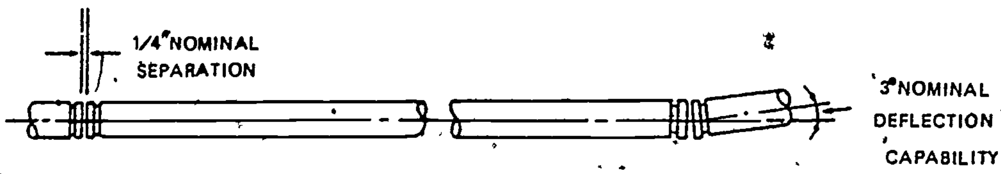

Figure 33. Details of Semirigid Plastic Pipe

Compression Type Couplings

Another method of joining temporary water mains is by using compression couplings. These couplings usually rely upon compressed rubber gaskets for sealing the joints.

Some of the advantages of the compression coupling are as follows: (1) less skill and labor required, (2) more flexible and allows greater deflection in direction, (3) fewer leaks, and (4) less overall cost. One disadvantage on some compression couplings is the corrosion of bolts used to tighten the joint. The use of cast-iron bolts which are more resistant to corrosion has somewhat alleviated this trouble.

Figure 34 shows a compression coupling and illustrates the different parts of the coupling. Notice how the end nut compresses the gasket between the retainer, the pipe, and the coupling body.

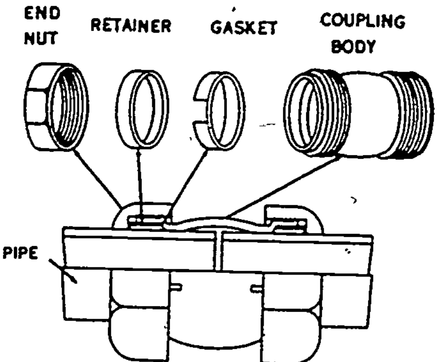

Figure 34. A Compression Coupling for Small Size Pipe

Water mains, which are three inches in diameter or above, may be constructed either of steel or asbestos pipe. A large main is more difficult to install because of problems involved in handling the pipe and fittings. Asbestos pipe should be used when available because it weighs much less than comparable sizes of steel pipe. A compression coupling for use on larger sizes of steel pipe is shown in figure 35. This coupling has compression rings on each end of the center ring which are sealed against the gaskets by tightening the bolts.

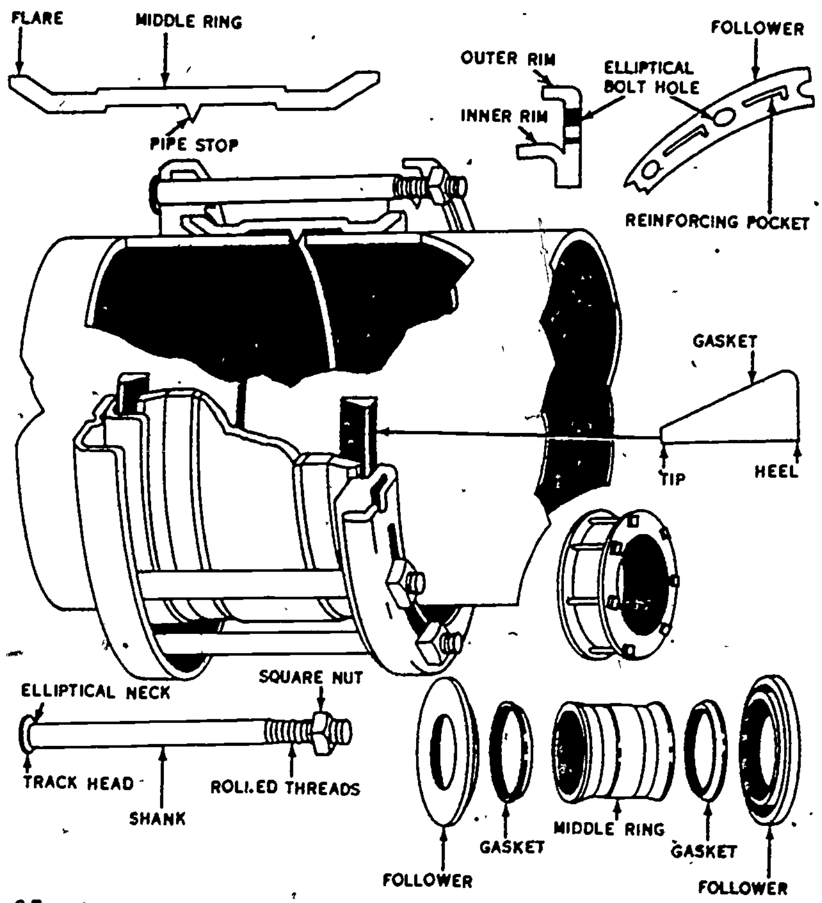

Figure 35. A Compression Coupling for Large Size Pipe

When installing lines using compression couplings, be sure to secure the pipe so that pressure will not force the joint apart.

REPAIRING RUPTURED WATER MAINS

When you receive a call informing you that a water main is ruptured, speed in repairing the line is an important factor. You should be familiar with the water distribution maps so that you can turn off the water as quickly as possible. You should also have the proper repair materials on hand.

One important item you should remember is while the water is off, you have an area on the base that is vulnerable to lack of water in the event of a fire.

A base can have several types of piping, such as cast iron, asbestos cement, reinforced concrete, steel, etc. Figure 36 illustrates some of the types of breaks that you may find in mains and the methods of repairing them.

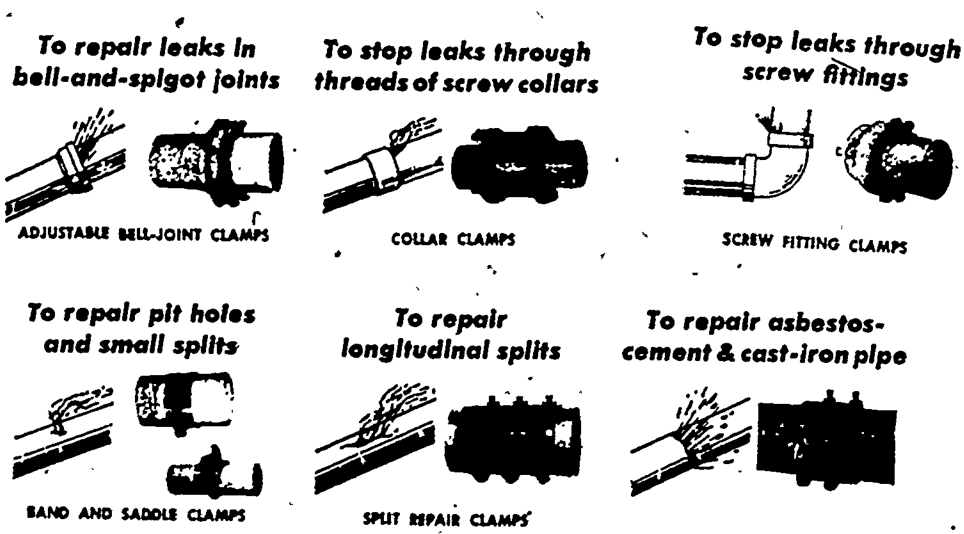

Figure 36.

SUMMARY

Temporary water mains are usually constructed during times of emergency to supply water until the regular system can be made operative. These mains are usually assembled on top of the ground, from steel, plastic, or asbestos pipe, using compression type couplings for ease and speed in construction. No special tools are required for cutting the pipe as is the case for iron or steel pipes. Asbestos pipe can be cut with a handsaw. The pipes do not require threading when compression couplings are used but the lines must be anchored or secured to prevent separation at the joints when the lines are laid above ground. All materials are salvaged for reuse when taking up a temporary water main.

QUESTIONS

1. What is the purpose of a temporary water main?

2. What tool would you use to cut cement asbestos pipe?

3. Why must above-the-ground lines, using compression-type couplings be anchored in place?

4. What is the name of the coupling used to connect plain end steel pipes?

5. Why is a space left between the pipe ends when using compression-type couplings?

6. What type of couplings are usually used with temporary water mains?

7. What kind of pipe should be used to construct temporary water mains?

8. Why are some temporary water pipes grooved on the ends?

9. How are the grooves cut on temporary water main pipes?

10. Why are temporary water mains installed above ground? Below ground?

REFERENCES

1. AFM 85-20, Plumbing

2. National Plumbing Code

3. AFM 85-13, Maintenance and Operation of Water Plants and Systems

FIRE HYDRANTS AND SPRINKLER SYSTEMS

OBJECTIVE

The purpose of this study guide is to familiarize you with fire hydrants and sprinkler systems.

INTRODUCTION

Adequate knowledge of the supply and distribution system for fire protection is necessary for all personnel concerned. Without proper operation and maintenance of the system, the entire effectiveness for fire protection is nullified.

INFORMATION

FIRE PROTECTION SYSTEM

Water is the most practical extinguishing agent for ordinary structural fires. It absorbs heat rapidly and with greater capacity than most other agents used for fire extinguishment.

Exterior Fire Protection System

Fire hydrants are an important part of the installation fire protection system and must be kept in good working order at all times. Hydrants in general are spaced within 500 feet of buildings. Of course, in industrial areas the distance might be less.

Fire Hydrants

Fire hydrants are manufactured in several different types and models. However, the three most important types are the flush, traffic, and standard.

The flush type, see figure 37, is normally installed in holes, below ground level, with the cover at ground level. This type of hydrant is ideal for areas where there is heavy foot or vehicle traffic. It is also used where above-ground hydrants would distract from the appearance of the surroundings. You will find these hydrants installed in such areas as airports, narrow streets, and sidewalks.

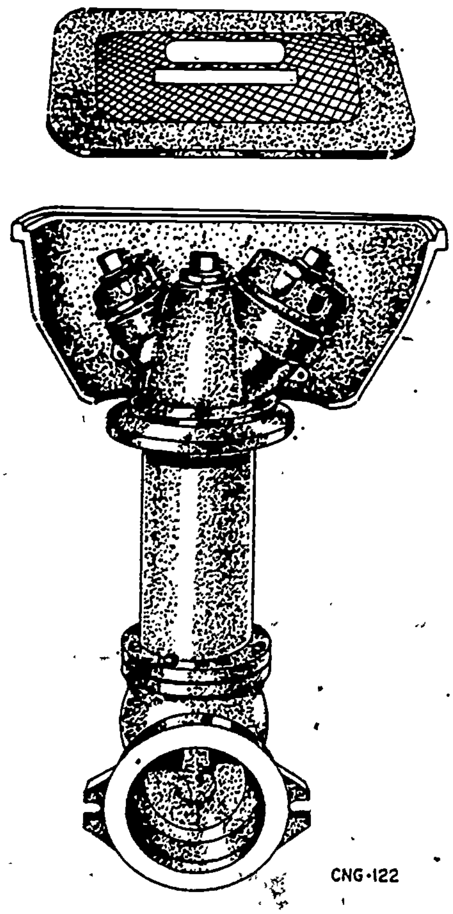

Figure 37. Flush Type Fire Hydrant.

The traffic model fire hydrant, see figure 38, is designed to breakaway when hit by a vehicle. This feature minimizes damage to both the vehicle and its occupants. This hydrant will breakaway without loss of water.

These hydrants have breakable bolts and breakable coupling (on the stem) at the ground level. In case of a collision, the top part of the hydrant will breakaway with minimum damage to the hydrant or vehicle. The main water valve remains seated because it is held closed by water pressure.

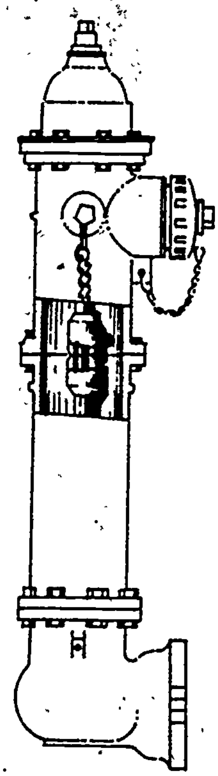

Figure 38. Traffic Type Fire Hydrant.

A broken hydrant can be repaired easily and quickly by using a safety flange repair kit. See figure 39. This kit consists of eight breakaway bolts, a breakable coupling, and a standpipe gasket.

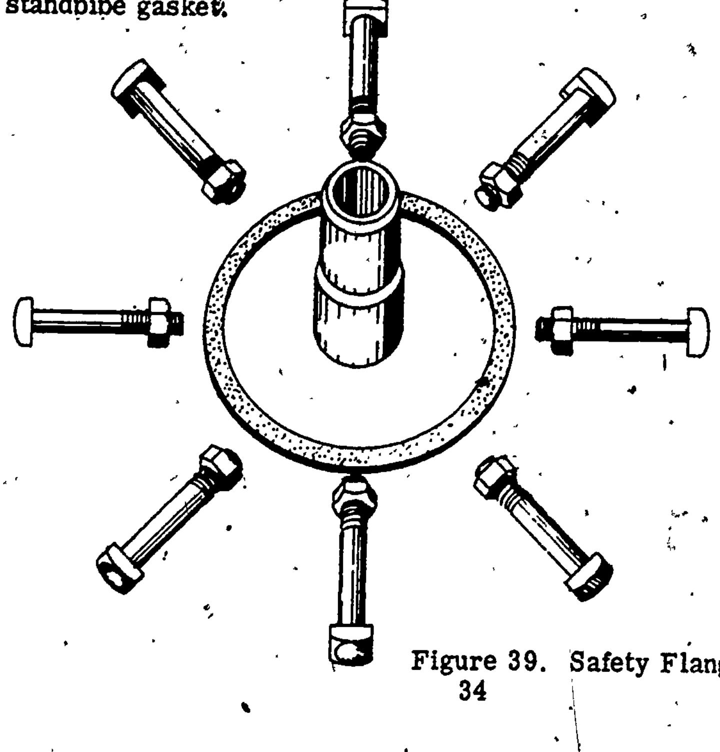

Figure 39. Safety Flange Repair Kit

The standard type of fire hydrant, see figure 40, is similar to the traffic model with the exception of the breakaway feature. The other component parts are the same and are interchangable.

Most fire hydrants have one pumper nozzle and two hose nozzles. The pumper nozzle is 4 inches in diameter and the hose nozzles are 2 1/2 inches. The nozzles should face in the direction that is the most convenient for use

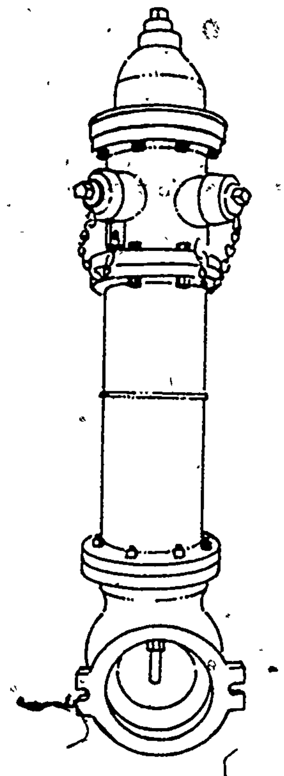

Figure 40. Standard Type Fire Hydrant.

A fire hydrant is a very simple fixture. However, it does consist of over forty different parts. A cutaway fire hydrant with the name of the parts is illustrated in figure 41.

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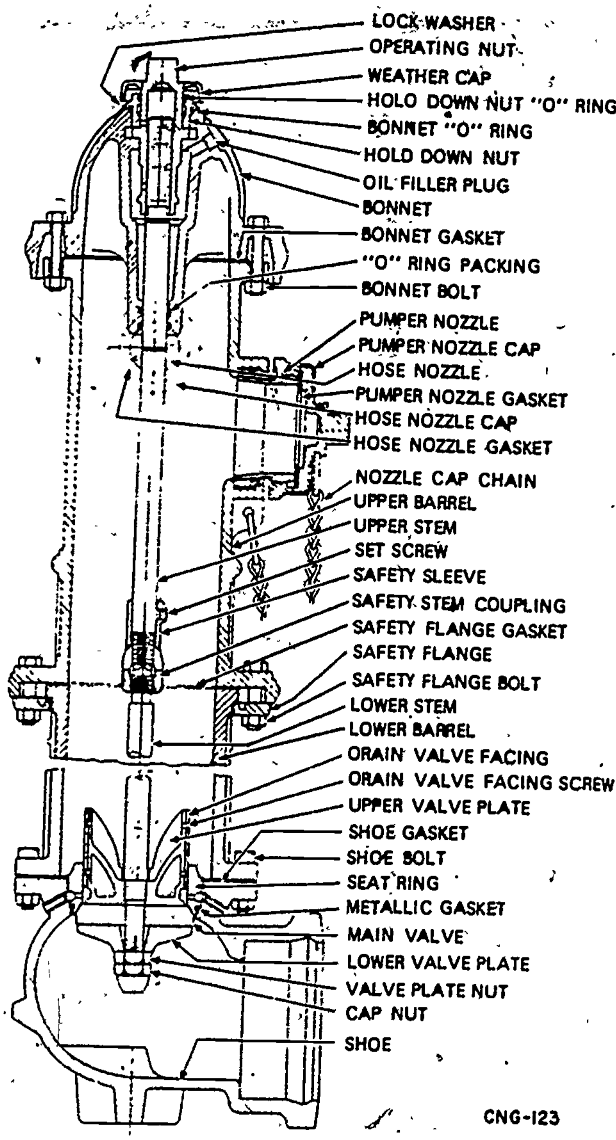

Figure 41. Cutaway Fire Hydrant.

Location of Fire Hydrants

The location of fire hydrants is a responsibility of the base Civil Engineer. When selecting the location of a fire hydrant the following factors are considered.

1. More than two feet but less than six feet from a paved road surface
2. At least three feet from any fixed object doorway or traffic lane
3. Must be readily accessible
4. Distance from other fire hydrants

Installation of Fire Hydrants

As a plumber, you may be called upon to install a fire hydrant. During the installation procedures, the following factors should be considered.

1. The lowest outlet should be at least eighteen inches above the ground.
2. The highest operating nut must be less than 48 inches above the ground.
3. The water main feeding the hydrant must be six inches in diameter or larger.
4. An isolation valve should be installed between the water main and the hydrant. (See figure 42.)
5. The waterline to the hydrant must be buried deep enough to eliminate the possibility of freezing.
6. The hydrant should be set on a concrete base. The base should be at least sixteen inches square and four inches thick.

   CAUTION: Make sure the drain hole is open.
7. The hydrant should be braced. (Opposite the water entrance) This is to keep the pressure from "blowing" the hydrant off the pipe. The hydrant can be braced by using concrete or bricks between the hydrant and solid ground.
8. If the soil is sandy and unstable, attach the hydrant to the water main with bridle rods and clamps. The rods should be at least 3/4 inch diameter and coated with an acid-resistant paint.
9. After the hydrant has been connected, pack at least seven cubic feet of crushed rocks around the base of the hydrant. This is to insure thorough draining of the hydrant.
10. The dirt should be replaced in layers six inches thick or less. Each layer should be tamped thoroughly before adding the next layer.

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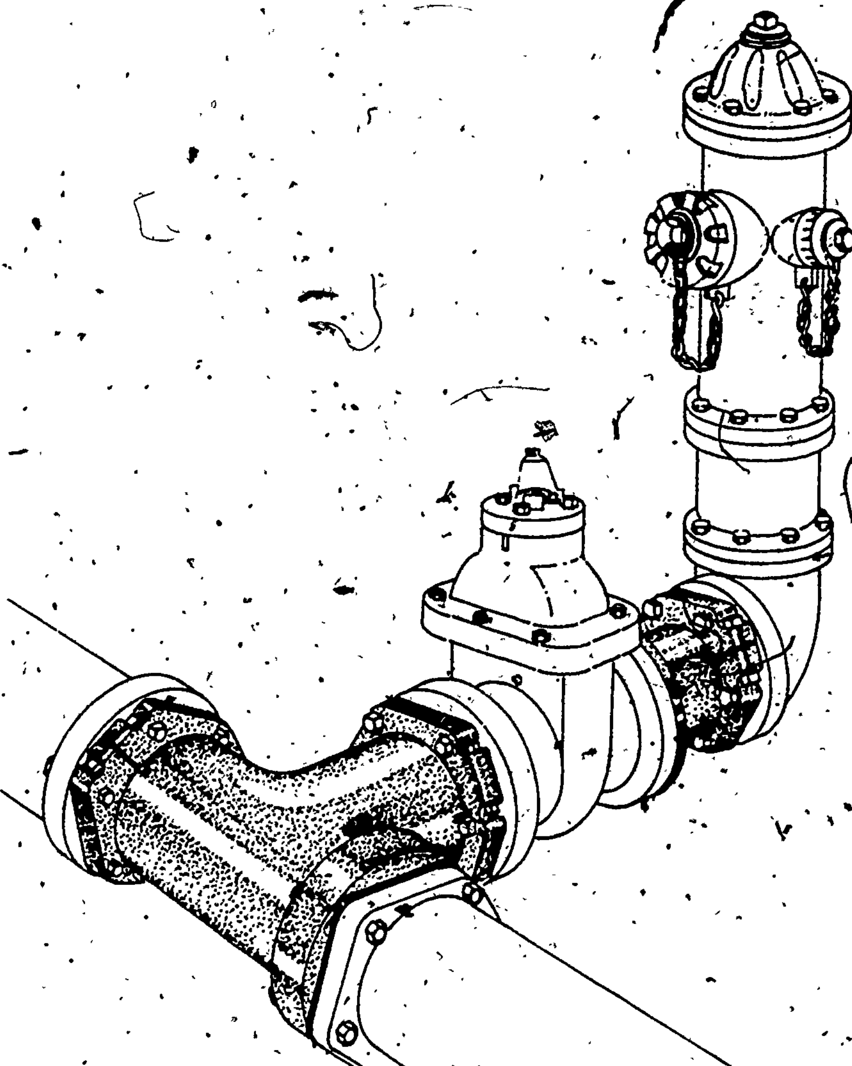


Figure 42. Isolation Valve.

Extending the Height of a Hydrant

Occasionally, it may become necessary to raise the height of a fire hydrant. This can be easily accomplished by the use of an extension kit. See figure 43. The extension kit consists of an extension barrel, an extension stem, and the necessary bolts, nuts, and gaskets. The extension kits come in six-inch increments from six inches to four feet.

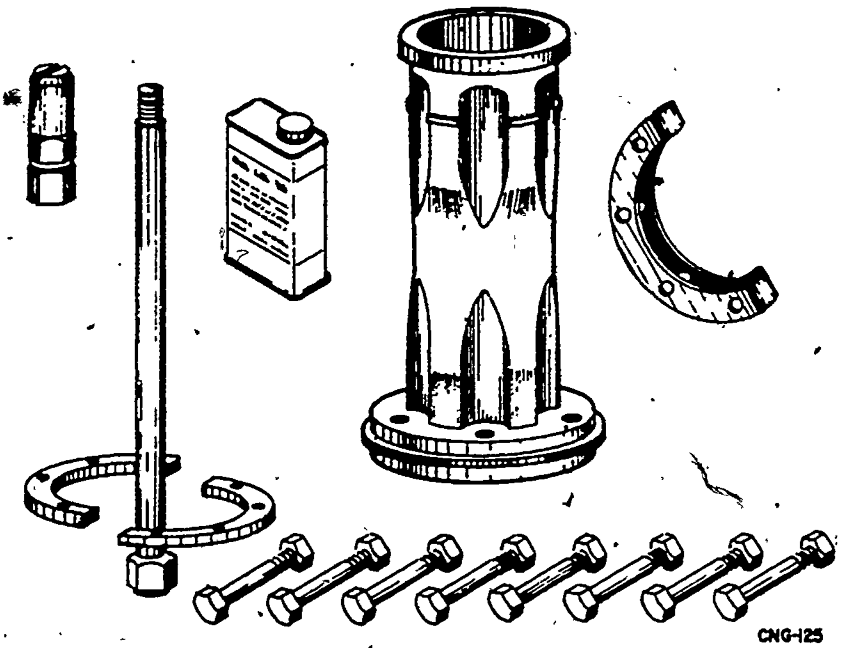


Figure 43. Hydrant Extension Kit.

