SECTION 23 23 00

REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping.

B. Refrigerant.

C. Moisture and liquid indicators.

D. Valves.

E. Strainers.

F. Check valves.

G. Pressure relief valves.

H. Filter-driers.

I. Solenoid valves.

J. Expansion valves.

K. Receivers.

L. Flexible connections.

1.02 RELATED REQUIREMENTS

A. Section 08 31 00 - Access Doors and Panels.

B. Section 09 90 00 - Painting and Coating.

C. Section 22 07 19 - Plumbing Piping Insulation.

D. Section 22 07 16 - Plumbing Equipment Insulation.

E. Section 23 54 00 - Furnaces.

F. Section 23 61 00 - Refrigerant Compressors.

G. Section 23 62 13 - Packaged Air-Cooled Refrigerant Compressor and Condenser Units.

H. Section 23 63 13 - Air Cooled Refrigerant Condensers.

I. Section 23 81 24 - Computer Room Air Conditioners - Floor Mounted.

J. Section 23 82 16 - Air Coils.

K. Section 23 09 93 - Sequence of Operations for HVAC Controls.

L. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers; Air-Conditioning, Heating, and Refrigeration Institute.

B. AHRI 710 - Performance Rating of Liquid-Line Driers; Air-Conditioning, Heating, and Refrigeration Institute.

C. AHRI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter Driers; Air-Conditioning, Heating, and Refrigeration Institute.

D. AHRI 750 - Standard for Thermostatic Refrigerant Expansion Valves; Air-Conditioning, Heating, and Refrigeration Institute.

E. AHRI 760 - Standard for Performance Rating of Solenoid Valves for Use With Volatile Refrigerants; Air-Conditioning, Heating, and Refrigeration Institute.

F. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ANSI/ASHRAE Std 15).

G. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc..

H. ASME (BPV VIII, 1) - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers.

I. ASME (BPV IX) - Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications; The American Society of Mechanical Engineers.

J. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers.

K. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes; The American Society of Mechanical Engineers.

L. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers.

M. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers (ANSI/ASME B31.9).

N. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

O. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

P. ASTM B88 - Standard Specification for Seamless Copper Water Tube.

Q. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).

R. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.

S. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.

T. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society.

U. AWS D1.1/D1.1M - Structural Welding Code - Steel.

V. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..

W. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..

X. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..

Y. UL 429 - Electrically Operated Valves; Underwriters Laboratories Inc..

1.04 SYSTEM DESCRIPTION

A. Where more than one piping system material is specified ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

B. Provide pipe hangers and supports in accordance with MSS SP-69 unless indicated otherwise.

C. Liquid Indicators:
   1. Use line size liquid indicators in main liquid line leaving condenser.
   2. If receiver is provided, install in liquid line leaving receiver.
   3. Use line size on leaving side of liquid solenoid valves.

D. Valves:
   1. Use service valves on suction and discharge of compressors.
   2. Use gage taps at compressor inlet and outlet.
   3. Use gage taps at hot gas bypass regulators, inlet and outlet.
   4. Use check valves on compressor discharge.
   5. Use check valves on condenser liquid lines on multiple condenser systems.

E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.

F. Strainers:
   1. Use line size strainer upstream of each automatic valve.
   2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
   3. On steel piping systems, use strainer in suction line.
   4. Use shut-off valve on each side of strainer.

G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.

H. Filter-Driers:
   1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
   2. Use a filter-drier on suction line just ahead of compressor.
   3. Use sealed filter-driers in lines smaller than 1/2 inch outside diameter.
   4. Use sealed filter-driers in low temperature systems.
   5. Use sealed filter-driers in systems utilizing hermetic compressors.
   6. Use replaceable core filter-driers in lines of 1/2 inch outside diameter or greater.
   7. Use replaceable core liquid-line filter-driers in systems utilizing receivers.
   8. Use filter-driers for each solenoid valve.

I. Solenoid Valves:
   1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
   2. Use in liquid line of single or multiple evaporator systems.