Repair and Maintenance of Fire Hydrants

Fire hydrants are an important part of the base fire protection system and must be kept in good working order at all times. Mains must be located and checked periodically for leaks.

Modern hydrants can be maintained by replacing all working parts and seats through the top of the hydrant. Many hydrants require special wrenches or fittings to withdraw the lower parts. Proper tools should be obtained for every type of hydrant on the base.

The variety of makes and models of fire hydrants necessitates listing data for each hydrant on the base. Most information is cast on each hydrant, but descriptive matter and operating and repair instructions should be obtained from manufacturers and filed for reference. An indexed looseleaf hydrant record book should be kept showing pertinent physical data including a sketch or drawing referencing each hydrant.

Inspect and Service

Start inspection of the hydrant nearest to its source of water supply. Locate the valves on the hydrant stub or gird system so they can be shut off if the hydrant is found to be defective. Carry out valve inspection survey. Replace lost caps. Remove one hydrant cap and replace with a cap fitted with a pressure gauge. Open the hydrant SLOWLY until it is wide open.

CHECK TIGHTNESS OF NOZZLES. Inspect at each point where nozzles enter the hydrant barrel. Chalk lead around nozzles when necessary.

CHECK FOR LEAKAGE IN TOP OF HYDRANT. If necessary, remove cover, tighten packing gland, or repack.

CHECK FOR LEAKAGE PAST GASKETS UNDER OTHER CAPS. Replace defective gaskets.

CHECK FOR CRACKS IN BARREL. Order installation of new barrel or hydrant when required.

LOOK FOR LEAKAGE THROUGH DRAIN VALVE. Valve should be closed when hydrant is wide open. When necessary, replace drain valve facing or gasket if water comes up around hydrant when hydrant valve is wide open.

CHECK STATIC PRESSURE. Record pressure shown by pressure gauge reading. Close hydrant valve.

DETERMINE RESIDUAL PRESSURE. Remove second hydrant cap, leaving pressure gauge in position; open hydrant valve slowly until wide open; read and record residual pressure on gauge when hydrant is discharging maximum stream. Allow flushing to continue until discharge is clean. CLOSE HYDRANT SLOWLY.

CHECK TIGHTNESS OF VALVE AND SEAT. Watch lowering of water level in hydrant after valve is closed. If level does not drop, listen with ear against hydrant. If noise is heard, main hydrant valve is probably leaking and must be replaced. If water is quiet, drain valve is fouled and must be opened.

INSPECT OPERATING NUT. Replace it if it has rounded corners. Rounded corners are usually caused by the use of an improper wrench. Figure 44 illustrates the type of wrench that should be used when opening and closing fire hydrants.

The operating wrench, shown in figure 44, fits the operating nut, holddown nut, hose nozzle-caps, pin type and lug type hose coupling.

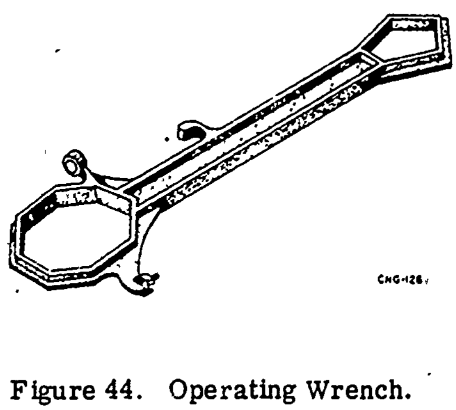


Figure 44. Operating Wrench.

INSPECT NOZZLE THREADS. Replace the nozzle if the threads are badly damaged.

CHECK CHAINS. If paint has frozen the chains tight to the caps, chip out the paint and free the chain.

LUBRICATE OPERATING NUT. Remove the screw in the top of the operating nut and apply oil or grease as recommended by the manufacturer. If the hydrant does not operate freely after lubrication, lubricate the packing and thrust collar by oiling the joint between the nut and collar.

In subzero weather inspect the hydrants near each important structure weekly; inspect all the other hydrants monthly. Do not flush the hydrants in subfreezing weather.

1. Place an operating wrench on the nut and turn it slightly to make sure it is not frozen. If it is frozen, thaw it out by applying heat with a torch.

2. Remove hydrant cap and inspect for ice in barrel. If the hydrant contains ice, you must thaw it out and drain it.

Interior Fire Protection Systems

The requirements for proper fire protection on an Air Force base consist of much more than the distribution of fire extinguishers throughout buildings and the moving of a few firetrucks. You will also find fire sprinkler systems inside many of the buildings on a base. A sprinkler system automatically spreads water over a burning part or floor areas in a building. It will extinguish the fire completely or hold it in check until the fire department arrives. These systems are automatically put into operation by the breaking of fusible links or the contact of heat-activated devices. In addition, some systems may have manual controls, see figure 45.

The type of system to be installed in a building is decided during construction planning. Otherwise, the system must be installed or modified on existing buildings. This is more expensive. In either case, the system should be selected and installed with the following factors in mind:

1. Type of building (size, construction, material).

2. Occupancy (contents and hazards).

3. Heating facilities and location.

4. Available water supply.

THE WET PIPE SYSTEM. The wet pipe system is filled with water and connected to an adequate water supply. The sprinkler heads are sealed. Heat on the fused head causes the sprinkler heads to discharge water on the area below them. A waterflow tong on an alarm valve indicates waterflow and alarms.

This is the simplest and least expensive system. It is suited for locations where freezing temperatures are of no concern.

THE DRY PIPE SYSTEM. A standard dry pipe system is a modified version of the wet pipe system. It has a dry pipe valve which is kept closed by air pressure--instead of water pressure--in the piping. Since there is not any water in the piping, there is not any danger of frozen lines. An installed air compressor is used to provide the pressure to hold the valve (sometimes called the differential clapper) closed.

When the fuse in the sealed head melts and separates, the air pressure is released. The water pressure then opens the dry pipe valve, flows through the piping, and is distributed on the fire.

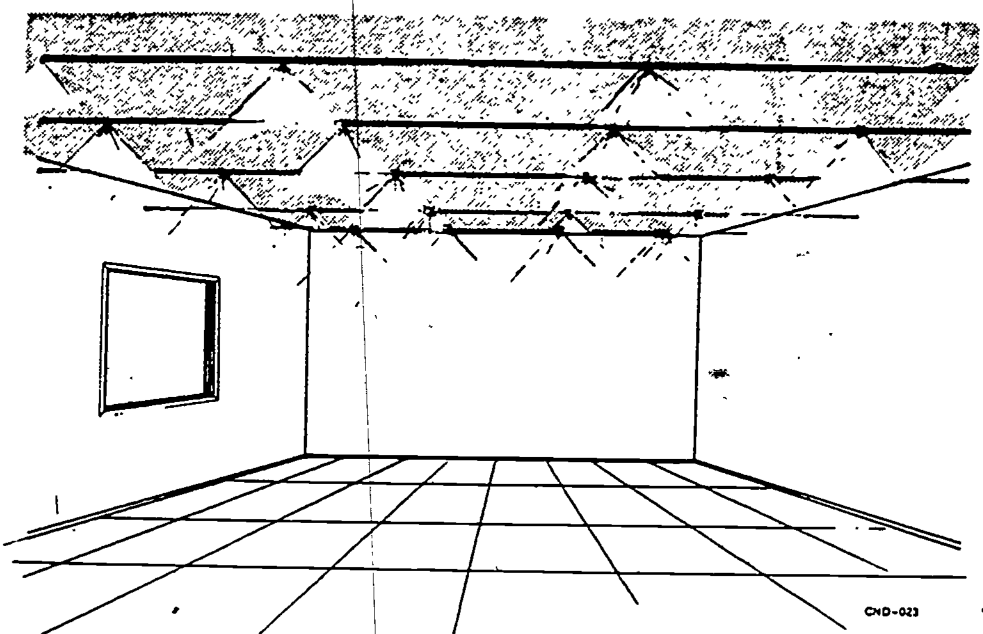


Figure 45. Typical Building Fire Sprinkler System

Delays in action because of the time needed to clear the pipes of air may be reduced by special exhausters or accelerators. They operate simultaneously with the dry pipe valve.

This system has the same extinguishing ability as the wet pipe system, however, it is more complex and costly. It is installed where freezing temperatures are expected.

THE DELUGE SYSTEM. The deluge system is a special type of automatic dry pipe system with open sprinkler heads. When the system operates, all of the installed heads will discharge water over the entire area served by the valve.

Sprinkler Heads

Sprinkler heads are located strategically throughout a building, depending on type of building and its contents. They may be installed in the pendant or upright position. Where they must be installed in the pendant position, they shall be of the type approved for that purpose.

STANDPIPE SYSTEMS. Standpipes, as shown in figure 46. provide a constant source of water for first aid firefighting. They are designed to be used at all floor levels by either building occupants or the fire department but should not be relied upon for total extinguishment of a fire. They improve the protection of excessively high buildings and poorly accessible areas.

Standpipe systems are classified as follows:

1. Wet pipe systems with open supply valve and water pressure maintained at all times.

2. Dry pipe systems which automatically admit water by opening a hose valve.

3. Dry pipe systems activated by manual operation of remote controlled devices at each hose station.

4. Dry pipe systems supplied through external fire department pumper connections.

Standpipe hose will be of 1 1/2 or 2 1/2 inch unlined linen in 50-foot lengths.

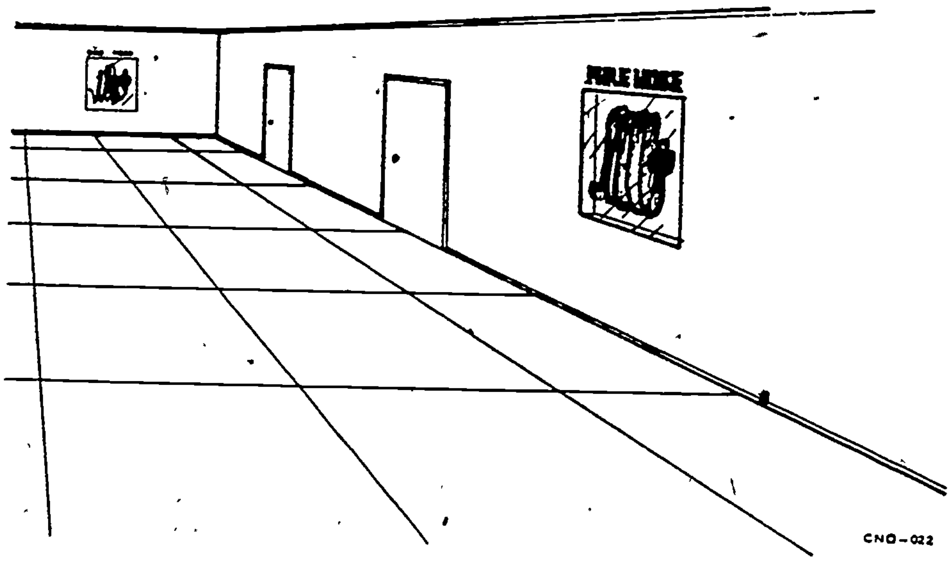


Figure 46. Standpipe in Building.

LAWN SPRINKLER SYSTEMS

Rainfall, which is preferred, cannot always be counted on to deliver adequate amounts of water at the proper time. Continued long, hot summer weather with little rainfall can destroy or ruin a beautiful lawn, unless nature's supply of moisture can be supplemented at the proper time.

A modern permanent plastic pipe irrigation system can provide an economical answer to this problem. The smooth interior walls of plastic pipe permit greater flow and less friction loss than metal or other pipes. The fact that plastic pipe cannot rust, rot, or corrode assures years of troublefree service. Scale build-up is virtually eliminated, assuring the same pressure and flow capacity after years of service, even where the mineral content of the water is extremely high. Nonporous walls eliminate water loss through seepage. Due to its light weight and flexibility (compared to metal pipe), ditching and installation can be accomplished quickly and more economically than for other types of pipe and with a minimum amount of damage to lawns.

The above factors plus the low initial cost of plastic pipe and fittings, make possible the installation of a permanent irrigation system costing less than irrigation systems using other types of pipe.

In the modern lawn sprinkling system, underground piping carries water to self-closing snap valves. The valves are located conveniently with their tops at ground level. To these valves small, lightweight portable sprinkling units are easily and instantly connected. The mere connection opens the valves and the valves close again upon removal of the sprinklers. The number of sprinkling units used is determined by the available water supply, the size of the overall system installed, and the output size of the sprinkling units themselves.

Plastic Pipe

In recent years the use of plastic pipe has increased. At first it was used mostly for farm water systems and lawn and golf course underground sprinkling systems. Today it is commonly used for natural gas distribution, chemical and food processing, industrial and residential plumbing, and industrial waste disposal. Plastic pipe is a unique combination of chemical and physical properties. In the manufacture of plastic piping products, only virgin plastic compounds that meet exacting specifications are used. By doing this the special properties of the raw materials will not be changed or diluted. Plastic materials are usually classified in two basic groups--thermoplastics and thermosetting resins. Thermoplastics can be reformed by heating. The shape of thermosetting resins cannot be changed for reuse once their shape is fixed. Thermoplastics are used more than thermosetting resins for the manufacture of plastic pipe.

Plastic pipe has many desirable characteristics. It will not rust, rot, or corrode. It has smooth interior walls that reduce friction. Its light weight makes it easy to handle. Due to its nonelectrolytic characteristic it will not corrode due to electrolysis. Many types of plastic pipe have excellent resistance to chemical attack.

Plastic pipe is affected by temperature changes. The allowable pressure decreases as temperature increases. It expands and contracts when the temperature of the pipe changes.

Polyvinyl Chloride (PVC) Plastic Pipe

PVC has a high tensile strength. It is stronger and more rigid than most of the other types of thermoplastics. PVC comes in two types; type 1 (normal impact) and type 2 (high impact). The maximum service temperature is 150°F for type 1 and 140°F for type 2. PVC has excellent chemical resistance to a large number of corrosive fluids. It has proven to be very satisfactory for industrial and laboratory chemical distribution systems as well as portable water systems.

Acrylonitrile-Butadiene-Styrene (ABS)

ABS is a very tough plastic with a high impact strength. Its maximum operating temperature is 180°F. However, it has a somewhat lower chemical resistance than PVC. ABS pipe is primarily used for irrigation lines, gas transmission, drain lines, and waste and vent piping.

ABS pipe can be connected by either solvent welding or threading.

Polyethylene Plastic Pipe

Polyethylene is less expensive and therefore is used more often than other types of thermoplastics. Its mechanical strength is comparatively low. However, it has a high chemical resistance. Its maximum operating temperature is 120°F. It is frequently used for chemical drainage, field irrigation, and potable water systems. The best method of connecting polyethylene plastic is by thermoseal fusion. However, it can be joined by using serrated insert fittings and clamps.

Handling and Storing Plastic Pipe

Care must be taken when handling and storing plastic pipe to prevent scratches and gouges on the surface of the pipe. Strap wrenches, instead of standard pipe wrenches, should be used with plastic pipe. When placing plastic pipe in a vise or chuck, wrap the pipe with soft metal or emery cloth.

Store plastic pipe in a clean area with good ventilation. The storage rack should be wood or metal without sharp edges or burrs. The rack must support the pipe enough to keep it from sagging. Do not store plastic pipe near steam lines or other heat sources. Store plastic fittings alone. Do not mix them with metal ones.

Cutting Plastic Pipe

Plastic pipe can be cut with just about any type of cutting tool; saws, tube and pipe cutters, and knifes. When using saws to cut plastic, select a fine-toothed blade with very little set. Place the pipe in a miter box or holddown jig to insure a square cut. Tube and pipe cutters require a special blade to cut plastic.

After cutting, remove the burrs with a fine-tooth file or deburring tool. Before installing, make sure the pipe is free of chips, burrs and all types of foreign matter.

Bending Plastic Pipe

Bending plastic pipe weakens it, therefore, bending is not recommended. Bending is particularly objectionable when the pipe has to operate at or near its maximum rated temperature and pressure. The use of fittings make a more professional looking job as well as maintains the original temperature and pressure ratings.

If bending is required for some special reason such as expansion loops or lack of fittings, the following procedures are recommended.

1. Seal both ends of the pipe.

2. Apply enough air pressure to maintain the ovality of the pipe when bending.

   NOTE: Preheated sand may be used instead of air pressure.

3. Heat the pipe (where it is to be bent). This can be accomplished by holding the the pipe under a stream of hot (180°F) water.

4. When the pipe becomes soft and pliable, quickly bend it around a preformed jig.

   NOTE: The radius of the bend should not be less than five or six pipe diameters.

5. Keep the pipe in the bending jig until it cools enough to become rigid, then, cool it quickly by dipping it in cold water.

6. Do not relieve the air pressure or remove the sand until after the pipe has completely cooled.

   NOTE: Do not attempt to bend "thermoset" plastic.

Using Threaded Fittings

Normally, glued or welded fittings are used with plastic pipe. However, if the pipe is to be used in a temporary application, threaded fittings are more applicable as they make disassembly easier.

Threading plastic pipe reduces the wall thickness and reduces the pressure rating. Only thick walled plastic pipe should be threaded.

Either cabot-type tite joint thread tape or teflon-type base thread lubricant should be used on the threaded plastic pipe.

Solvent Welding

Solvent welding is the preferred method of connecting plastic pipe. It's easily accomplished and makes a strong, tight, permanent connection.

The following general guideline will aid you in making a good solvent weld joint.

NOTE: Follow the manufacturer's instruction for specific step-by-step instructions.

1. Select the correct cement. (PVC cement for PVC pipe) (ABS cement for ABS pipe)
2. For thin walled pipe, apply the cement to the male end only.
3. For thick walled pipe, apply the cement to both the male and female ends.
4. Apply the cement with a natural bristle brush.

NOTE: Nylon and synthetic brushes are attacked by the solvent in the cement.

5. An oil can is a good container for acetone type cleaner. It prevents excessive evaporation and the solvent is always readily available.
6. Do not allow water to get in the cement. Water and cement will not mix but water will ruin the cement.
7. Allow the completed cemented joint to cure for about five to fifteen minutes before moving it.
8. Wait 24 hours before applying full pressure to a solvent-cemented joint.

Underground Installation

When laying plastic pipe underground, it should be buried below the frostline. If the soil in the bottom of the trench is unyielding (such as clay or rock) overexcavate the trench about four inches. Fill the bottom of the trench with rockfree soil or coarse sand. This will allow the pipe to move a little for temperature changes.

Assemble the pipe on the top of the ground (allow the joints to set up) and then place the pipe in the trench. The pipe should be completely assembled and pressure checked before being covered up.

During backfilling, the pipe should be at operating temperature and pressure. This helps to prevent pipe deformation. The top eight to twelve inches of backfill material must be free of rocks or other sharp objects.

Expansion in Plastic Pipe

Plastic pipe expands and contracts with changes in temperature. When the total temperature change is 30°F or less, special provisions to compensate for thermal expansion is not necessary. If a line contains several directional bends, these bends will usually compensate for thermal changes.

The best method of compensating for thermal changes is by using an expansion loop. Expansion loops can be fabricated by using fittings and short lengths of piping. If there isn't enough room for an expansion loop, you will have to use an expansion joint. An expansion joint is a factory made unit that consists of two tubes; one telescoping inside the other. There is a gas and fluid tight seal between the two tubes. The outer tube is anchored firmly and the inner tube is free to move in and out (with a piston-like action) as the pipe expands and contracts.

Alignment of expansion joints is very important. The free member must be directed straight into the anchored member or binding will occur. Guide loops should be installed on the free member to keep it aligned.

Supporting Plastic Pipe

Plastic pipe should be supported twice as often as metal pipe. The hangers should have broad smooth bearing surfaces to prevent damage to the pipe. Do not install plastic pipe on or near steam lines or other high temperature surfaces. Support all plastic fittings individually and brace all valves against operating torque.

Plastic pipe operating at high temperature or carrying hazardous fluids should be run in channel iron to provide continuous support.

Compressed Air System

A compressed air system is an auxiliary system that furnishes compressed air to operate pneumatic tools, paint spray units, fire sprinklers and other pneumatically (air) operated equipment.

Components and Operation of Compressed Air Systems

An electric motor or gasoline engine drives an air compressor which furnishes air to the receiver tanks. The system is equipped with safety relief valves to prevent excessive pressure; shutoff valves to allow isolation of components; check valves to prevent receiver pressure from bleeding back through the air compressor; pressure operated controllers for automatic operation; and pressure gages to allow you to monitor the operation of the system. Figure 47 shows a typical system.

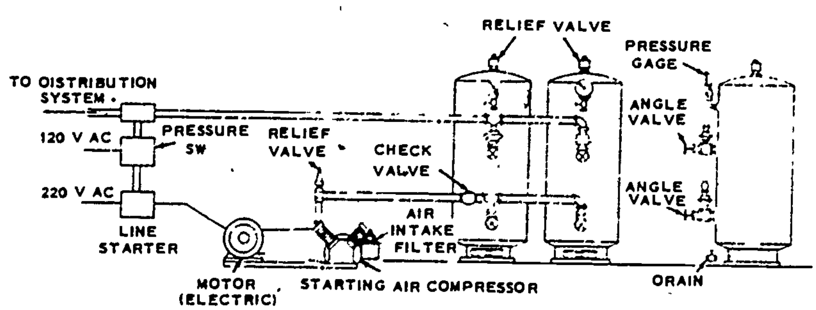


Figure 47. Typical Air Compressor System.

Study figure 47 and the following explanation to aid you in understanding the operation of a typical compressed air system.

The high-pressure line from the air receiver tanks to the distribution system has a branch connection to a pressure switch. When the system pressure drops, the switch closes, completing a 120-volt ac circuit to the line starter. The line starter completes the high-voltage circuit to the motor. The energized electric motor drives the air compressor which delivers high-pressure air to the receiver tanks. When the pressure in the system increases to a predetermined setting, the pressure switch opens, interrupting the 120-volt circuit that opens the high-voltage line and turns off the motor.

The compression cycle of an air compressor consists of two strokes, the suction stroke and the compression stroke. The air compressor is a machine designed for compressing air from an initial inlet pressure to a higher discharge pressure.

Compressor Construction and Operation

Air compressors are constructed similarly to engines except that they have no fuel or ignition system, and the valves are spring and pressure operated rather than cam operated. Compressors are available in a variety of designs, and are classified as single stage or multistage. Single stage compressors normally consist of a one cylinder air compressor and a driving device. They are classified as a single stage compressor because they complete the compression from initial to final pressure in one compression step.

Multistage compressors are normally used in powerplants. These compressors are of the same basic construction as single stage compressors. The major difference is that the air is compressed two (2) or more times from initial to final pressure. Higher air pressures are available with multistage compressors.

The suction stroke begins when the piston starts its downward motion. This difference in pressure causes the inlet valve to open and the air is admitted to the cylinder. The inflow of air continues until the piston reaches the bottom of the stroke. The compression stroke begins when the piston starts upward. At this point the pressure is the same as that in the compressor intake and the inlet valve closes allowing pressure to build up. As the piston moves upward, the pressure in the cylinder becomes great enough to force open the discharge valve. Discharge pressure increases as system pressure increases. Figure 48 illustrates compressor motion during this cycle.

Compressors incorporate unloader valves to unload the compressor allowing it to start against atmospheric pressure only. This relieves the compressor motor of heavy starting loads. After operating speed is reached, the valve closes allowing air to be compressed. Many types of unloader valves will be found on various compressor units.

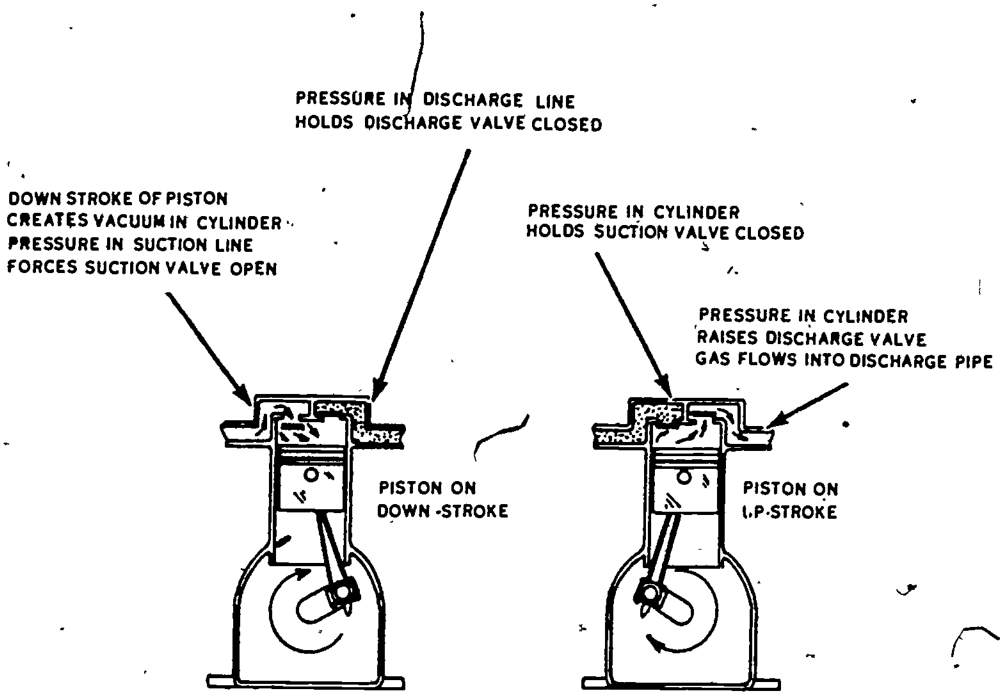


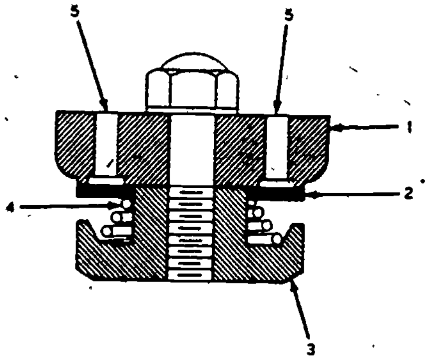
Figure 48. Operating Cycle of a Reciprocating Compressor.

The air valves are vital parts of the compressor and more development work has been done on the valves than on any other part of the compressor. The valves of most modern compressors are automatic, that is the opening and closing of the valves is caused solely by the difference in pressure between the air within the cylinder and the external air on the opposite sides of the valves (intake and discharge). Thin-plate, low-lift valves are generally used on air compressors. Figure 49, detail A, shows a typical low-pressure suction valve and detail B, shows a low-pressure discharge valve.

Note that the low-pressure valves consist of a valve seat, valve plate, valve spring, and bumper. The valve plate, being ring shaped, covers only the valve ports and is supplemented by the bumper, which functions as a guide to keep the valve plate centered. There are also other designs.

Intercoolers are used to remove heat from the air between stages in multistage compressors and are usually an integral part of the compressor unit. As air passes from the outlet of the low-pressure stage to the inlet of the high-pressure stage, it passes through intercooler tubes. Intercoolers are used because they increase the efficiency of the second stage cylinder. A relatively cool intake charge will admit more volume to the compressor cylinder and result in a larger storage volume potential in the receiver. A low temperature in the cylinder also insures better lubrication of the piston and valves.

Air-cooled intercoolers may be of the radiator type or may consist of a bank of finned, copper tubes located in the path of blast air supplied by the compressor fan. Although the compressor will compress air running in either direction, it must run in the direction specified by the manufacturer to get proper cooling from the fan located on the drive pulley.



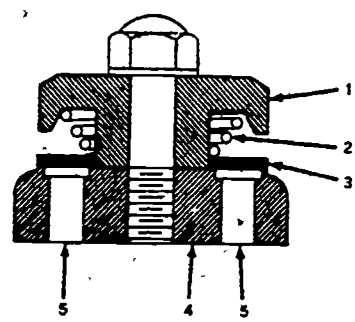


Figure 49. Low-Pressure Valves.

Methods of Driving Air Compressors

Most powerplants have two air compressors; one driven by an ac electric motor and the other driven by a gasoline engine. Normally the electric motor driven compressor supplies all air pressure and the gasoline driven compressor is the standby or emergency source.

PRESSURE CONTROLLERS

The motor operated compressor is controlled by a pressure switch. Figure 50 shows a typical pressure switch. The pressure switch opens the motor circuit when the air receiver pressure increases to the desired operating pressure and closes the circuit when the pressure fails to a minimum pressure. Since the pressure switch controls the pressure in the air receiver, the pressure switch must never be set higher than the operating range of the system. If properly adjusted the pressure differential controller will automatically start and stop the air compressor to maintain desired tension on the differential adjustment.

Safety

While working on compressed air systems, you must be constantly alert and observe all safety precautions. The electrical circuits, moving machinery, and high-pressure air lines of an air compressor require a worker to know his job and work carefully at all times, to avoid an accident. To aid you in doing your job safely, observe the safety items discussed in this study guide.

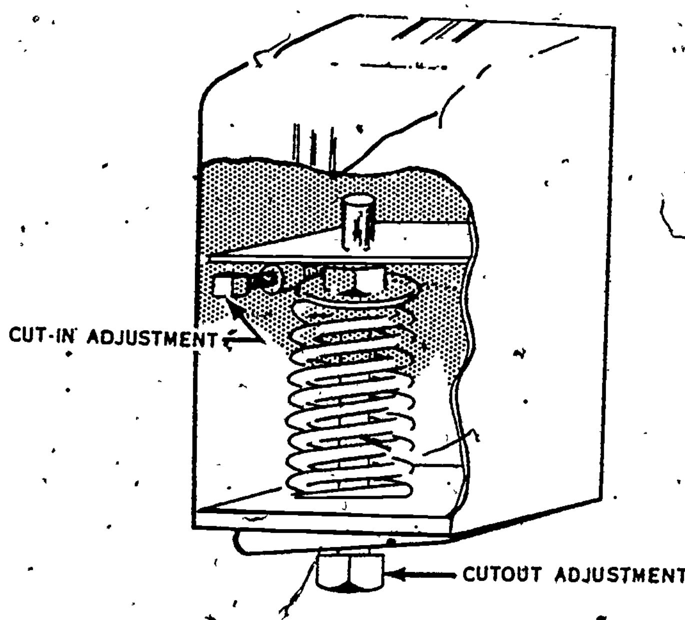


Figure 50. Typical Pressure Switch and its Adjustments.

Compressor flywheels, pulleys, and belts will have safety guards installed on them. Do not operate the compressor with the guards removed, or attempt to remove the guard until the compressor is shut down. Care must be taken to prevent clothing, wrenches, or equipment from catching in the moving parts of the compressor.

Before performing any maintenance on the compressor, be certain that the electrical switches are locked in the OPEN position, and tagged to prevent accidental starting. Before starting the compressor, check to insure that all valves are in the correct OPEN or CLOSED position. Safety valves should be checked for proper operation.

Compressed air systems can be dangerous if not operated and maintained in accordance with the safety directives. AFR 127-101 should be consulted for further information on this subject.

Inspection and Maintenance of Compressed Air Systems

Air compressors are designed to give years of troublefree service, however, they do require inspection and servicing at regular intervals to maintain satisfactory operation. When compressor maintenance is required follow the procedures outlined in AFM 85-30 and the manufacturer's manual for the unit.

A daily inspection should be performed on the air compressors. Before starting the inspection secure the switch in the OFF position to prevent accidental starting. The compressor belts should be inspected for tension and condition. The belts must be tight enough to avoid slippage and loose enough to prevent excessive bearing wear.

When it is necessary to replace excessively worn, frayed, or cracked belts the entire set of belts must be replaced. Check compressor guards daily to be certain they are in place and securely mounted.

Check the compressor oil level daily, it must be maintained between the high and low marks. The oil must be changed regularly as prescribed by the manufacturer. Use a good grade compressor oil, if available. If compressor oil is not available, use a medium viscosity SAE 30 motor oil.

Air cleaners and filters should be inspected and serviced as necessary. They are normally cleaned weekly, however, dusty conditions will shorten this time. Consult the manufacturer's manual for servicing procedures of various types of filters and cleaners.

Remove dirt and oil from the outside of the unit daily giving special attention to intercoolers, fins, and tubing. Open the manual drain cocks at least once a day to remove moisture from the system.

Before starting the compressor be certain that all valves are in the correct position and that all personnel and equipment are clear of the unit. After the unit is started check the operating condition of the system. All pressure gages should be checked for correct indication and the safety relief valves for free operation.

Air receivers are compressed air storage tanks and are an essential part of compressed air systems. Systems that operate at 200 psi or above require a hydrostatic test every three (3) years. A hydrostatic test is performed to insure the air receiver tank will withstand the working pressure with a reasonable margin of safety. This test will be performed at one and one-half (1 1/2) times the maximum working pressure. Components that should not be subjected to test pressures must be removed. All openings in the tank must be plugged and the tank is filled with water. Water is then pumped into the receiver until the desired pressure is reached and this pressure is maintained for five (5) minutes. Water is used during this test to minimize the explosive force if the receiver should rupture. After the test has been successfully completed, the test date and pressure is stenciled on the receiver.

SUMMARY

Fire hydrants require very little maintenance and repair. However, it is the plumber's responsibility to make sure they operate correctly. There are three types of fire hydrants in general use; flush, traffic, and standard. Each of these types are used for specific applications.

Some Air Force buildings (example: warehouses) have automatic sprinkler systems for fire protection. The three main types of sprinkler systems are the: wet pipe, dry pipe, and standpipe. Each type has some advantages and some disadvantages.

Plastic pipe is used for natural gas distribution, chemical and food processing, and plumbing and industrial waste disposal.

QUESTIONS

1. What is the most practical method of putting out fires?
2. Where are flush-type fire hydrants used?
3. Name three types of fire sprinkler systems?
4. What is meant by a "wet pipe system"?
5. What keeps the differential clapper (dry pipe) valve closed?
6. What actuates the dry pipe system?
7. What kind of lubricant should be used on threaded plastic pipe?
8. How long should a plastic welded pipe joint be allowed to set before applying a full test?
9. List four advantages of plastic pipe?
10. What AFM should be used when information is required pretaining to compressor maintenance?

REFERENCES

1. AFM 85-30, Operation and Maintenance of Air Compressors
2. Audel, Plumbers and Pipefitters Library

UTILITY EQUIPMENT

OBJECTIVE

This study guide will aid you in learning how to care for tools and equipment and the types and construction features and the installation of utility equipment.

INTRODUCTION

The Air Force, like other large corporations, has the responsibility for the health and welfare of many thousands of people, not only the military people, but the civilian employees and dependents as well. As a plumbing specialist, it is your responsibility to install all types of utility equipment, such as dishwashers, steam kettles, scullery sinks, drinking fountains, refrigerated food storage boxes, service sinks, and washing machines.

INFORMATION

Installation Requirements

The waste system from utility equipment (sinks, steam tables, coffee urns, etc) that is used in the preparation or serving of food must discharge into a waste sink. See figure 51. This eliminates the possibility of the waste backing up into the fixture and contaminating the food. The waste sink must be installed in a lighted, well-ventilated space. It must be water supplied and there must be a two-inch air gap between the indirect waste line and the top of the waste sink. (See figure 51.)

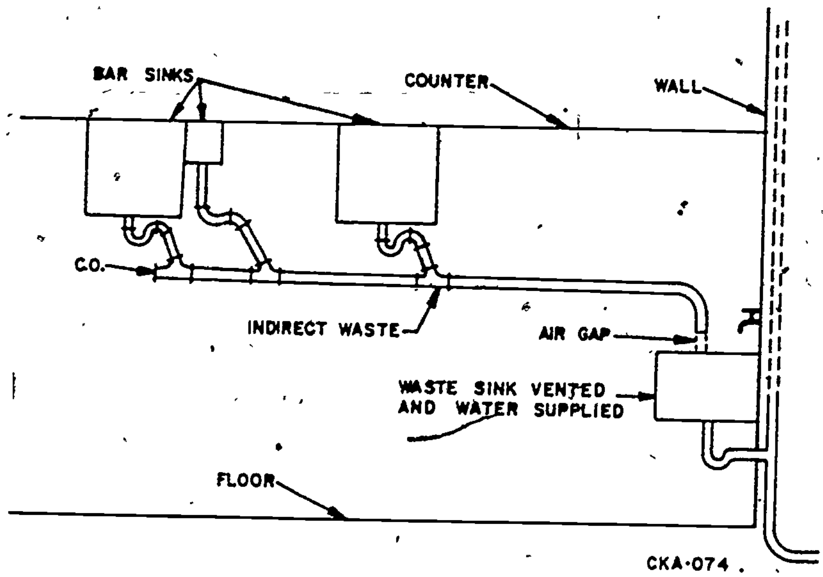


Figure 51.

Traps in an indirect waste system do not have to be vented.

If food preparation equipment (refrigerators, food storage cabinets, water cooler, etc) requires a water supply, the supply line must contain a vacuum breaker. (See figure 52.) The vacuum breaker eliminates the possibility of contaminated water backing up into the potable water supply. Figure 52 also illustrates an indirect waste line (with a two-inch air gap) discharging into a floor drain.

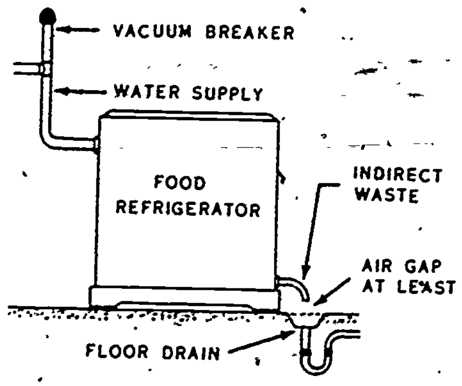


Figure 52. Indirect Waste

Drinking Fountains

Most of the drinking fountains that are used by the Air Force today are mechanically cooled, as shown in figure 53. They may be fastened to the wall, as shown in figure 54 and supplied with chilled water.

Wall Mounted

Wall-mounted drinking fountains are generally constructed of vitreous china, porcelain, or stainless steel.

The fountain contains a bubbler head, as shown in figure 55, which projects at least 3/4 of an inch above the rim of the drinking fountain. This eliminates chances of cross-connection or water contamination.

Drinking fountains should be installed with the bubbler from 30 to 40 inches above the floor, depending on the general height of the people who will use it.

The wall-hung fountain is installed by hanging a bracket, much the same as the lavatory. This is illustrated in figure 56. The waste strainer is connected through a pipe to a 1 1/4 inch P-trap under the unit. The water supply is attached directly to a spring control valve that automatically shuts off the flow of water when the handle is released. Drinking fountains require a minimum of 3/8-inch water supply line.

There are many variations of drinking fountains, so check the manufacturer's installation procedures and specifications to install the unit.

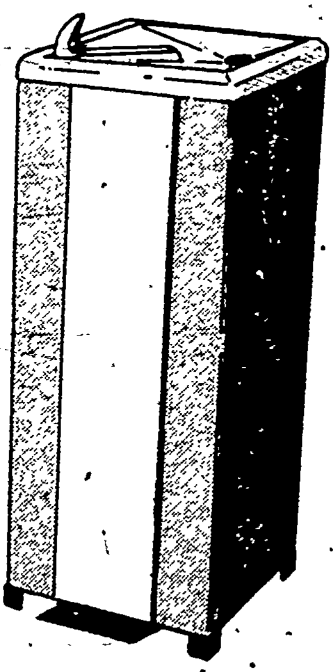


Figure 53. Drinking Fountain.

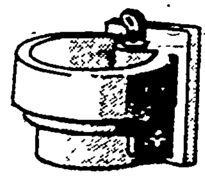


Figure 54. Wall Mounted.

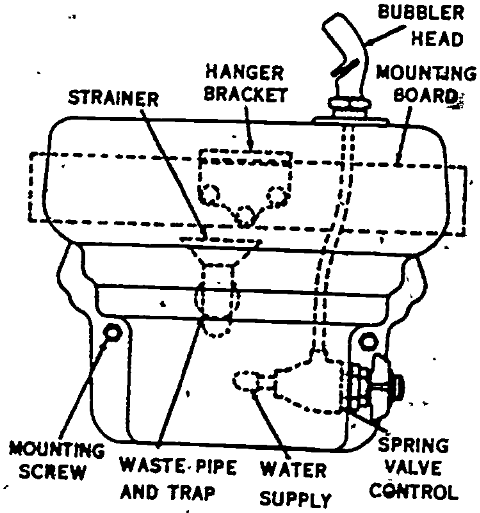


Figure 55. Wall-Mounted Drinking Fountain

The maintenance and repair of drinking fountains is usually limited to clearing of stoppages and the replacement of the valve and bubbler head. Stoppages are usually caused by foreign objects (usually chewing gum) passing through the strainer into the trap.

These stoppages can be eliminated the same as with the lavatory by using a vacuum plunger or a snake.

Pressure Reducing Valve

Most water fountains are equipped with a pressure reducing valve in the water supply line. This valve reduces the pressure and supplies an even flow of water to the bubbler head. The valve (see figure 56) has a set-screw (located under a removable capnut) that can be adjusted to obtain the desired flow of water.

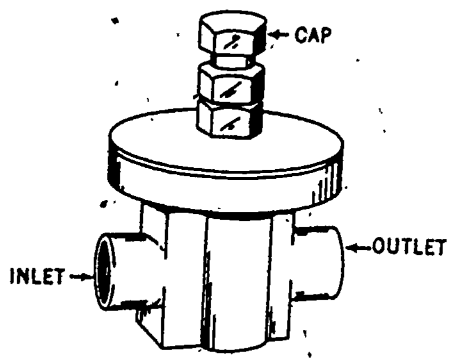


Figure 56. Pressure Reducing Valve.

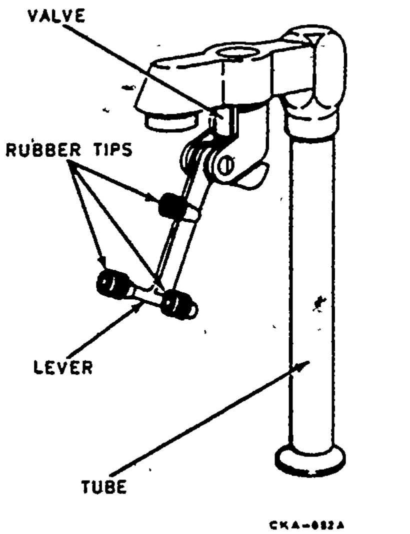


Figure 57. Glass Filler Attachment.

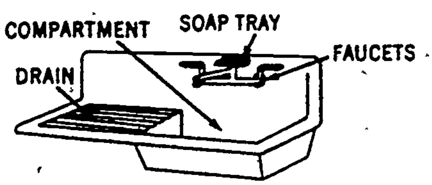


Figure 58. Wall-Mounted Sink.

Fountains that are located near food service lines in dining halls have glass fillers similar to the one shown in figure 57. Many of these glass fillers are fitted with a rubber tipped fork-shaped handle. The user can obtain a glass of water with one hand by pressing the glass against the the forked handle to start the flow of water. The glass filler has a pressure regulating valve similar to the one in the drinking fountain.

When installing a mechanically cooled drinking fountain, the plumber must install both the water line and the drain line. The maintenance of the refrigerating equipment is the responsibility of the refrigeration shop.

Kitchen Sinks

There are two types of kitchen sinks in general use; the wall hung and the counter mounted. The wall mounted (figure 58) is somewhat outdated and is not used very often. The counter mounted comes either with drainboards (figure 59) or without (figure 60.)

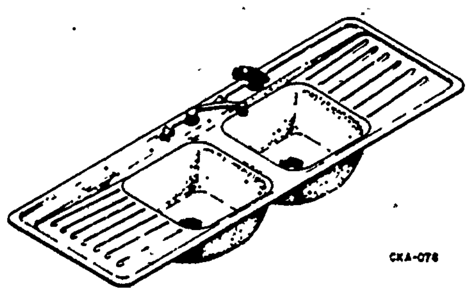


Figure 59. Counter-Mounted Sink With Drainboards.

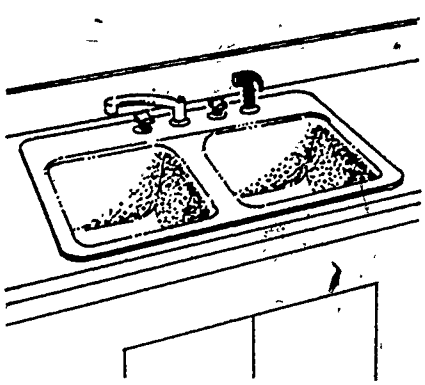


Figure 60. Counter-Mounted Sink Without Drainboards.

Kitchen sinks are usually constructed of enameled cast iron or stainless steel. Modern sinks are designed to be used with either a strainer basket (figure 61) or a waste grinder (figure 62).

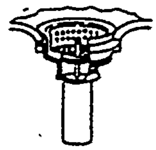


Figure 61. Strainer Basket.

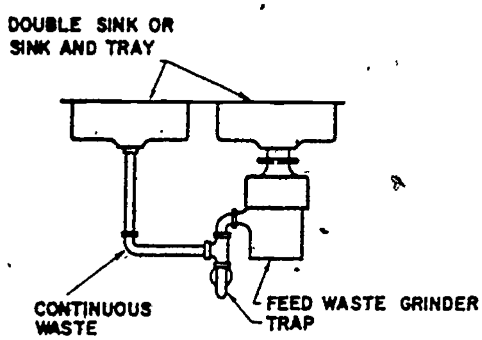


Figure 62. Waste Grinder.

The waste line for both types of sinks must be at least 1 1/2 inches in diameter. Food waste grinders may be trapped separately or with other compartment of a double sink as illustrated in figure 62. If the food waste grinder is trapped separately, it must be connected to the waste line by means of a double Y. (See figure 63.) A cleanout plug should be installed at the sewer line between the two traps.

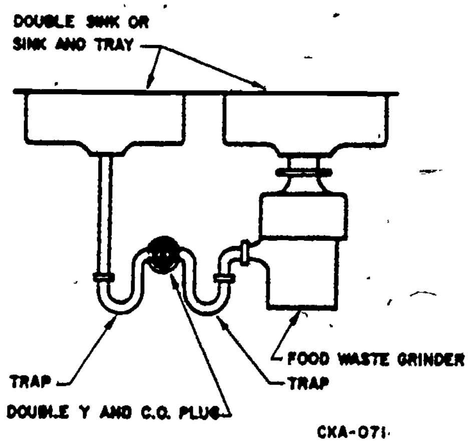


Figure 63. Double Y with Clean-Out Plug.

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To connect the sink drain to the P-trap use one of the continuous waste assemblies illustrated in figure 64.

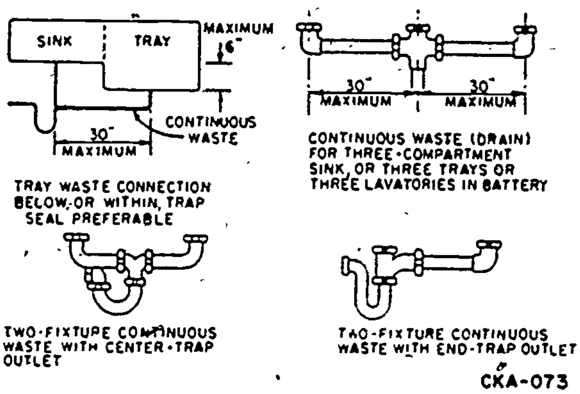

Figure 64. Continuous Waste Assemblies.

Utility Sink

A utility (also called slop, service or mop) sink is primarily used for cleaning and janitorial purposes. It is usually installed in a janitor's closet or equipment room.

Utility sinks hang on the wall and are supported at the bottom by a stand trap. (See figure 65). The stand trap should be adjusted to take most of the weight of the sink. The cleanout on the trap makes it a simple matter to unstop the drain. The drain line should be a minimum of three inches and the water supply line a minimum of 1/2 inch.