3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.

J. Receivers:
1. Use on systems five tons and larger, sized to accommodate pump down charge.
2. Use on systems with long piping runs.

K. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.05 SUBMITTALS

A. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.

B. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

C. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

D. Test Reports: Indicate results of leak test, acid test.

E. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.

F. Submit welders certification of compliance with ASME (BPV IX) or AWS D1.1.

G. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.

H. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.

B. Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work.

C. Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in DE.

1.07 REGULATORY REQUIREMENTS

A. Conform to ASME B31.9 for installation of piping system.

B. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.

C. Welders Certification: In accordance with ASME (BPV IX) or AWS D1.1.

D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties in shipping containers with labeling in place.

B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.

C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.09 MAINTENANCE PRODUCTS

A. See Section 01 60 00 - Product Requirements, for additional provisions.

B. Provide two refrigeration oil test kits each containing everything required to conduct one test.

C. Provide two filter-dryer cartridges of each type.

PART 2 PRODUCTS

2.01 PIPING

A. Copper Tube: ASTM B280, H58 hard drawn.
   1. Fittings: ASME B16.22 wrought copper.
   2. Joints: Braze, AWS A5.8 BCuP silver/phosphorus/copper alloy.

B. Copper Tube to 7/8 inch OD: ASTM B88 (ASTM B88M), Type K (A), annealed.
   1. Fittings: ASME B16.26 cast copper.
   2. Joints: Flared.

C. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
   1. Fittings: ASTM A234/A234M, wrought steel welding type.
   2. Joints: Welded in accordance with AWS D1.1.

D. Steel Pipe Sizes 12 Inch and Over: ASTM A53/A53M, 0.375 inch wall, black.
   1. Fittings: ASTM A234/A234M, wrought steel welding type.
   2. Joints: Welded in accordance with AWS D1.1.

E. Pipe Supports and Anchors:
   1. Conform to ASTM F 708, MSS SP-58, MSS SP-69, and MSS SP-89.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
   7. Vertical Support: Steel riser clamp.
   8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
   9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
   10. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
   11. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.02 REFRIGERANT

A. Refrigerant: See Schedules

2.03 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:

1. Henry Technologies: www.henrytech.com.
2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com.
3. Sporlan Valve Company: www.sporlan.com.

B. Indicators: Single or Doubleport type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.04 VALVES

A. Manufacturers:
1. Hansen Technologies Corporation: www.hantech.com.
2. Henry Technologies: www.henrytech.com.
3. Danfoss Flomatic: www.flomatic.com.

B. Diaphragm Packless Valves:
1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

C. Packed Angle Valves:
1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

D. Ball Valves:
1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

E. Service Valves:
1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.05 STRAINERS

A. Straight Line or Angle Line Type:
1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

B. Straight Line, Non-Cleanable Type:
1. Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of 500 psi.

2.06 CHECK VALVES

A. Manufacturers:
1. Hansen Technologies Corporation: www.hantech.com.
2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com.
3. Sporlan Valve Company: www.sporlan.com.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Globe Type:
1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for

maximum temperature of 300 degrees F and maximum working pressure of 500 psi.

C. Straight Through Type:
   1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.07 PRESSURE REGULATORS

A. Manufacturers:
   1. Hansen Technologies Corporation: www.hantech.com.
   2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com.
   3. Sporlan Valve Company: www.sporlan.com.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi range, for maximum working pressure of 450 psi.

2.08 PRESSURE RELIEF VALVES

A. Manufacturers:
   1. Hansen Technologies Corporation: www.hantech.com.
   2. Henry Technologies: www.henrytech.com.
   3. Sherwood Valve/Harsco Corporation: www.sherwoodvalve.com.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 425 psi, adjusted to meet system requirements.