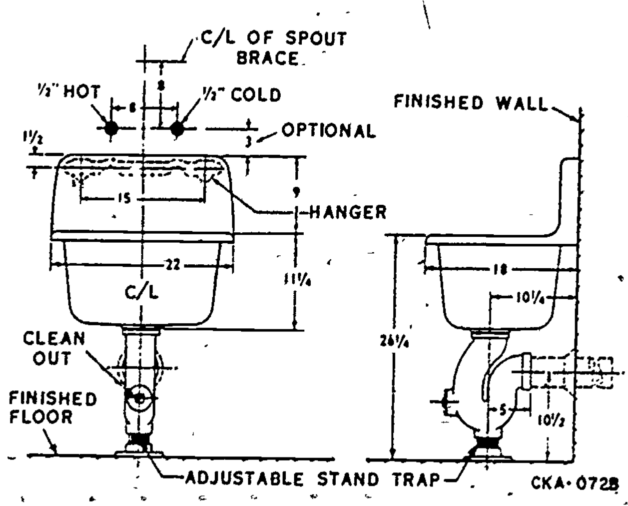

Figure 65. Utility Sink.

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The maintenance of utility sinks consists primarily of unstopping the drain and repairing the faucets.

Laundry Trays

Laundry trays are manufactured in both single and double compartment types. They are constructed of such things as concrete, plastic, fiberglass, stainless steel, and cast iron. Figure 66 illustrates a concrete laundry tray.

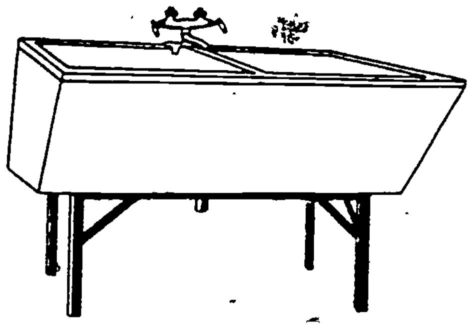


Figure 66. Laundry Trays.

The waste outlet for each compartment must be at least 1 1/2 inches in diameter and equipped with a stopper. The water supply must be at least 1/2 inch. Figure 67 illustrates a typical rough-in specification for laundry trays.

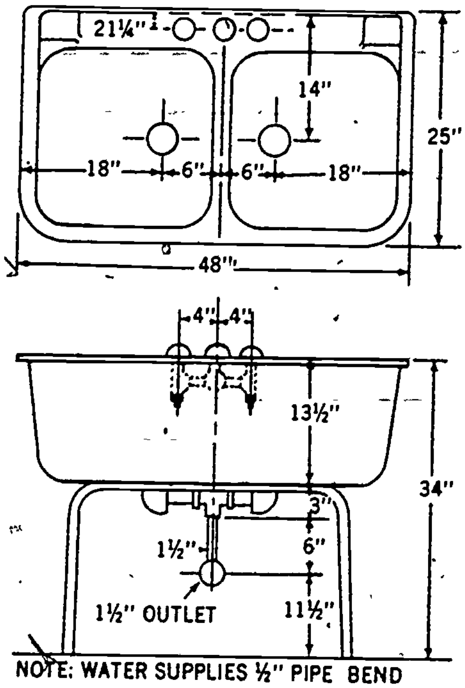


Figure 67. Rough-in Specification.

Scullery Sinks

Scullery sinks, see figure 68, are large deep vessels that are used to wash vegetables and pots and pans. They are usually constructed of galvanized sheet iron or stainless steel. These sinks are manufactured in one, two, and three compartment types. Since these sinks are used to wash greasy pots and pans, the waste must drain through a grease trap, see figure 69. A scullery sink does not need a fixture trap, the grease interceptor acts as a trap for the fixture.

Maintenance on a scullery sink consists mainly of cleaning the grease trap, unclogging the drain and repairing the faucets.

If a food grinder is installed, it must discharge directly into the building drain, never through an interceptor.

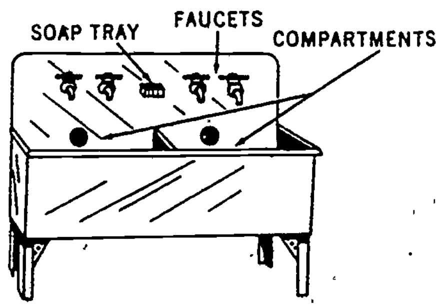


Figure 68. A Scullery Sink.

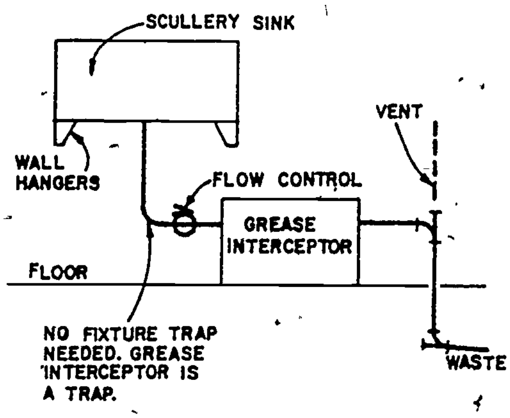


Figure 69. Scullery Sink Installation.

Domestic Washing Machines

It's the plumber's responsibility to install hot and cold water lines for washing machines and the waste line from them. The waste line must have a self-cleaning trap and be properly vented. The size and location of the water and waste lines must comply with the manufacturer's specifications.

The plumber performs maintenance on the water lines, faucets, and drain line. He does not maintain the washing machine itself.

Stoves

As a plumbing specialist, you will be called upon from time to time to install gas burning stoves. Your responsibility will consist of running the gas line, connecting the stove, lighting and adjusting the pilot light and burners. When handling gas fire equipment, you must follow the manufacturer's specifications very closely.

The gas line must be of black iron pipe and there must be a stopcock for each fixture. Most codes allow the last connections (from the stopcock to the fixture) to be made with a flexible connection or copper tubing.

After the last connection has been made (and before lighting the pilot light) bleed the line of air. This should be done as near the fixture as possible. With full gas pressure applied to the line, check each connection with a gas leak solution. If a leak is found it must be repaired before lighting the pilot light.

NOTE: If a commercial gas leak solution is not available, use soapy water.

Domestic Dishwashers

The plumber's responsibility towards dishwashers is the same as for washing machines. He will install the water and drain lines. Dishwashers should discharge through an air gap, see figure 70. to eliminate the waste backing up and contaminating the dish compartment.

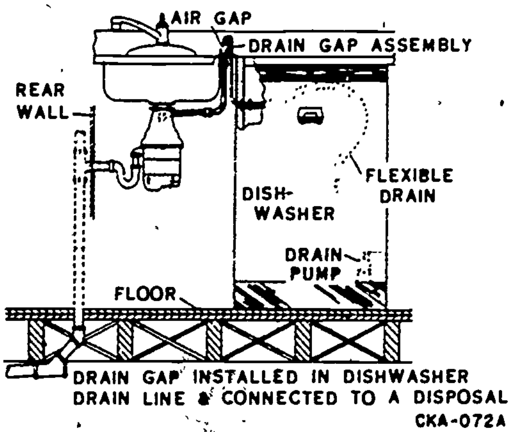


Figure 70. Dishwasher Installation.

Commercial Dishwashers (Clippers)

Commercial dishwashers are normally found in cafeterias and mess halls. The plumber is responsible for installing the hot and cold water lines, gas line (if necessary) and drain line. The manufacturer's specifications will furnish the required sizes of all lines.

These dishwashers must be located in a well-lighted and ventilated space. It also must be level. These dishwashers have a booster heater (gas, steam, or electrical) to raise the final rinse water to 180°F for sterilization purposes.

Figures 71 and 72 illustrate two methods of connecting the waste drain and vent.

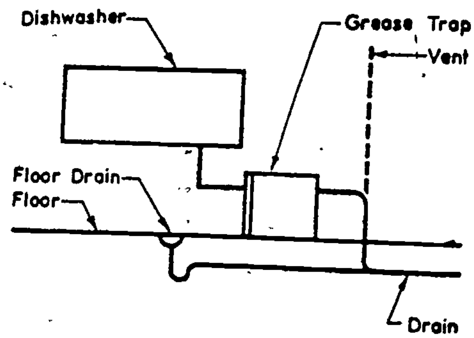


Figure 71. Dishwasher with Grease Trap.

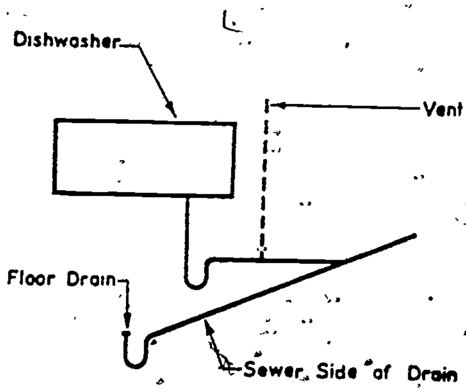


Figure 72. Dishwasher without Grease Trap.

Figures 73 and 74 show the outward appearance and the internal parts of the commercial dishwasher.

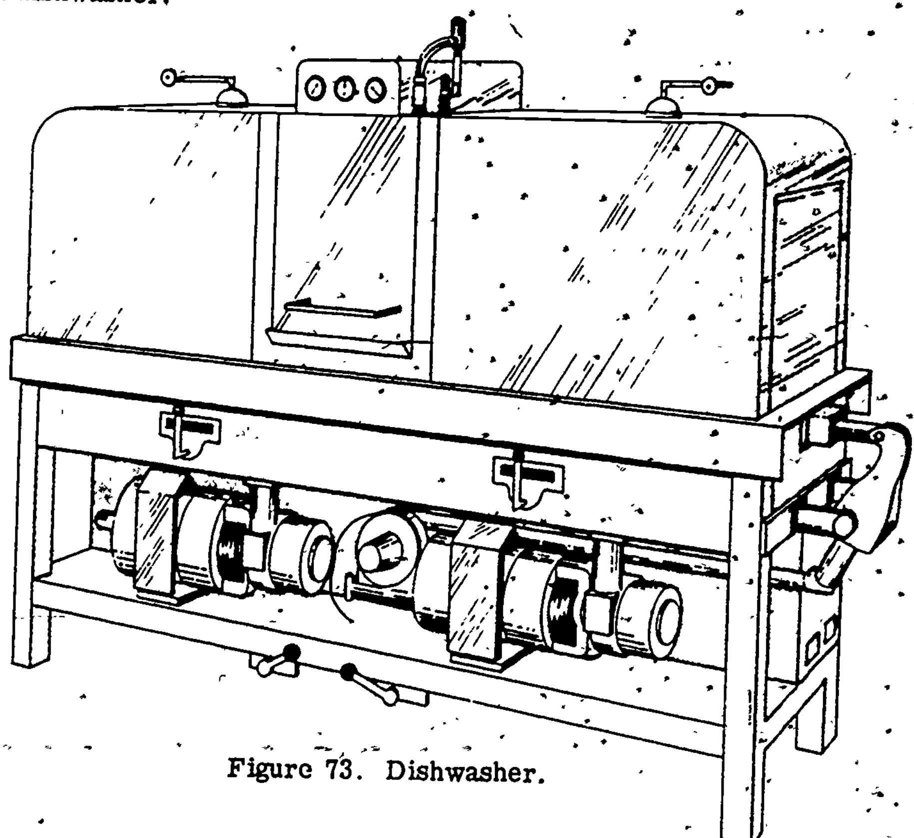
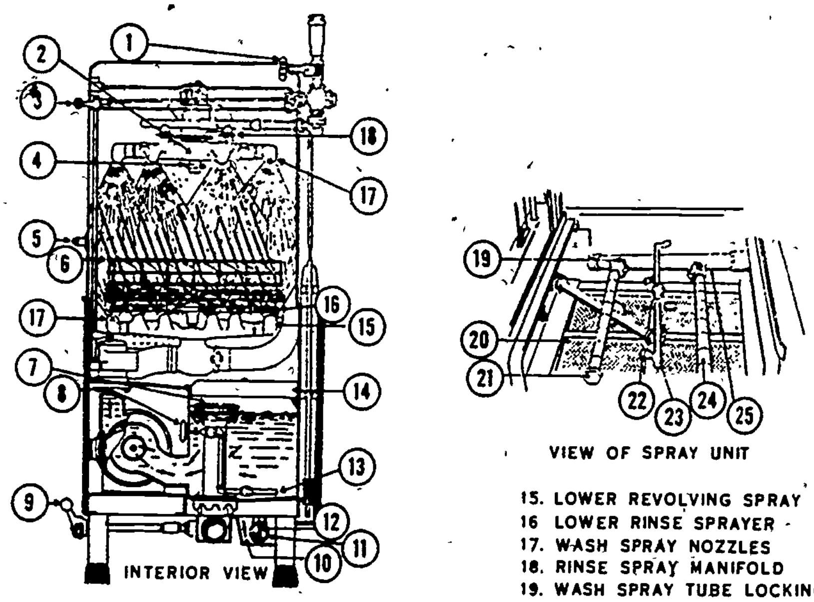


Figure 73. Dishwasher.



1 HOT WATER INLET VALVE
2. UPPER REVOLVING WASH SPRAY ARM
3 WASH AND RINSE CONTROL HANDLE
4 HAND WHEEL FOR REMOVING WASH SPRAY ARM
5. DOOR HANDLE
6. DISH RACK
7 OVER FLOW PIPE AND CAP
8 STEAM INJECTOR VALVE - STEAM HEATED MODEL
9. TANK DRAIN VALVE
10. PILOT LIGHT GAS VALVE - GAS HEATED MODEL
11 GAS BURNER - GAS HEATED MODEL
12. GAS BURNER VALVE - GAS HEATED MODEL
13. STEAM INJECTOR - STEAM HEATED MODEL
14. SCRAP TRAYS
15. LOWER REVOLVING SPRAY ARM
16 LOWER RINSE SPRAYER
17. WASH SPRAY NOZZLES
18. RINSE SPRAY MANIFOLD
19. WASH SPRAY TUBE LOCKING PIN
20. SCRAP BASKETS
21 WASH SPRAY TUBE CLEAN-OUT CAP
22. RINSE SPRAY NOZZLES
23. RINSE SPRAY REVOLVING UNIT
24. WASH SPRAY TUBE
25. WASH SPRAY MANIFOLD

CKA-075

Figure 74. A Cross Section of a Dishwashing Machine.

The dishwasher requires a considerable amount of maintenance. This maintenance may include the correction of water leaks, cleaning of the spray nozzles, adjusting the gas burners, oiling the motors, cleaning the screens, adjusting the conveyer, repairing the various types of valves, etc. It is recommended that the manufacturer's instructions be procured and followed when performing maintenance work on this equipment.

Steam Kettles

Steam kettles are used in cafeterias and mess halls to prepare large quantities of food. There are three types of steam kettles; the gas fired, steam heated, and electric heated. They come in sizes from 20 to 80 gallons.

Steam kettles are normally installed in a depressed (2 to 3 inch) floor area. The depressed area must contain sufficient floor drains to accommodate the draining and cleaning of the kettles. Each kettle must be supplied with the correct amount of electricity, steam or gas as required by the manufacturer's specifications. Some method must be provided to dispose of the products of combustions from gas-fired units.

If the kettle has a tapping for a water connection, install an air gap fitting (see figure 75) in the cold water supply line. If the kettle does not have a tapped water connection, install a swing spout faucet above the kettle. It may be possible to use one swing spout faucet to service two kettles. Figures 76, 77, and 78 illustrate the three types of steam kettles.

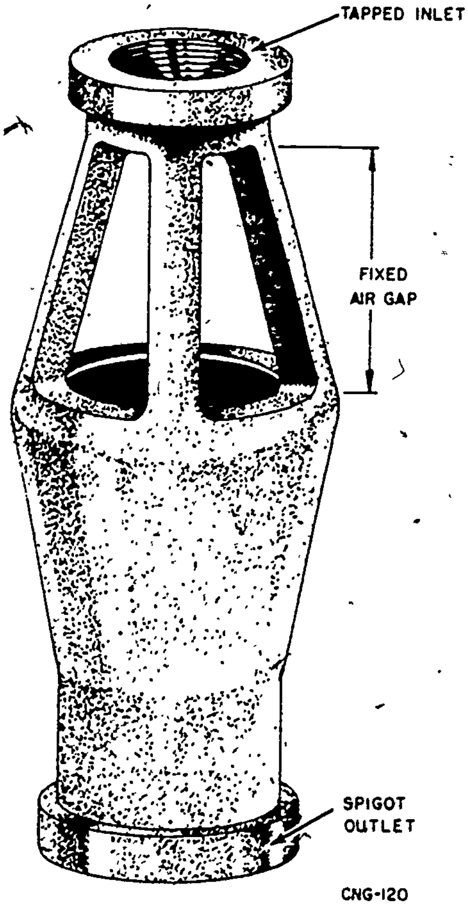
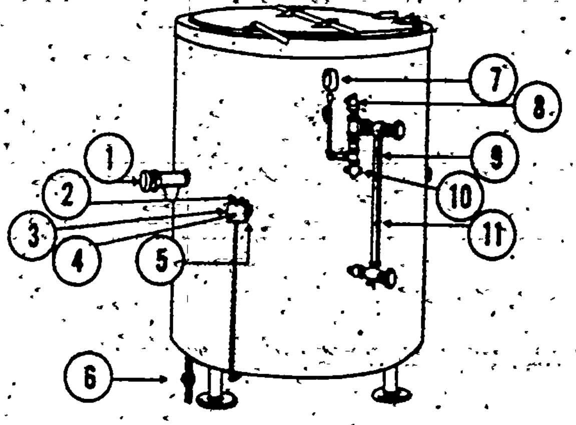
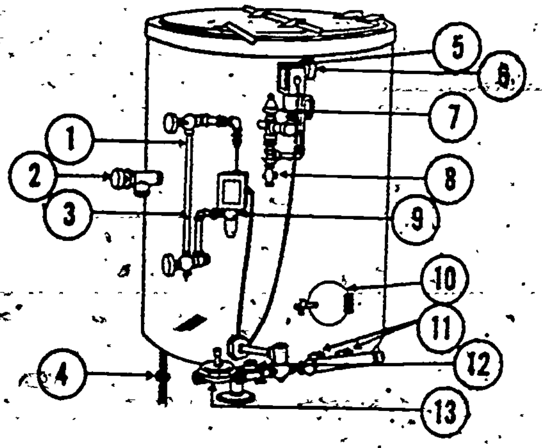


Figure 75. Fixed Air Gap Fitting.



1. DRAIN-OFF FAUCET
2. ELECTRICAL SWITCH BUTTON
3. SIGNAL LIGHT
4. ELECTRICAL CONTROL BOX
5. THERMOSTAT
6. WATER INLET VALVE
7. STEAM PRESSURE GAGE
8. SAFETY VALVE
9. WATER JACKET GAGE GLASS
10. TRAPPED AIR RELEASE PET-COCK
11. WATER JACKET, WATER LEVEL MARK

Figure 76. An Electrically Heated Steam Kettle.



1. WATER JACKET GAGE GLASS
2. DRAW-OFF VALVE
3. WATER JACKET WATER LEVEL MARK
4. WATER INLET VALVE
5. ELECTRICAL CONTROL SWITCH
6. STEAM PRESSURE GAGE
7. SAFETY VALVE
8. TRAPPED AIR RELEASE PET-COCK
9. LOW WATER CUT-OFF VALVE
10. INSPECTION DOOR
11. GAS BURNER VALVES
12. PILOT VALVE PUSH BUTTON
13. GAS PRESSURE REGULATOR

Figure 77. Gas Heated Steam Kettles.

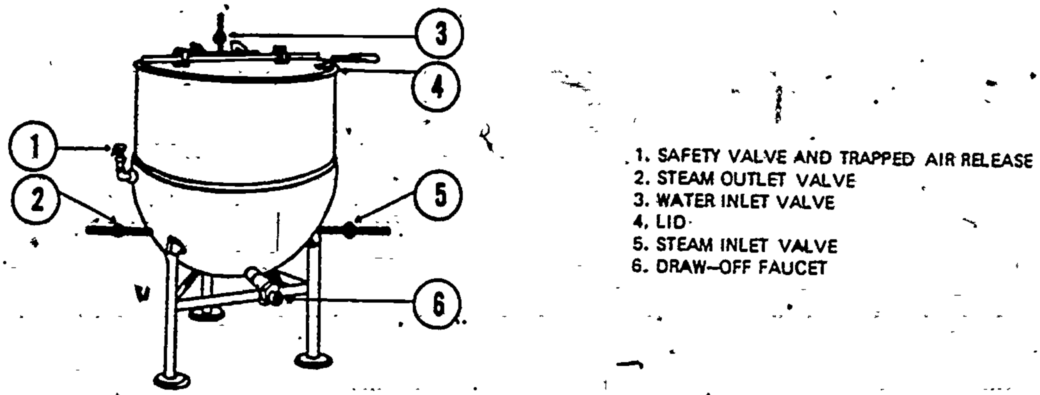


Figure 78. A Conventional Steam Heated Kettle.

Steam Tables

Steam tables are used to keep food hot while it is being served. Steam tables require an indirect waste discharging into a water supplied receptor.

The maintenance of the steam table consists mainly of repairing leaks and cleaning the drain.

Ice Makers

Ice makers come in a variety of sizes and shapes. They must have cold water supply and an indirect drain. Normally a floor drain is sufficient.

CLEANING, SHARPENING AND INVENTORYING OF TOOLS

You know by now that tools play a very important part in the plumbing trade. There is an old saying that a plumber can do a job as well as the tools he has to work with. Remember when you were issued a toolbox and tools earlier in the course, you had to sign a custody or hand receipt for them. It was then your responsibility to take care of the tools.

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Cleaning

When you received your tools, they were clean, sharpened and serviceable. It is only right that you should return them the same way. As you remove all the tools from the box, wipe each one clean with an approved cleaning fluid.

Sharpening

Cold chisels require sharpening and dressing more than any other tool.

A flat cold chisel is a tool which you use quite often, especially, to cut cast-iron pipe when you do not have a chain cutter or a power hacksaw.

The size of a flat cold chisel is determined by the width of the cutting edge. Lengths will vary, but these chisels are seldom under 5 inches or over 8 inches long. Chisels are usually made of octagonal (eight-sided) tool steel bar stock, carefully hardened and tempered. Notice that the cutting edge of the chisel shown in figure 79 is slightly convex (curved outward). This causes the center portion to receive the greatest shock and protects the weaker corners. The point angle should be 60-70 degrees for general use.

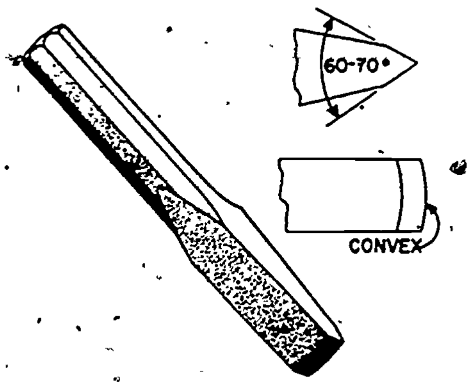

Figure 79. Cold Chisel

Keep your chisel sharp and the edge ground at the proper angle (60°-70°). When grinding the chisel, hold it against the wheel of the grinder with very little pressure so as to avoid overheating. Dip the point in water often enough to keep it cool. Otherwise, the heat generated will "draw" the temper of the steel. If this happens, the cutting edge will become soft and useless until rehardened and tempered. Remember that a cold chisel will cut only metal softer than itself.

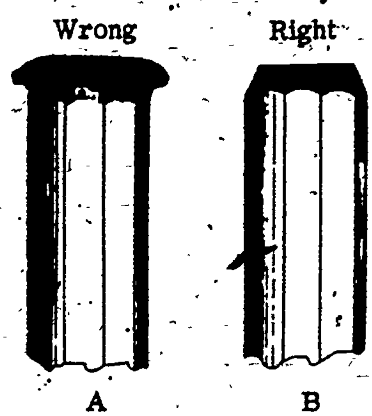

Figure 80. Heads of Chisels

Hammer blows cause the head of the chisel to spread out until it looks like a ragged mushroom as illustrated in figure 80.

The spread-out head is rough and will "ream out" the inside of your hand if the chisel slips. Also, chunks may break away from the overhanging mushroom with enough force to cause injury. So keep the head ground down to look like B in figure 80. Don't ever let it look like A.

There are other chisels which you might use, such as the single and double cape chisels, and diamond or round point chisels. Be sure to keep the heads ground at an angle so they will not mushroom.

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Inventory of Tools

Now that you have all your tools cleaned, sharpened, and laid out on the table, the instructor will name each tool that you are to place in your toolbox. He will check to see that you have each and every tool.

You are probably wondering why you must inventory these tools. It is very simple; service tools cost money, there must be a direct line of responsibility. For example, if a man is not held responsible for his tools, he will not take care of them.

SUMMARY

An indirect waste or an airgap is required on any device used for the purpose of handling or preparing food. The gap must be at least 2" between the equipment drain outlet to the floor or other drain.

Drinking fountains are generally constructed of vitreous, stainless steel, or porcelain and are wall hung and electrically cooled. A waste of 1 1/4 inches in diameter is sufficient to carry the waste water. Most maintenance on drinking fountains consists of repair of the self-closing valves or the adjustment of automatic stream regulator valves.

There are several different types of sinks and laundry tubs in use. Laundry tubs are made in single or double compartments, and the scullery sink is generally made as a two- or three-compartment sink. The majority of sinks are constructed of cast iron or steel with an enameled surface or finish. Sinks can be installed on wall brackets or can set on a stand. Laundry tubs (sometimes called trays) are mounted on stands of fixed legs. Two-compartment sinks are constructed of a heavy material, and therefore extreme care will be taken when handling and installing. Carelessness in lifting or mounting a sink may result in injury to the personnel.

It isn't a pretty sight to see you lose a finger, hand, arm, eye, or your life because you have slipshod habits or a don't care attitude when using either hand or power tools. No one likes to tell you that they don't want to work with you because of your poor working habits. A workman who keeps his tools in good repair and works in a safe manner will always get willing help when he needs it.

QUESTIONS

1. Explain the purpose of an air gap in the water supply line.
2. Kitchen sinks are normally constructed of ____________________
3. What is the minimum size drain that can be used on water fountains?
4. What is the main purpose of scullery sinks?
5. Name the item that provides water at a constant pressure to the bubbler heads on a water fountain.
6. What size drain should be used on a service sink?

7. Explain the purpose of an indirect waste on a food preparation fixture.

8. Name the three types of steam kettles.

References

1. AFM 85-20, Plumbing

2. National Plumbing Code

CORROSION CONTROL

OBJECTIVE

The purpose of this study guide is to acquaint you with the types, causes, and how to control corrosion.

INTRODUCTION

The Air Force, as well as private industry, is interested in eliminating the waste of material and manpower caused by the action of corrosion. Waste causes expenses in replacing materials that are no longer serviceable and often causes hardship to the Air Force because it cannot replace the unserviceable equipment. The Air Force does not wish to have its mission jeopardized, because some vital system is rendered unserviceable due to corrosion.

Since the Air Force has worldwide commitments, corrosion becomes a great problem. If the entire Air Force were at one installation, the problem would not be so difficult to control. Each metallic structure used by the Air Force has its own corrosion problem, requiring an individual solution.

In our homes, scale clogs hot water heaters and pipes, while corrosion and its products eat away the metal walls of these units, causing leakage. The Air Force, as well as industry, has similar problems, but the problems are much greater in the Air Force. Instead of maintaining a few feet of pipe as we do in our homes, the Air Force maintains miles and miles of pipe. Thus, if the effect of corrosion on Air Force equipment can be decreased, a substantial saving can be made.

CORROSION

Theory of Corrosion

Man has had corrosion problems to contend with ever since he started making articles out of metal. For thousands of years, the only fact known about corrosion was that it would affect some metals more than others. For example: iron, one of the most abundant and useful metals, corrodes very much while metals, such as gold, platinum, and silver corrode very little. In later years, men began to study corrosion to find out what caused it. As might be expected, many theories were proposed to explain corrosion and its causes. Among the many theories, the electrochemical theory is most generally accepted as an explanation of corrosion.

The electrochemical theory of corrosion is best explained by the action which takes place in a galvanic cell. A galvanic cell can be produced by placing two dissimilar metals in a suitable electrolyte as shown in figure 81. The resulting electrochemical reaction causes one metal to be negative or anodic and the other metal to be positive or cathodic. In a dry cell, the zinc can is the anode, and the carbon rod the cathode. Now, when an external electrical circuit is completed, current flows from the zinc case into the electrolyte, taking with it particles of zinc. This is an example of galvanic corrosion of the zinc case. It is this electrochemical action which illustrates the electrochemical theory.

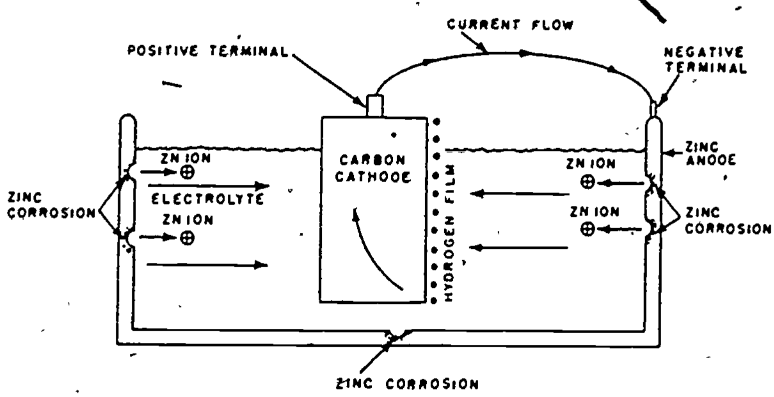

Figure 81. A Galvanic Cell Showing Internal Galvanic Action

Types of Corrosion

Corrosion may be divided into several types, such as uniform corrosion, localized corrosion, and compositional corrosion. Each of these types is explained in the following paragraphs.

UNIFORM ETCH CORROSION. Uniform etch corrosion is caused by direct chemical attack. An example of this type of corrosion is zinc exposed to hydrochloric acid. If you examine the surface of zinc in a solution of hydrochloric acid, you will find that the entire surface is corroding. Furthermore, if the zinc is left in the acid long enough, it will be dissolved by the acid.

LOCALIZED CORROSION. Localized corrosion is caused by the electrolyte action of a galvanic cell. A local galvanic action is set up when there is a difference of potential between the areas on a metallic surface which is in an electrolyte. Localized corrosion may be in the form of pits, pockets, or cavities due to the deterioration or destruction of metal.

Localized corrosion may develop under a number of various conditions when different types of metal are buried in the ground.

CORROSION DUE TO MILL SCALE. Mill scale embedded in the walls of iron pipe during its manufacture is one cause of pipe corrosion. The mill scale (see figure 82) actually becomes the cathodic area, the iron pipe the anodic area, and the moist soil the electrolyte, as shown in figure 82. Current leaves the iron pipe wall, passes through the electrolytic soil to the mill scale and returns to the iron pipe. This electrochemical action causes severe pitting of the pipe metal at the anodic areas. Continued action of this type will eventually weaken the pipe to the extent of failure.

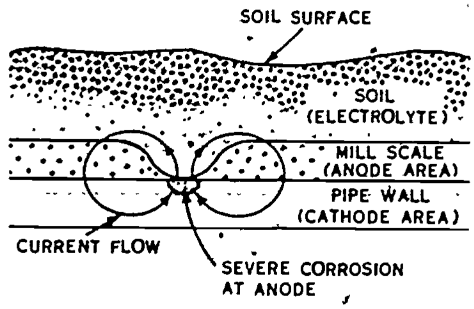

Figure 82. Corrosion Due to Mill Scale.

CORROSION DUE TO CINDERS. Another type of corrosion occurs when iron pipe is laid in a cinder-fill in direct contact with the cinders. The cinders and the iron pipe constitutes the dissimilar metals with the pipe forming the anodic area, the cinders the cathodic area, and the highly ionized soil serving as the electrolyte. The current leaves the pipe through the soil to the cinders and returns to the pipe. Severe corrosion occurs at the points where the current leaves the pipe. This galvanic corrosion wears away the pipe at an accelerated rate because of the nonpolarizing effect of the cinders and highly ionized soil contamination of the cinders.

CORROSION DUE TO DISSIMILARITY OF PIPE SURFACE. This type of galvanic corrosion occurs when there are bright or polished surfaces on some areas of the pipe wall in contact with suitable electrolytic soil. These bright surfaces become anodic to the remaining pipe surfaces. In a highly ionized soil, the polished surfaces corrode at an accelerated rate, weakening the pipe at the point. These bright surfaces may be made by a pipe wrench producing scars and scratches on the pipe when it was assembled. The threads on both ends of a coupling may expose shiny surfaces which corrode easily. Corrosion in the threads will eventually cause the perforation of the pipe wall.

CORROSION DUE TO DIFFERENT SOIL CONDITIONS. This is a general corrosion problem, especially prevalent in highly alkaline areas. Corrosion currents leave the pipe wall into compact soils and enter the pipe wall from light sand soil. The intensity of the corrosion currents and the resulting rate of corrosion at the anodic areas of the pipe are directly proportional to the conductivity of the soil. Earth current meters are used to determine the location of the anodic and cathodic areas and the extent to which corrosion current exists. This meter determines if the pipe requires protection.

CORROSION DUE TO STRAY CURRENT. Direct current circuits that pass in and out of an electrolyte usually cause stray currents, many of which are a direct cause of corrosion. This condition poses the greatest problem in the vicinity of electrical transportation systems, electrified coal mines, or manufacturing plants where the direct current distribution system requires a ground as a complete or partial circuit return. If a metallic structure, such as a tank or pipeline is laid in such an area, a large galvanic cell is created, making an ideal situation for corrosion. Corrosion does not occur at the point where the current enters the structure because it is cathodically protected. However, at the section where the current leaves the structure, severe stray current corrosion occurs. Over a period of a year, this type of corrosion has been known to displace as much as 20 pounds of pipe wall for every ampere of current.

CORROSION DUE TO BACTERIA. Biological corrosion is another distinct type of corrosion resulting from electrolytic or galvanic cell action of minute organisms. It is the deterioration of metals by corrosion processes which occur as either a direct or an indirect result of the metabolic activity of certain bacteria, particularly in water or soil environments. These organisms causing bacterial corrosion are bacteria, slime, and fungi.

Microbiological corrosive action in the soil is due to physical and chemical changes in the soil by the action of these organisms. Some anaerobic bacteria types are responsible for the production of active galvanic cells. These cells are produced by the variations of oxygen content in the soil (differential aeration) or the reduction of the hydrogen film over the cathodic areas (depolorization).

Anaerobic bacteria are mostly found in highly waterlogged, sulfate bearing, blue clay soils. The bacteria concentration as well as the corrosion rate varies considerably with the different seasons of the year. Cast iron and steel pipe are corroded mostly by sulfide production.

COMPOSITIONAL CORROSION. Compositional corrosion is a type which alters the composition of metals. A few specific types are discussed in the following paragraphs.

Dezincification. One type of compositional corrosion is referred to as dezincification. It is a selective corrosion which occurs in copper and zinc alloys. When alloys of this kind (brasses) are exposed to this type of corrosion, the zinc will dissolve out of the alloy leaving only the copper. Since most pipe fittings are made of brass, dezincification attacks may weaken these fittings to the point of failure. In this case, the zinc ions go into solution leaving the copper. The solution may be impure water or oil that acts as an electrolyte.

Graphitization. Another type of compositional corrosion is graphitization or graphitic softening. It is a peculiar form of disintegration which attacks grey cast iron. Cast iron is an alloy made of iron and carbon, the carbon being in the form of graphite. When cast iron with such a composition is subjected to graphitization, the iron dissolves out, leaving behind only the graphite. This action leaves cast-iron pipes and other similar equipment weakened mechanically. However, after graphitization, the graphite pipe may last for many years if it is not subjected to any mechanical forces or sudden pressures. The action of this type of corrosion is similar to dezincification.

Hydrogen Embrittlement. Hydrogen embrittlement is a term applied to metal that becomes brittle due to the action of some form of corrosion which causes the formation of hydrogen on its surface. When hydrogen forms on the surface of steel, the action of the hydrogen may form blisters or actually embrittle the metal. It has been demostrated that hydrogen liberated near the surface of steel in an electrolyte will diffuse into the metal quite rapidly. This hydrogen picked up by the steel is in an atomic state and causes the steel to become brittle.

When the production of atomic hydrogen at the surface of the metal stops, the hydrogen leaves the metal, in a few days, and the metal again regains its original ductility.

It has been found that carbon steels are affected by hydrogen embrittlement according to the hardness in the steel. The harder the metal, the greater is the susceptibility to hydrogen embrittlement. Hydrogen embrittlement in carbon steels is also increased by the presence of stresses.

Stress Fatigue of Metals

Corrosion affects metals that are under stress. The action caused by stresses on a pipeline or structure is due to the shifting of the various rocks and soils of the earth. Usually, a complete pipeline is not under stress; certain sections are under stress while adjacent sections are not. Because of these pressures and strains localized electrochemical action takes place. The section of the pipe or structure under stress becomes anodic while the unstressed sections become cathodic. In this way, the pipe under stress begins to corrode and weaken due to the action of corrosion.

Corrosion Caused by Nonelectrolytes

Nonelectrolytes are materials that will not conduct electricity. These materials may include nonelectrolytic vapors, liquids and bacterial organisms. Since they do not conduct electricity, they do not, in themselves, cause corrosion.

NONELECTROLYTE GASES AND VAPORS. Nonelectrolytic gases and vapors usually must be subjected to high-temperatures before corrosive action can take place. Hydrogen sulfide causes scaling of iron at temperatures from 1400 to 2000°F. High chromium-alloy steels resist this type of corrosion best. The only remedy for this type of corrosion is to keep the gases away from the metal or use a metal that can resist corrosion.

High carbon steels are attacked by hydrogen at temperatures above 750°F. This hydrogen combines with the carbon grains in the steel and causes the metal to weaken at the grain boundaries between the iron and carbon.

At high temperatures, oxygen will combine directly with most metals. The temperature at which oxygen will combine with the metals depends mostly upon the type of metal. In the process of cutting iron with an oxyacetylene torch, the oxygen combines with the iron.

NONELECTROLYTIC FLUIDS. Nonelectrolytic fluids include such liquids as pure water, lubricating oils, fuel oils, alcohols, etc. These fluids do not cause corrosion, but corrosion does occur in storage tanks that contain these liquids and pipelines that carry them. The corrosion is not caused by the nonelectrolyte liquids, but by the foreign products in them. For example, if impure water is introduced into an oil pipeline, the water will cause the inside of the pipe to corrode. The pipe is usually cooler than the oil so that the water collects on the inside of the pipe. In a storage tank, the water being heavier than the oil will settle to the bottom of the tank, causing the bottom to corrode. Hydrogen sulfide and sulphur dioxide may also be introduced into the pipeline to add to the corrosiveness of the water that collects on the metal. The only way to prevent corrosion from this source is to either coat the inside of the pipeline and tanks with a protective film or to remove the water from them.

BACTERIAL ORGANISMS. Bacterial organisms such as bacteria, fungi, slime, moulds, yeasts and lichens are also nonelectrolytic in nature but responsible for microbiological corrosion. Colonies of bacteria which live close to a metal surface in stationary slimy deposits produce such corrosive substances as carbon dioxide, hydrogen sulphide, ammonia, and organic and inorganic acids. These corroding substances are found only in the locality of the colony, and may be undetected in the surrounding water or soil. Bacteria causing corrosion in this way need to produce only small amounts of corrosive products for localized attack. However, colonies of bacteria which do not produce corrosive products may act as a protective film around the metal causing unequal distribution of electrical potential which gives rise to local anodes and cathodes. In this way, the production of local cells will cause increased corrosive action.

Biological corrosion is extremely difficult to control since the organisms are very resistant to normal methods of sterilization. Probably the most logical method to reduce microbiological corrosion is by the use of some barrier coating between the environment and the metal.

Corrosion Caused by Electrolytes

An electrolyte is any substance that conducts electricity. It conducts electricity by virtue of the fact that it contains ions which carry electrical charges, either negative or positive, and move in electrical fields. Some of the more important electrolytes are discussed in the following paragraphs.

ATMOSPHERIC CONDITIONS. Corrosion due to atmospheric conditions is caused mainly by the water in the atmosphere. Pure water is a nonelectrolyte, but because it is a universal solvent, it is not very often found to be pure. Rainwater is considered to be pure, but this is not true. As rain falls to the ground it dissolves gases out of the atmosphere and becomes impure. For this reason, any water vapor in the atmosphere is also impure. If a piece of metal is exposed to atmospheric air, and the metal is cooler than the air, water vapor from the air will collect on the surface of the metal. The layer of water on the metal may be so thin that it cannot be seen; but there is a sufficient amount of it, if impure, to start corrosion. In this case, when the gases dissolve into the water, the water becomes an electrolyte. And when metal is exposed to an electrolyte, galvanic cells are produced on the surface of the metal, since there are impurities in it. Because of electrochemical action each one of these cells starts to act on the metal causing corrosion.

WATER AND WATER SOLUTIONS. If metal is exposed to water or water solutions, corrosion is apt to occur if the water or metal is impure. If the water or metal is pure, corrosion probably will not occur; however, these conditions seldom exist in nature. Impurities in the water and metal produce galvanic cells the action of which causes corrosion.

CHEMICAL AGENTS. Chemical agents such as acids and salts also cause corrosion. When these agents are present in the environment, direct chemical attack on metal is the result. For example, if a piece of zinc is exposed to hydrochloric acid, a definite chemical reaction takes place. The zinc and hydrochloric acid combine, producing zinc chloride and hydrogen. This action continues until the zinc is completely dissolved or the acid is too weak to act on the zinc. Corrosion in this case is the dissolving of the zinc.

Another example, which may be used to illustrate corrosion through the use of a chemical agent is to place aluminum in a lye solution. The lye will pit (corrode) the aluminum as long as chemical action continues between the aluminum and lye.

STRAY ELECTRIC CURRENTS. Stray electric currents are those which are caused by the existence of direct current distribution systems using the ground as a return line. These stray currents complete a circuit between the distribution return line and a buried pipeline that is laid in the vicinity. Pits and cavities formed by corrosion develop in the pipe where the current leaves the pipeline. This action weakens the pipe.

Stray current corrosion has not been as great a problem since the electric street cars have almost gone out of existence. The only place where stray current corrosion is any problem now is in a few areas which have direct current distribution systems using a ground return.

MATERIALS LEAST LIKELY TO BE AFFECTED BY SCALE AND CORROSION

Whenever the plumber installs various types of plumbing equipment in areas where corrosion is active, he should try to select equipment which is made of materials least affected by it. To prevent electrochemical action in plumbing equipment, it should be made of materials that are not affected by electrolysis. Plastic materials such as polyethylene polyester and polyvinyl chloride are not acted upon by corrosion. Glass is another material that is not acted on by corrosion. This is why hot water tanks are lined with glass. Other materials used for the manufacture of pipe which resist corrosion are vitrified clay, cement, fiber, asbestos and rubber. Glass fibers reinforced with epoxy or polyester resins are also resistant to corrosion.

Dielectric bushings may be installed to stop electrolytic action in plumbing, heating and gas systems or wherever dissimilar metals are used. These are made of nylon and are usually colored. They withstand pressures to 1000 lbs. and temperatures up to 300°F. The bushings are usually placed in pipe systems as recommended by the manufacturer. Among some of the metals least likely to be affected by corrosion are copper, brass, Monel, stainless steel, and alloys of these metals.

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COATINGS AND WRAPPINGS FOR CORROSION PROTECTION

Coatings and wrappings are commonly used to combat corrosion on exterior piping systems. There are many different types of coatings such as asphalts, coal tars, plastics, mastics, greases, and cements. These coatings are considered to be insulating materials, but each is not effective in all environments. Each one was developed for a certain type of corrosive environment.

Asphalt Coatings

Asphalt base coatings are by far the most common type of protective coatings used. Asphalt base coatings are produced from petroleum residue and natural sources. These coatings can take considerable abrasion and impact, and temperature changes without creating a corrosive condition. However, they absorb considerable water and dissolve easily into a form of petroleum product.

Coal Tar Coatings

Coal tar coatings are also commonly used on pipelines. They possess continuity, hardness, adhesion and corrosion resistance. Coal tar coatings are less expensive than asphalt coatings. They do not have a very good impact resistance and a wide temperature change often causes the surface to crack.

Paint Coatings

Some of the most important paints of this kind are the coal tar, asphalt, rubber and vinyl.

Coal tar paints have the outstanding characteristics of low permeability, resistance to electrolytic reaction, and are not affected by the action of water. These paints are recommended for piers, marine installations, flood control structures, sewage disposal plants, and industrial concrete pipelines.

Asphalt paints are especially weather resistant and durable against industrial fumes, condensation and sunlight action. Because of their resistance against water solvency, they are used on steel tanks and concrete reservoirs.

Rubber base paints are very resistant to acids, alkalies, salts, alcohols, petroleum products and inorganic oils. Resistance of these products makes them ideal for use on the inside of metallic and concrete storage tanks. If these structures are submerged in water or underground, a special form of this paint should be used because of condensation.

Vinyl type paints are one of the many synthetic resin base paints. These paints dry to a film that is tough, abrasion-proof, and highly resistant to electrolysis. They are odorless, tasteless, nontoxic, and nonflammable. The film is expecially resistant to oils, fats, waxes, alcohols, petroleums, solvents, formic acid, organic acids, ammonium hydroxides, and phenols. Because of these vinyl characteristics, it is very applicable for tanks, pipelines, wellheads, off-shore drilling rigs, pipe in oil industries, railroad hopper cars, dairy and brewery equipment, storage tanks, and concrete exposed to corrosive environments.

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Grease Coatings

Greases are another material used to form a protective coating on structures. These greases are usually made from a petroleum base and resemble paraffin or wax. They can be applied either hot or cold; however, they must be protected by some type of wrapping to keep the grease from being displaced or absorbed by the backfill soil.

Cement Coatings

"Portland" cement coatings have been used with success when properly applied to pipelines to be laid in highly corrosive soils such as areas containing acid mine drainage or in brackish marshes. Well-mixed cement, usually a mix of 1 to 2, may be applied to pipelines. The thickness of the cement applied may be up to 2 inches. If the cement is properly mixed and tamped around the pipe, it may last for at least forty years. However, cement has a tendency to absorb moisture and crack, which in many ways limits its use. In fact, in places where the cement cracks, electrolysis immediately starts to corrode the metal. This corrosion can be partially prevented by painting the pipe with a bituminous primer before coating it.

Metallic Coatings

Metallic coatings such as galvanizing (zinc coated) is very effective in protecting any metallic structure or pipe against atmospheric type corrosion. This type of coating is ideal for cold water lines and metals exposed to normal atmospheric temperatures. However, at elevated temperatures as in high temperature equipment, metals such as iron corrode rapidly. The reason for this is that at a critical temperature of approximately 140°F iron becomes anodic to zinc. This results in the iron becoming the sacrificial anode which corrodes readily.

Plastic Wrapping

Plastic wrappings come in rolls like scotch tape. They may be procured in various widths to suit the user. The tape is wrapped around the pipes before they are laid in the trench. The wrappings are applied by a simple device that is clamped on the pipe and turned by the plumber. Pipe joints are wrapped after the pipes are laid in the trench.

GALVANIC CATHODIC PROTECTION

Galvanic cathodic protection is a method used to protect metal structures from the action of corrosion. As explained before, galvanic cell corrosion is the major contributing factor to the deterioration of metal by electrochemical reaction. The area of a structure that corrodes is the anode or positive side of the cell. Corrosion occurs when the positive electric current leaves the metal and enters the electrolyte. Galvanic cathodic protection is designed to stop this positive current flow. When the current is stopped, the corrosive action stops and the anodes disappear. This type of protection depends upon the neutralization of the corroding current and the polarization of the cathode metal areas.