2.09 FILTER-DRIERS

A. Manufacturers:
   1. Flow Controls Division of Emerson Electric: www.emersonflowcontrols.com.
   2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com.
   3. Sporlan Valve Company: www.sporlan.com.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Performance:
   1. Flow Capacity - Liquid Line: As indicated in schedule, minimum, rated in accordance with AHRI 710.
   2. Flow Capacity - Suction Line: As indicated in schedule, minimum, rated in accordance with AHRI 730.
   3. Water Capacity: As indicated in schedule, rated in accordance with AHRI 710.
   4. Pressure Drop: 2 psi, As indicated in schedule, maximum, when operating at full connected evaporator capacity.
   5. Design Working Pressure: As indicated in schedule or 350 psi, minimum.

C. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns; of construction that will not pass into refrigerant lines.

D. Construction: UL listed.
   1. Replaceable Core Type: Steel shell with removable cap.
   2. Sealed Type: Copper shell.
   3. Connections: As specified for applicable pipe type.

2.10 SOLENOID VALVES

A. Manufacturers:
   1. Flow Controls Division of Emerson Electric: www.emersonflowcontrols.com.
   2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com.
   3. Sporlan Valve Company: www.sporlan.com.

B. Valve: AHRI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi.

C. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

D. Electrical Characteristics: per drawings.

2.11 EXPANSION VALVES

A. Manufacturers:
   1. Flow Controls Division of Emerson Electric: www.emersonflowcontrols.com.
   2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com.
   3. Sporlan Valve Company: www.sporlan.com.

B. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, mechanical pressure limit (maximum operating pressure MOP feature), adjustable superheat setting, replaceable inlet strainer, with replaceable capillary tube and remote sensing bulb and remote bulb well.

C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.12 ELECTRONIC EXPANSION VALVES

A. Manufacturers:
   1. Danfoss Automatic Controls: www.danfoss.com.
   2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com.
   3. Sporlan Valve Company: www.sporlan.com.

B. Valve:
   1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
   2. Capacity: per drawings.
   3. Electrical Characteristics: per drawings.

C. Evaporation Control System:
   1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.
   2. Electrical Characteristics: per drawings.

D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.13 RECEIVERS

A. Manufacturers:
   1. Henry Technologies: www.henrytech.com.
   2. Parker Hannifin/Refrigeration and Air Conditioning: www.parker.com.
   3. Sherwood Valve/Harsco Corporation: www.sherwoodvalve.com.

B. Internal Diameter 6 inch and Smaller:
   1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

C. Internal Diameter Over 6 inch:
   1. AHRI 495, welded steel, tested and stamped in accordance with ASME (BPV VIII, 1); 400 psi with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

2.14 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Circuit Hydraulics, Ltd: www.circuit-hydraulics.co.uk.
   2. Flexicraft Industries: www.flexicraft.com.
   3. Penflex: www.penflex.com.

B. Corrugated stainless steel or bronze hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and avoid interference with use of space.

D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of or recessed into

and grouted flush with slab.

G. Pipe Hangers and Supports:
   1. Install in accordance with ASTM F 708 and MSS SP-89.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Provide copper plated hangers and supports for copper piping.

H. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

I. Provide clearance for installation of insulation and access to valves and fittings.

J. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 31 00.

K. Flood piping system with nitrogen when brazing.

L. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.

M. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 90 00.

N. Insulate piping and equipment; refer to Section 22 07 19 and Section 22 07 16.

O. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

P. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

Q. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

R. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

S. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

T. Fully charge completed system with refrigerant after testing.

U. Provide electrical connection to solenoid valves. Refer to Section 26 27 17.

3.03 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using electronic leak detector. Test to no leakage.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
   1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 3/8 inch.

2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 3/8 inch.
3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. 3-1/8 inch OD: Maximum span, 10 feet; minimum rod size, 3/8 inch.
8. 3-5/8 inch OD: Maximum span, 11 feet; minimum rod size, 1/2 inch.
9. 4-1/8 inch OD: Maximum span, 12 feet; minimum rod size, 1/2 inch.

B. Hanger Spacing for Steel Piping.
1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 3/8 inch.
2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 inches: Maximum span, 12 feet; minimum rod size, 1/2 inch.

END OF SECTION