Galvanic cathodic protection is a means to reduce or prevent the corrosion of a metal surface by the use of sacrificial anodes or impressed current methods. The sacrificial anode method is known as the galvanic anode method and the latter method merely as the impressed current method. These two methods can be used separately or in conjunction with each other, depending upon the corrosive characteristics of the electrolyte surrounding the structure.

Galvanic Anode Method

The galvanic anode method of cathodic protection uses an electrode referred to as a sacrificial anode that corrodes to protect a structure. This sacrificial anode is electrically connected to and placed in the same electrolytic area of the structure. The anode used to protect iron or steel structures should be made of magnesium or zinc, so that it will produce a sufficient potential difference to cause the structure to become a cathode. The action of this type of galvanic protection causes the electric current to flow from the sacrificial anode through the electrolyte to the structure to be protected. The electrical connection between the two metals completes the circuit and allows the current to return to the corroding metal. The sacrificial anode becomes the anode of the established dissimilar metal galvanic cell and the structure to be protected becomes the cathode. The current from the sacrificial anode is intense enough to oppose or prevent all positive current flows from leaving the anodes in the structure to be protected. These anodes are then suppressed and the metal in the structure becomes a cathode. The prevention of these positive current flow from the anodic areas in the structure reduces the corrosion rate to almost zero.

Galvanic cathodic protection is used in areas where the corrosion rate is low and electric power is not readily available. Figure 83 shows a typical example of galvanic cathodic protection.

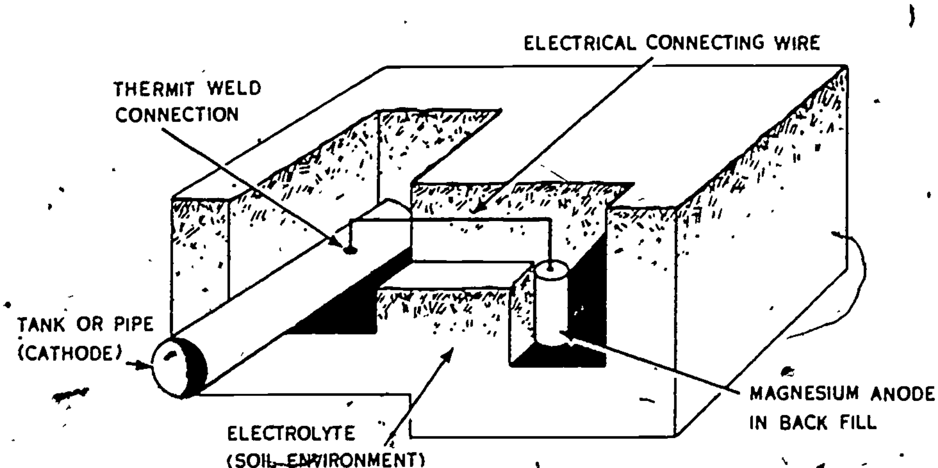

Figure 83. Galvanic Cathodic Protection.

Impressed Current Method

The impressed current method of cathodic protection is designed to protect large metal structures located in corrosive areas. With this method of protection a source of alternating current is required. In addition, a rectifier is needed to obtain the required direct current potential.

The basic principle of the impressed current method is merely the application of the galvanic cell reaction. The component parts of this method are: the cathode which is the metal structure to be protected, the anode made of suitable anodic material, the electrolyte or ground which is the ionized corrosive material, and the rectifier and various connections which serve to complete the electrical circuit. The operation of this method depends on the rectifier which forces direct current from the anode through the electrolyte (ground) to the metal structure to be protected. This method causes the metal structure to be the cathode, suppresses all anodic currents from it, and in turn prevents corrosion of the structure. Figure 84 shows a setup of an impressed current method of cathodic protection.

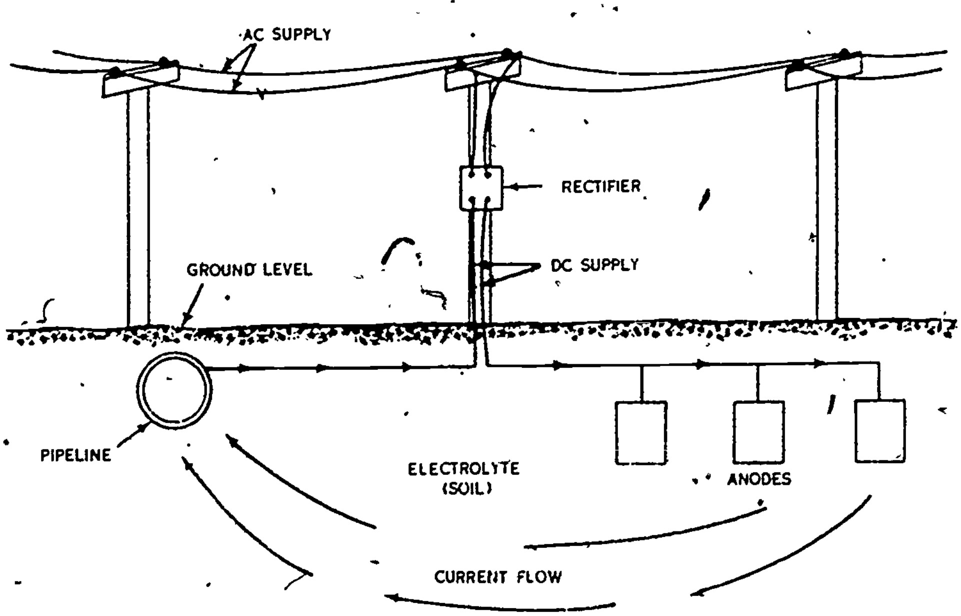

Figure 84: Impressed Current Method of Cathodic Protection.

FIELD TEST EQUIPMENT FOR CATHODIC PROTECTION

The field test equipment which the plumber uses to make tests when installing, operating, and maintaining cathodic protection systems are discussed in the following paragraphs:

Volt-Millivoltmeter

In corrosion and cathodic protection testing in the field, it is necessary to measure the potential of the structure being investigated as compared to the earth along the structure and to other metallic structures. It is also necessary to measure the potential of rectifiers, batteries, galvanic anodes, and sometimes potentials along the earth's surface to determine the distance being protected. The potentials may vary from millivolts to 20 volts or more. For this purpose various types of voltmeters are used One such instrument is the volt-millivoltmeter. It is a recording instrument designed with a chart that makes one revolution in 24 hours. When the instrument is connected to the points to be measured, it will record the variations in potential and reveal the electrolytic conditions around a structure.

Multicombination Meter

A meter quite often used in cathodic protection work is the multicombination meter. It is designed as a combination unit and actually consists of more than one instrument. The meter can be used as a high resistance voltmeter, an ammeter, and milliammeter, a low resistance voltmeter and millivoltmeter, and a potentiometer voltmeter.

The multicombination meter may be used to measure galvanic anode current between an anode and structure, galvanic current between structures, and potentials as with other types of voltmeters and millivoltmeters.

Resistivity Instruments

Resistivity measuring instruments are units used to test the corrosive action of a soil. Tests regarding soil corrosivity are necessary when designing cathodic protection systems. Information from these tests is used to locate the most corrosive areas where a pipeline is to be laid, the most corrosive areas of an existing pipeline, the best location for anode beds, and other applications when the corrosivity of the soil is to be known.

One of the simplest methods for making a resistivity test is to use a single probe resistivity meter. It consists of a probe with two electrodes, an indicating instrument, switches and required wiring. To use this instrument, the probe is inserted into the ground and current applied to it. The indicating instrument will give a reading, which expresses the corrosiveness of the soil.

Buried Pipe Locator

In the field of cathodic protection work, it is necessary to locate pipe in order to locate interferences in the cathodic protection system. For this purpose, an electronic pipe locator is used. The main components of the locator are the directional transmitter and the directional receiver. Each one of these units is carried by an operator. The operators are usually about 30 feet apart. During actual operation, the transmitter sends out signals which travel along the pipeline. The receiver, in turn, picks up these signals in varying intensities depending on the distance the operators are from the pipe. When both operators are directly over the pipe, a maximum response will be obtained in the phones and on the visual meter of the receiver. In this manner, almost any pipe can be located easily and accurately.

Protective Coating Leak Detector

A protective coating leak detector referred to as a "Holiday Detector" has been developed to detect the imperfections (holidays) in pipe coatings. The holiday leak detector is an instrument which operates by the use of an electric current. When it is being moved along a pipe which is covered by a coating or wrapping, a completed circuit between it and the pipe reveals a holiday, and causes a bell to ring, or a bulb to light or a buzzer to sound.

MAINTENANCE OF ANODE SYSTEMS

The anode system of cathodic protection requires very little maintenance because it has no power source and requires no regulation.

Magnesium and zinc anodes used in this system sometimes suffer local or self-corrosion which reduces their efficiency. When their efficiency drops to a minimum, they must be replaced. Anode life varies from five to 30 years, depending upon the type of anode used. It is conservative to figure that about 17 pounds of magnesium or 25 pounds of zinc are wasted away by electrolysis from an anode per ampere year.

Insulated wire is used to make the electrical connection between the anode and the structure to be protected. The insulation must be capable of long life in the electrolyte without failure. Wire with deteriorated insulation must be replaced.

Test stations should be installed in the anode system so that the effectiveness of cathodic protection can be determined.

MAINTENANCE OF IMPRESSED CURRENT SYSTEMS

The impressed system of cathodic protection requires considerably more maintenance than the anode system. This is because a direct current is used for the operation of the system. The current may be supplied by batteries, wind-driven generators, motor-generator sets, engine-driven generator sets, or transformer rectifier sets. By far, the most widely used and cheapest source of direct current is from the transformer rectifier set. Batteries, engine-driven generator sets and wind-driven generators can be used to furnish alternating current when it is not available to operate transformer rectifier sets. The transformer rectifier will require much less maintenance and servicing than other sources of current. However, systematic maintenance procedures must be used to keep these units in operating condition.

The transformer rectifier set consists of two units, a transformer and rectifier. The transformer is used to step the high voltage down to a value of 12 to 40 volts, and the rectifier is used to change alternating current to direct current. Connections on this unit must be kept tight.

The materials most often used for anodes with impressed current are aluminum, high silicon cast iron, and graphite. Scrap iron and steel may also be used for anodes. Steel anodes waste away at a rate of 20 pounds per ampere year. Anodes must be replaced when they are totally wasted away.

Wire with an insulation that resists electrolytic action must be used to make the connections between the anodes and the structures to be protected. The insulation on existing current carrying lines should be checked; and if deterioration is evident, the wires should be replaced. Any overhead electrical lines should also be checked to see that they are securely fastened to the poles and the connections are tight.

SUMMARY

Corrosion is a wasting away of a metal by electrochemical reaction. It affects almost any structure which is made of metal. The electrochemical theory is most generally accepted to explain the action of corrosion.

Corrosion may be divided into such types as uniform corrosion, localized corrosion and compositional corrosion. Uniform corrosion is caused by a direct chemical attack. Localized corrosion is caused by mill scale, cinders, pipe surface, soil conditions, stray currents. and bacteria. Compositional corrosion is caused by dezincification, graphitization and hydrogen embrittlement.

Corrosion is caused by electrolytes but not by nonelectrolytes. The materials which are least likely to be affected by corrosion are plastics, glass, vitrified clay, cement, fiber, asbestos and rubber. The metals which resist corrosion are copper, brass, Monel, stainless steel, and alloys of these metals. Coatings and wrappings are placed on pipe to reduce the action of corrosion. These may consist of paints, greases, cements, zinc coatings, and plastic wrapping.

Galvanic cathodic protection is a method of protecting metal structures from corrosion. There are two methods in use, the galvanic anode method and the impressed current method. Some of the most important test equipment used in cathodic protection field work are the volt-millivoltmeter, multicombination meter, resistivity meter, buried pipe locator, and protective coating leak detector. The equipment used in cathodic protection systems should be maintained as recommended by the manufacturer of the equipment.

REFERENCES

AFM 85-20

AFM 88-9, chapter 4.

QUESTIONS

1. What is corrosion?
2. What types of structures does it affect?
3. Explain the electrochemical theory.
4. Give an example of uniform corrosion.

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5. What is compositional corrosion?

6. How does hydrogen affect metals?

7. What effect do stresses have on metals?

8. Why do nonelectrolytes in some cases cause corrosion?

9. What materials are least likely to be affected by corrosion?

10. What is the purpose of wrappings and coatings on pipelines?

11. List some of the wrappings and coatings used on various structures.

12. What is galvanic cathodic protection?

13. What two types of cathodic protection methods are there?

14. What field test equipment is used in cathodic protection?

15. What is the purpose of each type of test equipment?

16. What maintenance should be performed on anode systems of cathodic-protection?

17. What maintenance should be performed on impressed current systems of cathodic protection?

ATC-SHEPPARD AFB TEX. 73-646

Department of Civil Engineering Training

Plumbing Specialist

UTILITY EQUIPMENT

February 1975

SHEPPARD AIR FORCE BASE

75-5-25

Designed For ATC Course Use

DO NOT USE ON THE JOB

455

TABLE OF CONTENTS

This supersedes WB 3ABR55235-V-1-P1 through V-8-P1, 14 December 1973. (Copies of the superseded publication may be used until the supply is exhausted.)

WINTERIZING BUILDING PLUMBING SYSTEMS

OBJECTIVE

This workbook will give you practical experience winterizing the pipes in a building and thawing frozen pipes.

Standard of Performance:

All questions must be answered and all answers must be correct.

All missions must be completed.

All completed work must comply with the standards in AFM 85-20.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-V-1	1/student
WB 3ABR55235-V-1-P1	1/student
AFM 85-20	1/team
Sponge	1/team
Force Cups (Plunger)	1/team
Garden Hose	1/team
Pail	1/team
Antifreeze	1/team

PROCEDURES

Mission 1

Winterize the plumbing systems in the booth area using the following procedure:

1. Drain the water pipes

   a. Close the stop and waste valve.

   b. Remove the cap from the side of the stop and waste valve.

   c. Open the drain valve in the hot water distribution main.

   d. Open all shower and lavatory faucets.

   e. Open the temperature and pressure relief valve (located at top of the water heater).

f. Explain why its necessary to open all the faucets and the temperature and pressure relief valve when draining the system. ________________

____

____

____

2. Drain the water closet

a. Flush the water from the tank.

b. Use the force plunger and remove as much water from the bowl as possible.

c. Use a sponge and remove the remaining water from the bowl and tank. (Both the bowl and tank must be completely dry.)

3. Drain the water heater

a. Shut off the source of heat.

NOTE: On a gas-fired heater this is accomplished by closing the gas shut-off valve. On an electrical hot water heater, you must disconnect the electrical power.

b. Attach a garden hose to the drain valve.

c. Place the other end of the garden hose in a pail or drain.

d. Check the temperature and pressure relief valve to make sure it's open.

e. Open the drain valve.

f. Why is it necessary to shut off the source of heat before draining the water heater? ________________

____

g. Why is it necessary for the temperature and pressure relief valve to be open when draining the water heater? ________________

____

4. Winterize a plumbing waste system

a. Prepare approximately 1 1/2 gallons of antifreeze mixture. (The mixture consists of two parts antifreeze and three parts water.)

b. Pour (very slowly) one quart of the mixture down the lavatory drain.

c. Explain the reason for step b. ______________________

____

____

d. Pour the antifreeze mixture into the water closet bowl slowly until the bowl is full. How will you know when the bowl is full?

____

____

e. Name four kinds of mixtures that can be used to winterize traps.

(1) ______________________

(2) ______________________

(3) ______________________

(4) ______________________

f. What is the main disadvantage of using alcohol and water for winterizing traps? ______________________

____

____

g. What is the main disadvantage of using calcium chloride and water for winterizing traps? ______________________

____

____

h. Name three things that can be used to wrap pipes to prevent freezing.

(1) ______________________________

(2) ______________________________

(3) ______________________________

Mission 2

THAWING FROZEN PIPE

1. Water will flow from a faucet at point "A" but downstream no water flows from the point "B". Locate the point where the pipe is restricted or frozen.

____

____

2. Frozen drainage lines can be detected by opening the faucets at the fixture and observing the ______________ of the ______________.

3. One method of thawing a frozen pipe is to pour hot water on a ______________ wrapped around the frozen pipe.

4. List three hazards involved when thawing frozen pipe with hot water.

a. ______________________________

b. ______________________________

c. ______________________________

5. Explain the procedures for applying the heat when thawing a frozen pipe with a torch. ______________________________

____

____

6. List three hazards involved when using torches to thaw frozen waterlines.

a. ______________________________

b. ______________________________

c. ______________________________

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7. List two advantages of using electrical devices to thaw pipes.

a. ______

b. ______

8. Explain why it is necessary to have clean tight connections when using electrical devices to thaw pipe. ______

______

______

9. Name the device that is used to connect electrical thawing equipment ~~to pipe~~.

______

10. Name three electrical devices that can be used to thaw frozen pipe.

a. ______

b. ______

c. ______

11. Name one disadvantage of using heat tapes for thawing pipe. ______

12. When using a welding machine or a low voltage transformer to thaw a frozen pipe, why is it necessary to make the connections as close to the frozen areas as possible? ______

______

______

13. What will happen if you touch the exposed electrical terminals when using an electrical device to thaw pipe?

______

______

______

14. Name two types of chemicals that can be used to thaw drainage lines.

a. ______

b. ______

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15. Explain how chemicals melt ice. ____________________

____

____

____

16. List three hazards involved when using chemicals to thaw frozen drainage.

a. ____________________

b. ____________________

c. ____________________

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MAINTENANCE OF VALVES

OBJECTIVE

This workbook will give you practical experience locating and identifying the major components of valves, and in repairing a globe valve.

Standard of Performance:

All questions must be answered and all answers must be correct.

All work must comply with the standards in AFM 85-20 and/or the manufacturer's specification.

EQUIPMENT

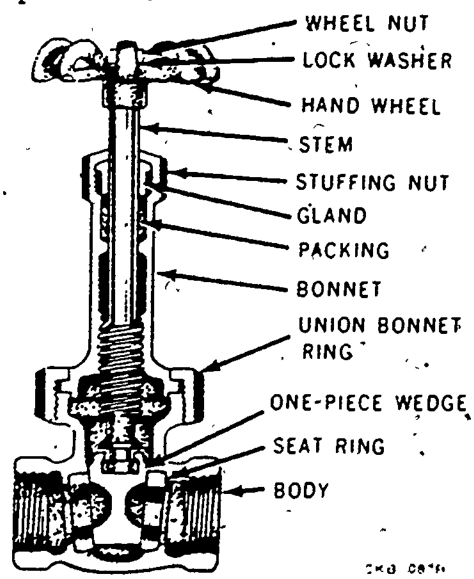
	Basis of Issue
SG 3ABR55235-V-2	1/student
WB 3ABR55235-V-2-P1	1/student
Plumber's Tool Kit	1/2 students
Shop Tools	1/2 students
Valve Repair Kit	1/2 students
Plumbing Valve	1/student

PROCEDURE

Mission 1

IDENTIFICATION AND PURPOSE OF VALVES

1. Identify the valves illustrated below by writing their names in the blank spaces provided.



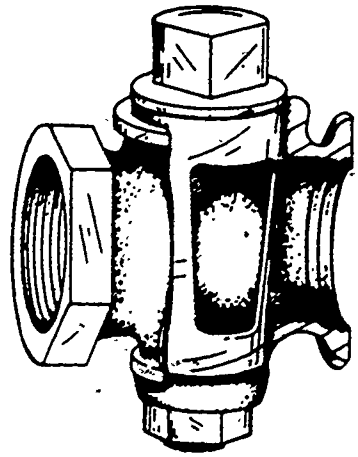


Figure 1. Plumbing Valves

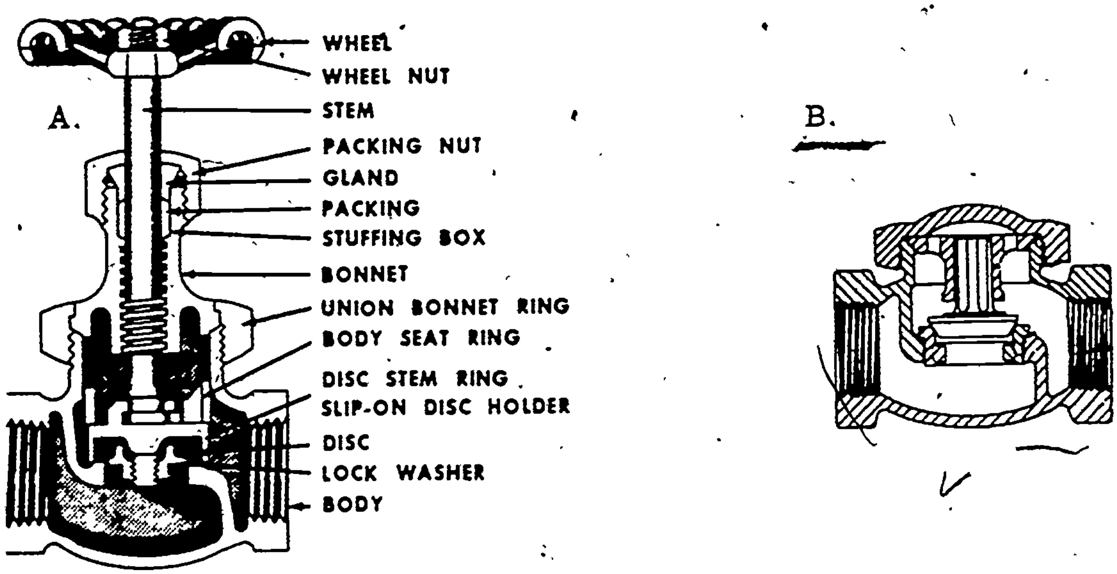


Figure 2. Plumbing Values

_______________________ _______________________

2. A gate valve must be either fully ________________ or ________________

3. A gate valve ________________ (can, cannot) be used to control the rate of flow.

4. When opening or closing a gate valve, back off the stem approximately 1/4 to 1/2 turn to prevent ________________________________

5. List four types of discs used on globe valves.

   a. ________________________

   b. ________________________

   c. ________________________

   d. ________________________

6. A globe valve ________________ (can, cannot) be used to control the rate of flow.

7. Name one advantage of a compositional type disc in a globe valve.

____

8. A check valve provides free flow in ________________ direction only.

MAINTENANCE OF VALVES

OBJECTIVE

This workbook will give you practical experience locating and identifying the major components of valves, and in repairing a globe valve.

Standard of Performance:

All questions must be answered and all answers must be correct.

All work must comply with the standards in AFM 85-20 and/or the manufacturer's specification.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-V-2	1/student
WB 3ABR55235-V-2-P1	1/student
Plumber's Tool Kit	1/2 students
Shop Tools	1/2 students
Valve Repair Kit	1/2 students
Plumbing Valve	1/student

PROCEDURE

Mission 1

IDENTIFICATION AND PURPOSE OF VALVES

1. Identify the valves illustrated below by writing their names in the blank spaces provided.

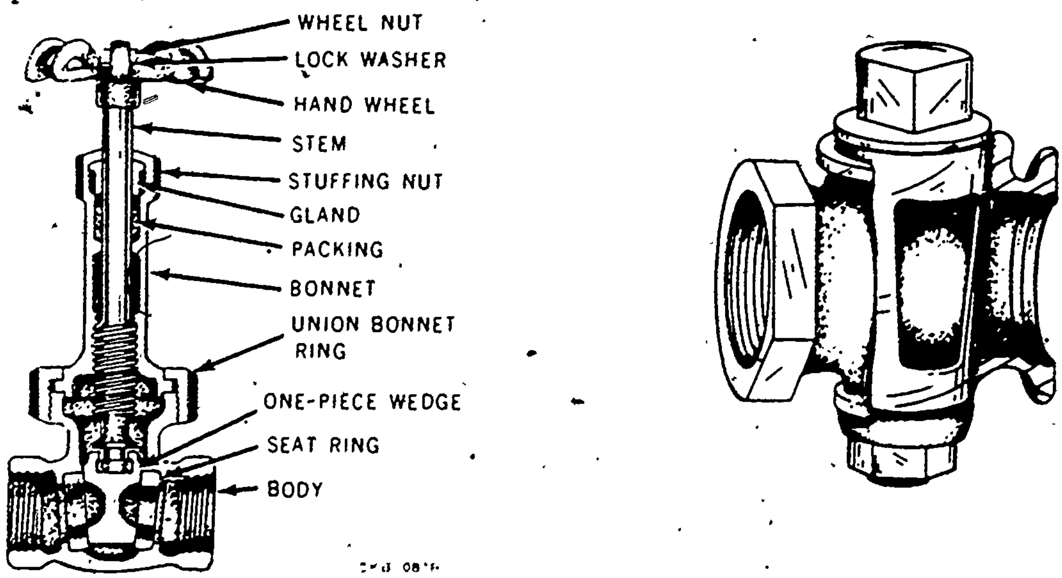
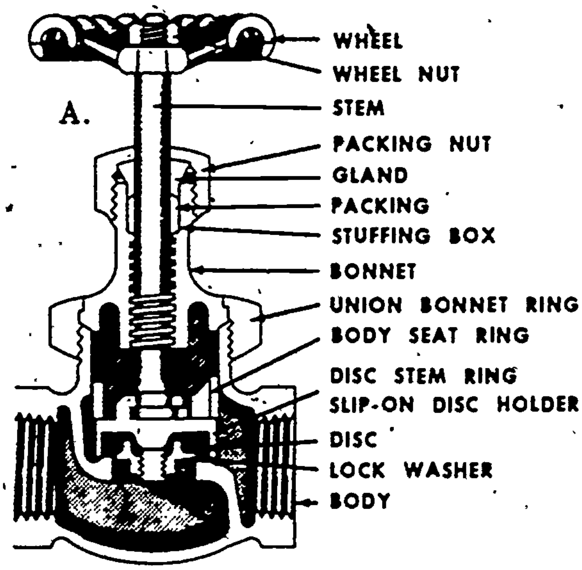


Figure 1. Plumbing Valves

A.



B.

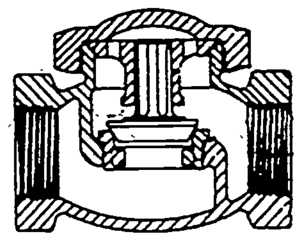


Figure 2. Plumbing Values

______________________ ______________________

2. A gate valve must be either fully ______________ or ______________

3. A gate valve ______________ (can, cannot) be used to control the rate of flow.

4. When opening or closing a gate valve, back off the stem approximately 1/4 to 1/2 turn to prevent ______________________

5. List four types of discs used on globe valves.

   a. ______________________

   b. ______________________

   c. ______________________

   d. ______________________

6. A globe valve ______________ (can, cannot) be used to control the rate of flow.

7. Name one advantage of a compositional type disc in a globe valve.

____

8. A check valve provides free flow in ______________ direction only.

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9. Name the two basic types of check valves.

a. ______________________

b. ______________________

10. Plug valves are either fully opened or fully closed with __________ turn of the handle.

11. List five places where plug type valves are normally used.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

e. ______________________

12. Maintenance of plug valves consists of ____________ and ____________________

13. Name the type of valve normally used in gas lines.

____

Mission 2

REPAIR OF A GLOBE VALVE

1. Refer to the cutaway drawing below when repairing the globe valve.

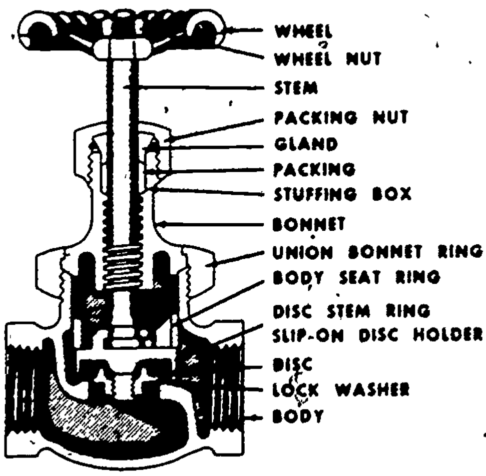

Figure 3. Globe Valve

2. Procure a globe valve from supply or your instructor.

3. Place the valve in the vise with the ends of the valve against the jaws of the vise.

4. Remove the wheel.

5. Remove the packing nut.

6. Remove the gland.

7. Remove the union bonnet ring.

8. Remove the stem, bonnet and disc assembly.

9. Inspect the valve seat.

NOTE: If the valve seat is rough, resurface it as follows:

10. Select the largest stem guide that will enter the valve body.

11. Select the largest cutting head that will fit the valve seat.

12. Select a pilot nut that will fit snugly in the valve opening.

13. Slip the stem guide on the stem.

14. Screw the cutter head on the end of the stem.

15. Screw the pilot nut on the end of the stem.

16. Place the cutter head in the valve body.

17. Tighten the stem guide in the valve body (handtight).

18. Attach the ratchet handle to the top of the stem.

19. Apply light downward pressure on the top of the stem.

20. Rotate the stem in the clockwise direction.

21. Check the valve seat frequently. Continue the cutting operation until the valve seat is smooth.

NOTE: Some globe valves have replaceable seats. If the valve seat cannot be repaired, remove and replace it as follows:

22. Select a seat key that will fit the old seat.

NOTE: Valve seats usually have a square or octagon opening.

23. Slip the stem guide on the seat key.

24. Place the seat key in the opening of the old seat in the valve body.

25. Tighten the stem guide (handtight).

26. Attach the ratchet handle to the top of the stem.

27. Remove the old seat by turning the ratchet handle counterclockwise.

28. Remove the seat key, seat and stem guide from the valve body.

29. Remove the old valve seat from the seat key.

30. Install the new seat.

    NOTE: Installation of the new seat is the reversal of the removal procedures.

31. Inspect the old valve disc. (If it is faulty replace it with a new disc.)

32. Reassemble the valve disc, valve stem, and bonnet.

33. Insert the assembly into the valve body.

34. Check the gland and packing. (Replace if necessary.)

35. Complete the reassembly of the valve.

36. Remove the valve from the vise.

37. Attach the valve to a source of pressure and flush the valve.

38. Close the valve and test for leakage.

39. If a globe valve leaks around the stem, what maintenance should be accomplished first? ____________________

40. If a globe valve with a compositional type disc leaks internally, what maintenance should be accomplished first? ____________________

41. A globe valve is leaking between the bonnet and valve body. What maintenance is required? ____________________

____

MAINTAINING SEWERS

OBJECTIVE

This workbook will give you practical experience maintaining sewers.

Standard of Performance:

All questions must be answered and all answers must be correct.

All completed work must comply with AFM 85-20.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-V-3	1/student
WB 3ABR55235-V-3-P1	1/student
Power Auger	1/class
Plumbers Tool Kit	1/2 students
Shop and Power Tools	1/2 students
Pipe Detection Instruments	1/class

PROCEDURE

Mission 1

CLEANING A SEWERLINE

NOTE: To accomplish this mission, you will work as a member of a team and use either an engine-powered or electrical-powered auger to clean a sewerline.

1. Inspect the sewerline.

   a. Locate two succeeding manholes.

   b. Remove the manhole covers.

   c. Observe the direction and rate of fluid flow.

2. Secure a power-driven auger and a rod reel.

3. Check the powered auger for

   a. general condition

   b. oil level

   c. gas level

4. Check the rod reel for
   a. excessive wear and damage
   b. proper fitting connections
   c. completeness of cutting and screwheads
5. Connect the cleanout rodding to the power unit.

   CAUTIONS: For safety purposes, use gloves.

   NOTE: Make sure that the connections are tight.
6. Insert the cleanout rod through the J-tube and into the sewerline.
7. Start the power unit and feed the rodding into the sewerline.

   NOTE: For safety purposes, make sure you have at least three men available when operating the power auger.
8. Add rodding sections as needed until the restriction is removed and the fluid flows freely.
9. Withdraw the rodding from the sewer.
10. Clean and rewind the rodding as it is withdrawn from the sewer.
11. Return the tools and equipment to their proper storage area.
12. Clean the working area.

Mission 3

1. Name the greatest hazard of working in manholes.

   ____

2. Explain how sewer gases are removed from manholes. ______________

   ____

3. Name one safety precaution that must be observed before entering a manhole.

   ____

4. Explain one method of locating a restriction in a sewerline. ______________

   ____

   ____

5. List three ways that sand and grit can be removed from a sewer.

a. ______________________________

b. ______________________________

c. ______________________________

6. A sewer hoe can be used on sewers of __________ (size) and larger.

7. Name one method of removing stubborn stoppages from sewerlines. __________

____

8. Name one time when chemicals should not be used in sewers. __________

____

9. Copper sulphate is effective in removing __________ from sewerlines.

10. The __________ __________ is used to guide the rod into the sewer (During rodding operations).

11. How many men are required to operate a power-driven sewer auger? __________

12. All tools should be oiled after use to prevent __________

13. When repairing a defective section of a sewerline, isolate the defective section with sandbags at the manholes and __________ the sewage from one manhole to another.

14. List the protective clothing that should be worn to guard against sewer gases when working in manholes.

a. __________

b. __________

c. __________

15. All electrical devices should be __________ before using.

Mission 4

LOCATING A BURIED PIPE

1. Use a map of the sewer system and locate the pipe needed on the map.
2. Go to the area and locate two manholes. (The required pipe must be between these two manholes.)

3. Push a probe in the ground until you find the pipe.

4. Determine the depth of the pipe.

5. Use a spade and dig down to the pipe.

6. List five bits of information concerning this pipe that can be found on the map.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

7. The general location of sewer piping can be determined by sighting from one ______________________ to another.

8. Name three methods of finding buried pipes.

   a. ______________________________

   b. ______________________________

   c. ______________________________

9. Name the best method of finding a pipe when there are several pipes in the area.

   ____

10. Name the two most common types of electronic equipment used to locate buried pipe.

   a. ______________________________

   b. ______________________________

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MAINTAINING GREASE TRAPS

OBJECTIVE

This workbook will give you practical experience inspecting and cleaning grease traps.

Standard of Performance:

All questions must be answered and all answers must be correct.

All work must comply with AFM 85-20.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-V-3	1/student
WB 3ABR55235-V-3-P2	1/student
Grease Trap	1/class
Plumbers Tool Kit	1/2 students
Shop and Special Tools	1/2 students

PROCEDURE

1. Go to the grease trap.
2. Remove the lid from the grease trap.
3. Skim off the grease and place it in a plastic bag.
4. Remove the putrid material and place it in a plastic bag.
5. Use a hose and wash out the grease trap.
6. Inspect the grease trap for holes, decay, and damage.
7. Replace the lid and place the unit back in operation.
8. A grease trap should be located ____________ the building as close to the fixture as possible.
9. A grease trap operates on the principle that ____________ is lighter than water.
10. The baffles chamber in a grease trap slows the movement of the waste and allows the ____________ to cool.
11. Waste lines that contain a grease trap do not need a ____________.

TEMPORARY MAINTENANCE OF EXTERIOR PIPING

OBJECTIVE

This workbook will give you practical experience making a temporary repair to a line by installing a clamp-on repair device and assembling a grooved pipe connection.

Standard of Performance:

All questions must be answered and all answers must be correct.

All work must comply with AFM 85-20 and/or manufacturer's specifications.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-V-4	1/student
WB 3ABR55235-V-4-P1	1/student
Plumbers Tool Kit	1/2 students
Shop and Special Tools	1/2 students
Mechanical Groove Coupling	1/2 students
Repair Clamp	1/student
AFM 85-13	1/class

PROCEDURE

Mission 1

TEMPORARY REPAIR OF A LINE

NOTE: The instructor will assign you a line to repair.

1. Pressurize your line with water.
2. Check the line for leaks.
3. Determine the type of leak.
4. Name five types of leaks that you can expect to find in a line.

a. ____________________________

b. ____________________________

c. ____________________________

d. ____________________________

e. ____________________________

5. Determine the type of repair clamp needed.

6. Name five types of repair clamps.

   a. ______________________

   b. ______________________

   c. ______________________

   d. ______________________

   e. ______________________

7. Install the correct repair clamp.

8. Pressurize the line and check for leaks.

9. Name the type of clamp used to repair asbestos cement and cast-iron pipe.

____

Mission 2

MAKING A GROOVED PIPE CONNECTION

1. Smear ordinary cup grease on pipe ends and outside the gasket to make the installation, see figure 4.

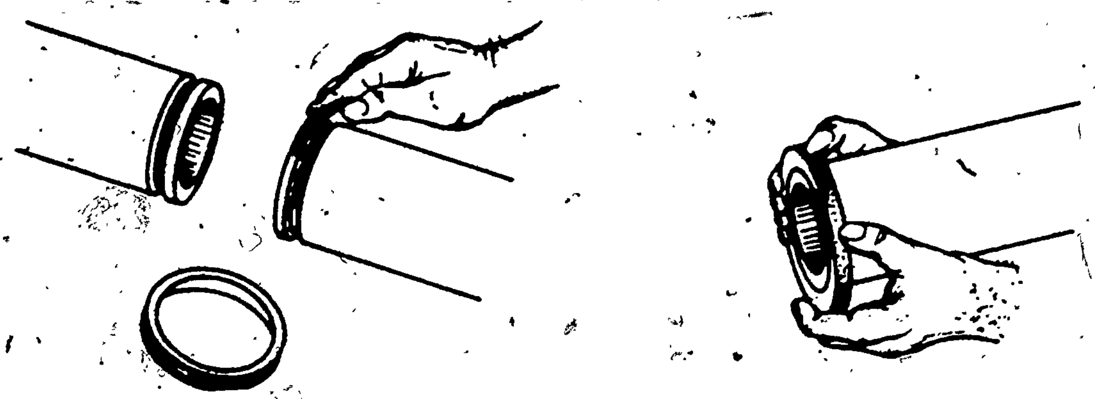

Figure 4. Applying Grease and Installing Gasket

2. Slide gasket over one pipe, bringing pipe ends together, see figure 5.

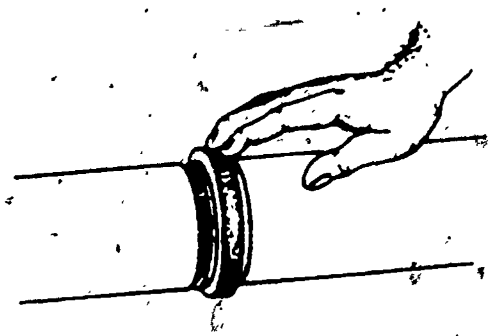

Figure 5. Positioning Gasket

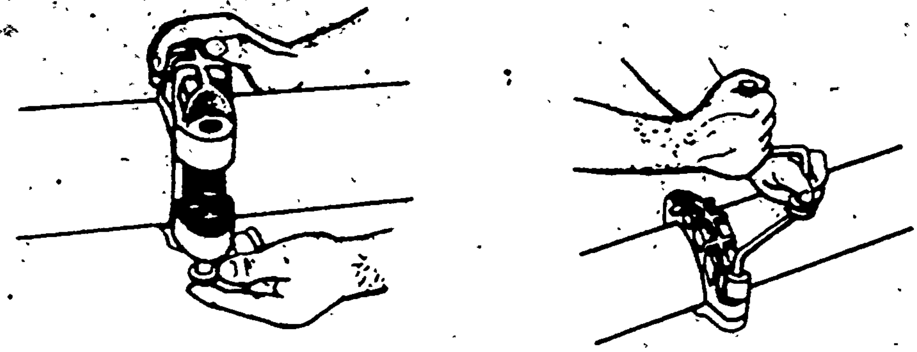

Figure 6. Installing Bolts and Securing Bolts

3. Slide gasket into central position over the pipe ends, see figure 6.

4. Put on self-centering housing clamp; insert bolts and nuts, figure 6.

5. Take up nuts uniformly until housing clamps are firmly secured together, metal to metal. Excessive bolt tension is unnecessary, figure 6.

6. Grooved pipe connections are used on ________________________ water mains.

7. Identify the major components of a mechanical grooved coupling, see figure 7, by writing the name of each component in the blank space provided.

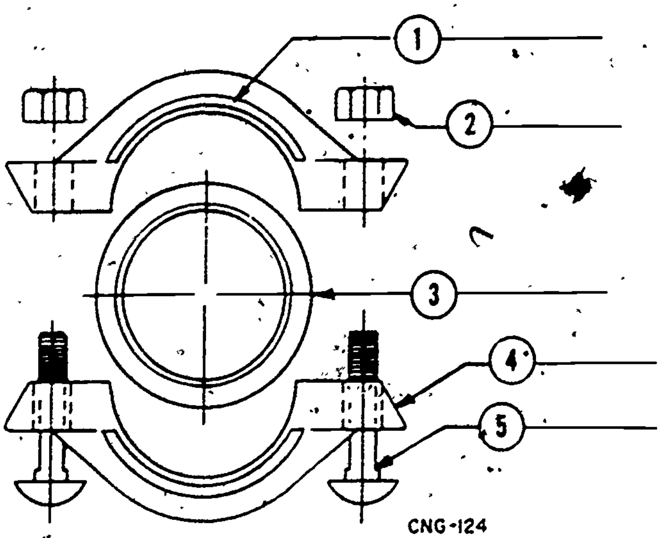

Figure 7. Grooved Coupling

MAINTAINING FIRE HYDRANTS

OBJECTIVE

The workbook will give you practical experience maintaining fire hydrants.

Standard of Performance:

The completed hydrant must be functional.

All questions must be answered and all answers must be correct.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-V-5	1/student
WB 3ABR55235-V-5-P1	1/student
Plumbers Tool Kit	1/2 students
Fire Hydrant	1/2 students
Shop and Special Tools	1/2 students

PROCEDURE

Mission 1

INSPECTION AND MAINTENANCE OF FIRE HYDRANTS

1. Go to the fire hydrant that has been assigned to you by the instructor.
2. Check the operation of the drain valve.
   a. Tighten all hose nozzle caps.
   b. Open the main valve (full open).
   c. Loosen the small hose nozzle cap and allow the trapped air to escape.
   d. As soon as water starts coming out of the nozzle cap, close the main valve.
   e. Remove the large hose nozzle cap.
   f. Lower a float on the end of a string into the barrel.
   g. Check for a lowering of the water level by observing the float and string.
   h. Remove the float and string.
   i. Replace the hose nozzle cap.

3. Check the drain valve.

   a. Tighten all hose nozzle caps.

   b. Open the main valve two turns.

   NOTE: Both the drain valve and the main valve will be open.

   c. Place your ear against the barrel of the hydrant.

   d. Listen for sounds of water escaping through the drain valve.

   NOTE: A hissing sound indicates that water is escaping through the drain valve and the drain valve is free of obstructions.

   e. Close the main valve.

4. Check for external leakage.

   a. Tighten all hose nozzle caps.

   b. Open the main valve (full open).

   c. Check for leakage around the operating nut.

   NOTE: If leakage occurs around the packing gland, tighten the packing. If this doesn't stop the leak, replace the packing.

   d. Check for drain valve leakage.

   NOTE: Water surfacing around the base of the hydrant indicates the drain valve is leaking.

   e. If the drain valve leaks, replace the gasket and valve facing.

5. Check for leakage around the nozzle caps.

   NOTE: If leakage occurs replace the gaskets.

6. Close the main valve.

7. Check static pressure.

   a. Check to make sure the main valve is completely closed.

   b. Remove one small hose cap.

   c. Attach a pressure gage to the small hose nozzle.

   d. Open the main valve (full open).

   e. Record the pressure on the gage ______________________.

8. Check residual pressure.

   a. Close the main valve.

   b. With the pressure gage attached to one small hose connection, remove the cap from the other small hose connection.

   c. Open the main valve (full open).

   d. Record the residual pressure on the gage ______________________.

   NOTE: A low residual pressure is usually caused by one or more of the following: water main too small, partially closed valves, too many directional changes or obstruction in the water main.

   e. Close the main valve.

9. Check for main valve leakage.

   a. Check the main valve to make sure it is completely closed.

   b. Remove one small hose nozzle.

   NOTE: If water fills the barrel the main valve is leaking.

   c. Remove and replace the main valve if necessary.

Mission 2

REMOVE AND REPLACE THE MAIN VALVE

1. Close the isolation valve.
2. Remove the holddown nut.
3. Remove the operating nut.
4. Unbolt and remove the hydrant bonnet.
5. Insert the seat wrench over the top of the valve stem and into the hydrant barrel.
6. Fasten the seat wrench to the seat ring by screwing the operating nut on the threaded portion of the hydrant stem.
7. Break the band between the seat ring and shoe by striking the top of the seat wrench.
8. Unscrew the seat ring by turning the seat wrench counterclockwise.
9. Replace worn or damaged parts.

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10. Replace the seat ring.

11. Replace the hydrant bonnet and tighten the bonnet bolts.

12. Replace the operating nuts.

13. Replace the holddown nut.

14. Open the isolation valve.

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IDENTIFICATION OF COMPONENTS OF A FIRE HYDRANT

Using the illustration below, identify the components of a fire hydrant, see figure 8, by placing the number of each component in the blank space by its name.

Oil Filter Plug_____

Main Valve_____

Pumper Nozzle_____

Upper Barrel_____

Upper Stem_____

Operating Nut_____

Lower Barrel_____

Bonnet_____

System Stem Coupling_____

Lower Stem_____

Safety Flange_____

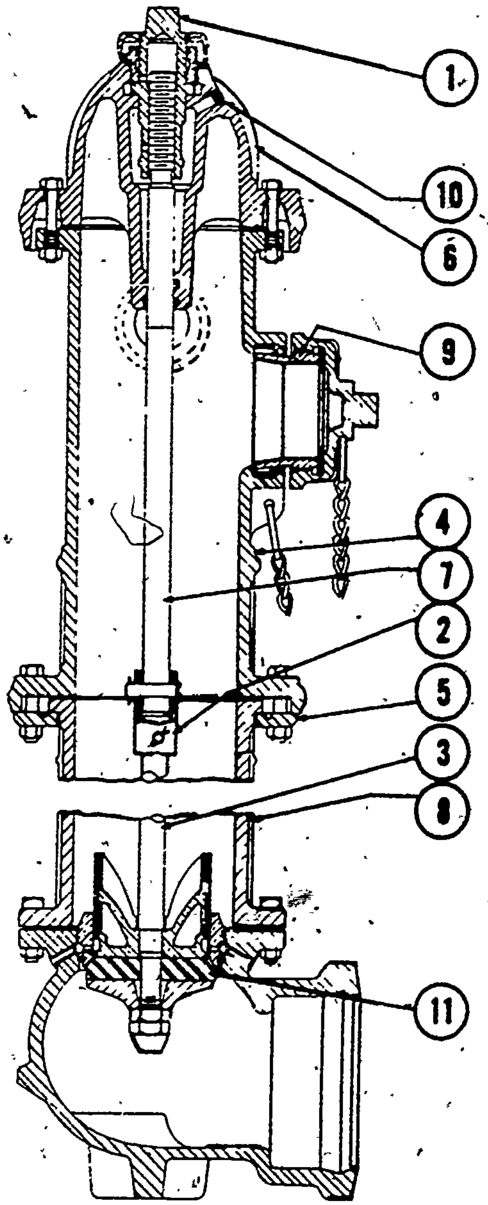

Figure 8. Fire Hydrant

Mission 4

QUESTIONS CONCERNING FIRE HYDRANTS

NOTE: Answer the following questions and fill in the blanks as required.

1. Name three models of fire hydrants.

   a. ____________________

   b. ____________________

   c. ____________________

2. Where would you expect to find a flush model fire hydrant installed? ____________

   ____

3. On a traffic model fire hydrant the ____________ ____________ feature protects the barrel when hit by a vehicle.

4. The ____________ ____________ ____________ protects the stem when the traffic model fire hydrant is hit by a vehicle.

5. On the traffic model fire hydrant the ____________ ____________ holds the main valve closed to prevent loss of water when the hydrant is knocked over by traffic.

6. The ____________ valve is used to shut off the water to the fire hydrants.

7. Fire hydrants are set on ____________ to prevent settling.

8. The side of the fire hydrant opposite the water entrance should be braced with

   ____________ ____________ or ____________ to prevent blow off.

9. ____________ ____________ is placed around the base of a hydrant to aid in draining the hydrant.

10. ____________ sections are used to extend the height of hydrants to compensate for variations in ground level.

11. Water coming up around a hydrant when the main valve is fully open, indicates the

    ____________ valve is leaking.

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ASSEMBLING PLASTIC PIPE

OBJECTIVE

This workbook will give you practical experience measuring, cutting and assembling plastic pipe.

Standard of Performance:

All questions must be answered and all answers must be correct.

All practical work must comply with good workmanship practices and the manufacturer's specifications.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-V-5	1/student
WB 3ABR55235-V-5-P2	1/student
Plumbers Tools	1/2 students
Shop Tools	1/2 students
Plastic Pipe	
Solvent	

PROCEDURE

Mission 1

MAKING A SOLVENT WELD

1. Select a length of plastic pipe from the storage area.
2. Select a fitting that will fit on the pipe.
3. Procure a brush and some plastic pipe cement.
4. Use a folding rule and measure off eight inches of pipe.
5. Use either a handsaw, hacksaw, tubing cutter, or pipe cutter and cut the pipe square.
6. Remove the burrs.
7. Clean the pipe with a rag.
8. Check the dry fit by slipping the pipe into the fitting.
9. Remove the glass by applying cleaner, primer, or by sanding.

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10. Apply a thin coat of the solvent to the pipe and fitting.

11. Rotate and bottom the pipe in the fitting while the surfaces are still wet.

    NOTE: If the cement gets dry, apply more cement and try again.

12. Hold for about one minute.

13. Wipe off excess cement.

    NOTE:

    a. Let the unit dry from 30 minutes to four hours before handling.

    b. Allow four hours drying time before applying 10 percent of desired test pressure.

    c. Allow 24 hours drying time before applying full test pressure.

14. Clean the tools.

15. Return all tools and equipment to the storage area.

Mission 2

QUESTIONS CONCERNING PLASTIC PIPE

1. List four characteristics of plastic pipe.

   a. ____________________

   b. ____________________

   c. ____________________

   d. ____________________

2. When the temperature of plastic pipe increases the maximum allowable pressure

   ____

3. Give five advantages of plastic pipe over steel pipe.

   a. ____

   b. ____

   c. ____

   d. ____

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   e. ____

4. List three types of plastic pipe.

a. ____________________

b. ____________________

c. ____________________

5. List four tools that can be used to cut plastic pipe.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

6. List two safety precautions that must be observed when making a solvent weld joint.

a. ____________________

b. ____________________

7. Threaded joints can be used on ____________ wall plastic pipe.

8. When laying plastic pipe in a trench, it should be snaked back and forth to compensate for ____________ and ____________ due to temperature changes.

9. When running plastic pipe under roadways it should be protected with ____________ ____________.

PNEUMATIC SYSTEM COMPONENTS

OBJECTIVE

This workbook will give you practical experience identifying pneumatic system components.

Standard of Performance:

All questions must be answered and all answers must be correct.

EQUIPMENT

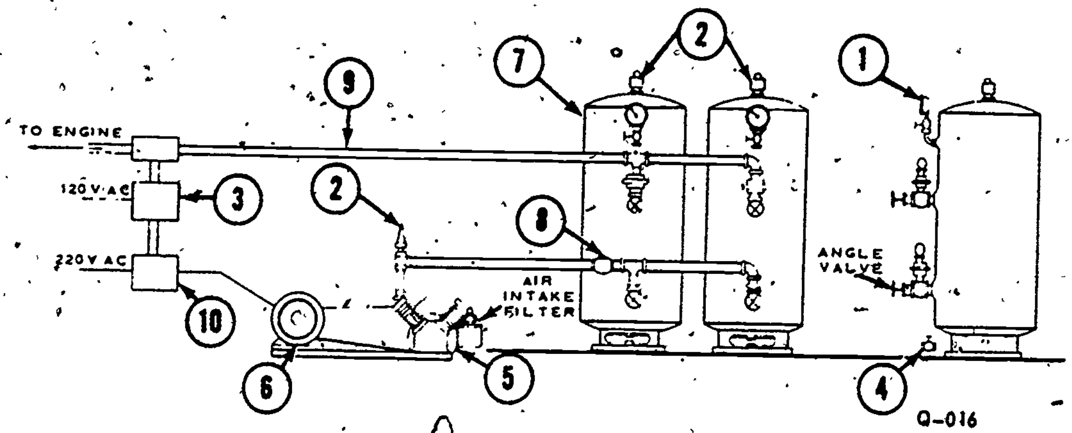
	Basis of Issue
SG 3ABR55235-V-5	1/student
WB 3ABR55235-V-5-P3	1/student

PROCEDURE

Mission 1

IDENTIFICATION OF PNEUMATIC SYSTEM COMPONENTS

Identify the components of a compressed air system, see figure 9, by writing the correct number in the space by its name.



_____ Pressure Switch

_____ Relief Valve

_____ Storage Tank

_____ Air Compressor

_____ Check Valve

_____ Gage

_____ Drain Valve

_____ Motor

Figure 9. Compressed Air System

Mission 2

QUESTIONS CONCERNING PNEUMATIC SYSTEMS

1. The pressure control switch automatically controls the operation of the __________.
2. The __________ valve releases excessive pressure.
3. The __________ valve reduces the tank pressure to the desired working pressure.
4. The __________ __________ indicates tank pressure.
5. The compressed air is stored in the __________ __________.
6. The __________ __________ drains moisture from the storage tank.
7. What type of pipe is used in the distribution system? __________
8. What is used to check for leaks in a pneumatic system? __________

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INSTALLING UTILITY EQUIPMENT

OBJECTIVE

This workbook will give you practical experience interpreting manufacturer's specifications and installing utility equipment.

Standard of Performance:

- All questions must be answered and all answers must be correct.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-V-6	1/student
WB 3ABR55235-V-6-P2	1/student
Plumber's Tool Kit	1/2 students
Shop and Special Tools	1/2 students
Water Cooler	1/2 students

PROCEDURE

Mission 1

1. Study the rough-in measurements shown in figure 10 and then answer each of the following questions.

   a. What is the distance from the floor to the bottom of the faucets?

   ____

   b. What is the distance from the floor to the center of the rough-in opening for hot and cold water piping and drainage?

   ____

   c. What is the distance between the hot and cold water piping?

   ____

   d. What is the distance from the center of the rough-in drain opening to the bottom of the sink? ______________________________

e. What is the distance from the center of the drain opening in the sink to the center of the faucet opening? ______________________

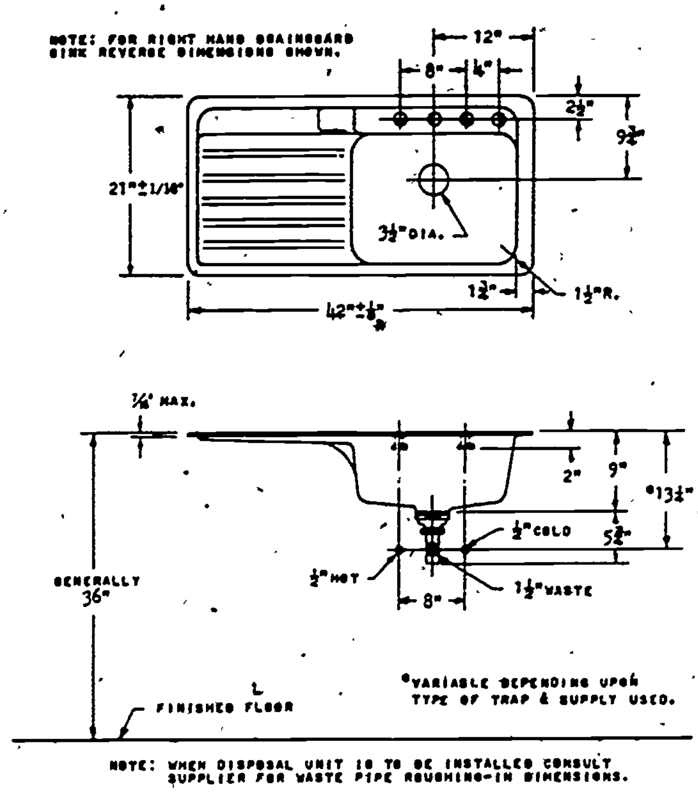

Figure 10. Rough-In Measurements for Kitchen Sink

2. Examine figure 11 and enter the answers to the following statements or questions on the blank lines.

a. What is the purpose of a slop sink? ______________________

____

b. What type of trap is used on ______________________

____

c. Why is this type trap used? ______________________

____

d. What unit or units support the slop sink? ______________________

522 ______________________

e. Identify the slop sink components by placing the name of each component on the blank line.

(1) ______________________

(2) ______________________

(3) ______________________

(4) ______________________

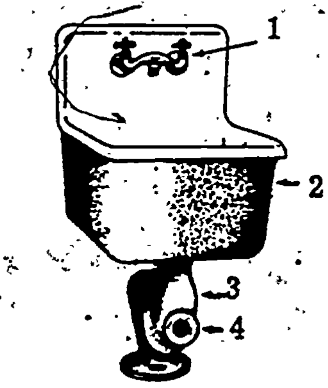

Figure 11. Slop Sink

3. Study the rough-in measurements in figure 12, then place your answers to each question on the blank line.

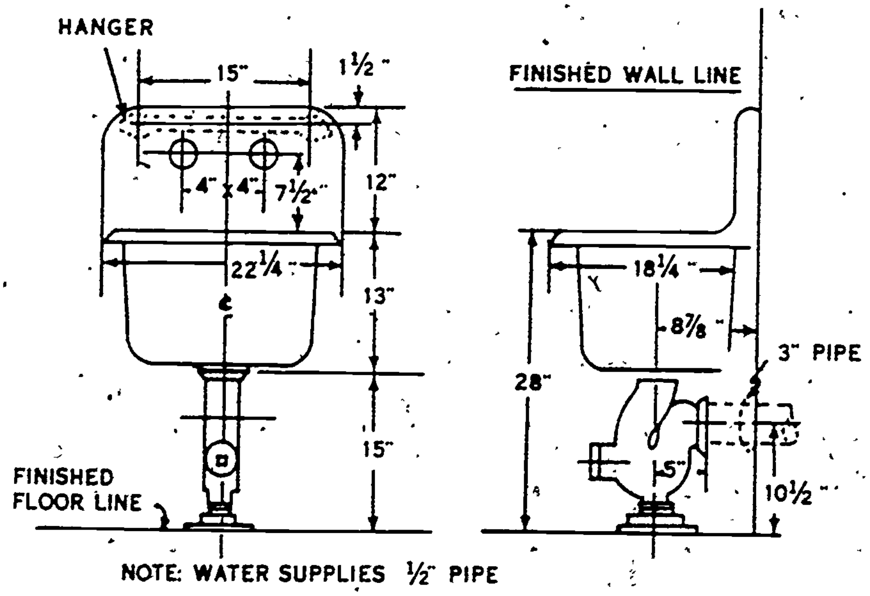

Figure 12. Rough-In Measurements for a Slop Sink

a. The distance from the finished floor to the top of sink is ______________.

b. This distance from the finished floor to the center of the drain opening is

____.

c. The distance from the finished floor to the center of the hanger bracket is

____.

d. The distance from the center of the trap to the finished wall is ______________

____.

4. Examine figure 13 and enter your answers to the following statements or questions on the blank lines.

   a. What type of sink is shown in figure 13? ____________

   b. List the name of each component below.

      (1) ____________

      (2) ____________

      (3) ____________

      (4) ____________

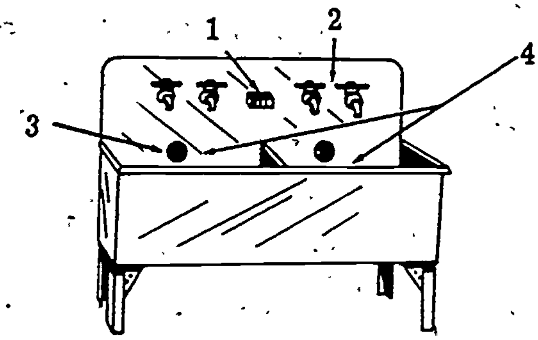

Figure 13. Sink

   c. What is the purpose of this sink? ____________

5. Examine figure 14 and enter the name of the components on the blank lines.

   a. ____________

   b. ____________

   c. ____________

   d. ____________

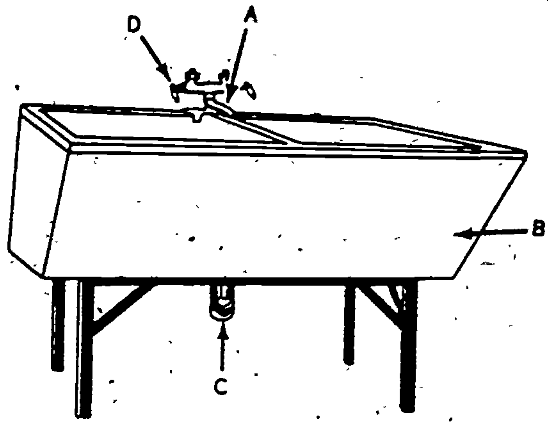

Figure 14. Laundry Tub

6. Study the rough-in measurements in figure 15 and place your answer to each question on the blank line.

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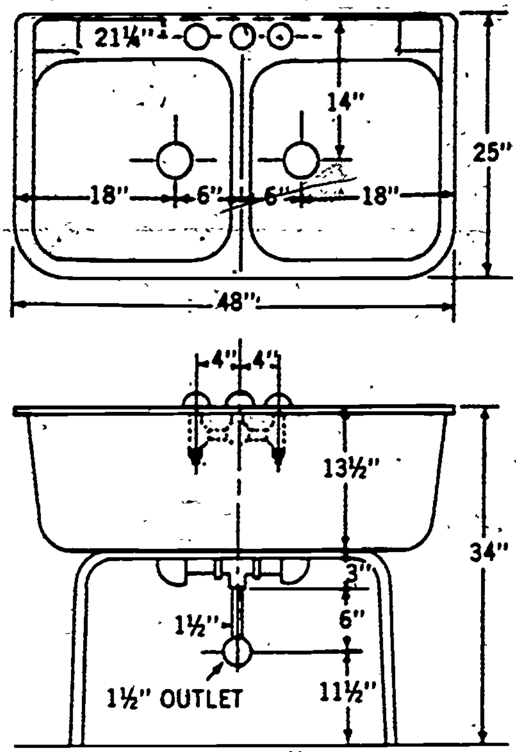


Figure 15. Rough-In Measurement for Laundry Tub

a. What type of material is used in constructing this sink?

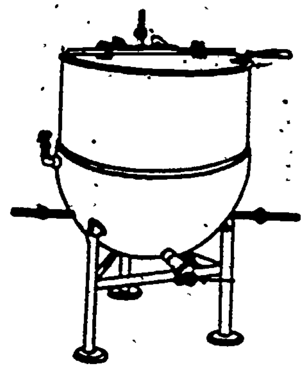
b. Where would you find this type of sink installed?

c. Where would leaks most likely occur in the water system of this type sink?

d. What type of trap is used on this type sink?

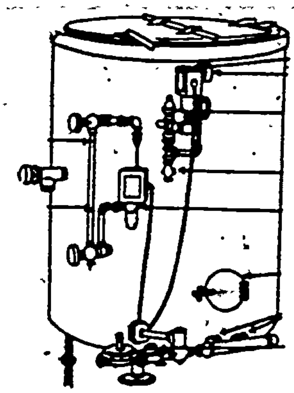
e. If you had a hard stoppage beyond the trap and you cannot remove the stoppage with a plunger, what procedure would you use to remove it?

8. Identify each of the following illustrated pieces of equipment, see figures 16, 17, and 18.



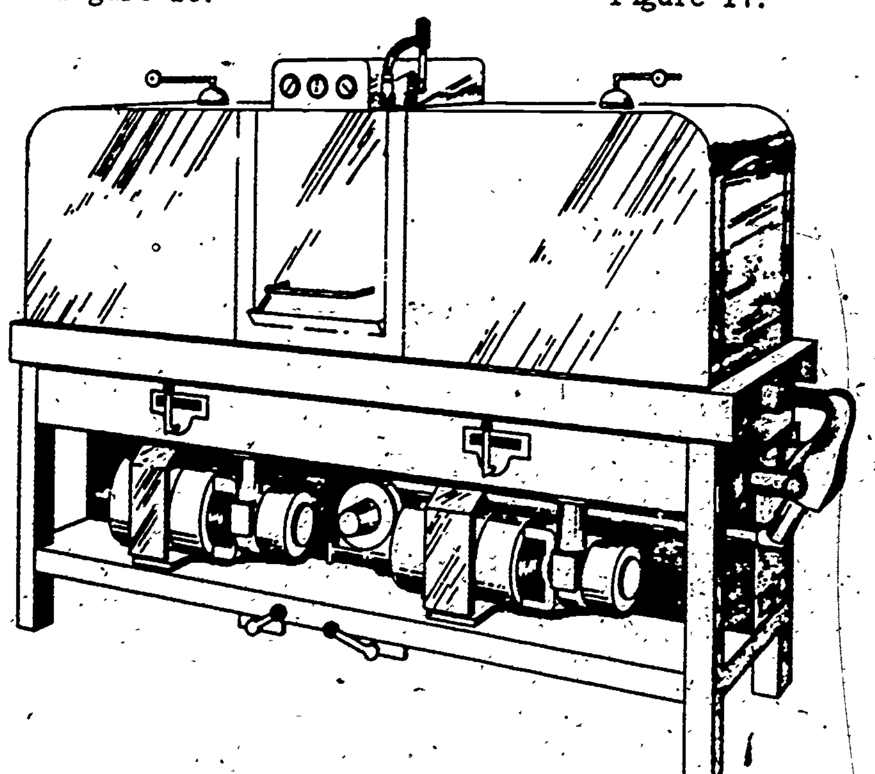
A ______________________

Figure 16.



B ______________________

Figure 17.



C ______________________

Figure 18.

Installation of a drinking fountain.

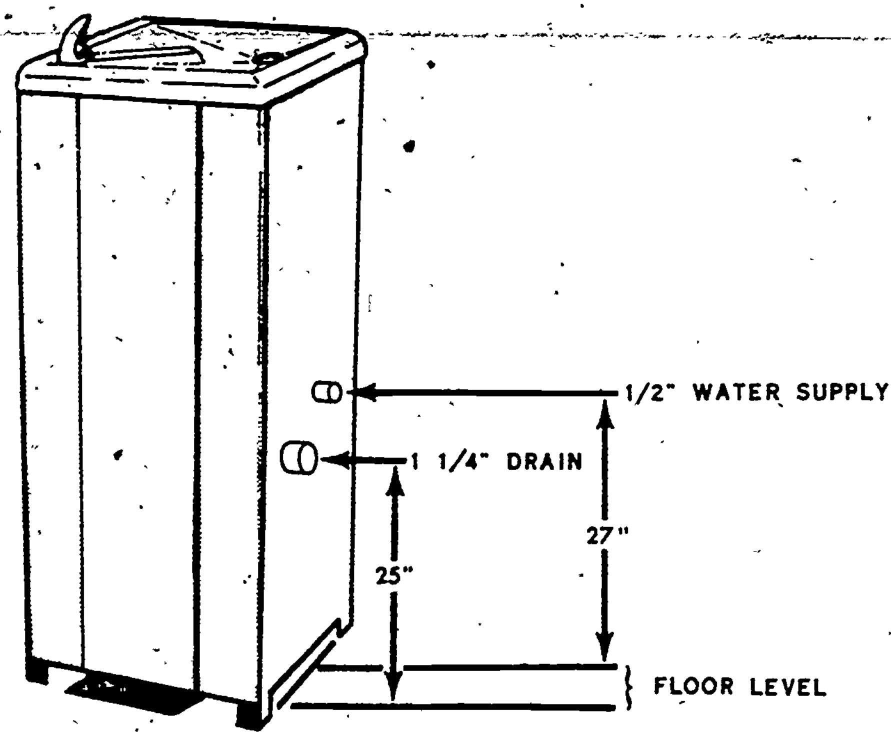


Figure 19. Drinking Fountain

1. Name the types of material that may be used to construct the drain line.

a. ____________________ e. ____________________

b. ____________________ f. ____________________

c. ____________________ g. ____________________

d. ____________________ h. ____________________

2. What type of fittings must be used if the drain line is constructed of threaded pipe?

____

3. Construct the drain line. NOTE: You may use any of the material listed in step 1.

4. Name the types of materials that may be used for the supply water line.

   a. ______________________

   b. ______________________

   c. ______________________

5. Name the type of joints that may be used in the supply water line.

   a. ____________ f. ____________

   b. ____________ g. ____________

   c. ____________ h. ____________

   d. ____________ i. ____________

   e. ____________ j. ____________

6. What specific precaution should the plumber take to prevent contamination of the drinking water? ______________________

   ____

7. Draw the symbols used for drinking fountains.

8. Construct the water supply line. NOTE: You may use any of the materials listed in step 5.

9. Operate the unit and check for satisfactory operation.

CLEANING AND MAINTAINING TOOLS AND EQUIPMENT

OBJECTIVE

The workbook will aid you in learning to care for tools and equipment.

Standard of Performance:

All tools and equipment must be cleaned, oiled if necessary and stored correctly.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-V-6	1/student
WB 3ABR55235-V-6-P1	1/student
Plumber's Tool Kit	1/2 students
Shop Tools	1/2 students
TO 32-1-101	1/class

PROCEDURE

1. Clean the dirt from all tools and equipment.
2. Apply a thin coat of oil to the metal parts of all tools.
3. Place all tools and equipment in their proper storage areas.
4. Stack the pipe on the rack neatly.
5. Check the oil level in the threading machine. Refill if necessary.
6. Clean the work area.

CORROSION PREVENTION

OBJECTIVE

Upon completion of this workbook, you will be able to:

1. Inspect a plumbing piping system for evidence of corrosion and list the types of all the corrosion found.
2. Name two types of protective coatings or wrappings that are used to prevent pipe corrosion.
3. Identify and explain the principles and operation of two cathodic protection devices.

Standard of Performance:

All questions must be answered and all answers must be correct.

EQUIPMENT

	Basis of Issue
SG 3ABR55235-V-7	1/student
WB 3ABR55235-V-7-P1	1/student
Plumbers Tool Kit	1/2 students
Examples of Corrosion	1/class

PROCEDURES

Mission 1

1. The ____________ theory is the most generally accepted as an explanation of corrosion.
2. A galvanic cell can be produced by placing two dissimilar metals in a suitable ____________.
3. Corrosion may be divided into such types as ____________, ____________, and ____________.
4. Uniform corrosion is due to direct ____________ attack.
5. Localized corrosion is caused by the electrolytic action of a ____________.

Mission 2

1. Cement coatings are mixed in a ratio of __________ to __________.
2. Coal tar paints are recommended for use on flood control structures, sewage disposal plants, industrial concrete pipelines, __________, and __________ __________.
3. __________ __________ coatings are commonly used on pipelines.

Mission 3

1. When the current is stopped, the corrosive action stops and the __________ disappears.
2. Galvanic cathodic protection is a means to reduce or prevent the corrosion of a metal surface by the use of __________ anodes or __________ __________ methods.
3. The impressed current method of cathodic protection is designed to protect large __________ __________ located in corrosive areas.
4. The basic principle of the impressed current method is merely the application of the __________ __________ reaction.
5. The operation of the impressed current system depends on the __________ which forces direct current from the anode through the electrolyte to the metal structure to be protected.

Mission 4

1. Procure a set of corroded plumbing pipe and fittings.
2. Identify the type of corrosion on each example. NOTE: Some examples may have more than one type of corrosion.

Example 1 ______________________________

Example 2 ______________________________

Example 3 ______________________________

Example 4 ______________________________

Example 5 ______________________________

MODIFICATIONS

Pages 47-53 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.