

CONSTRUCTION STANDARD SPECIFICATION

SECTION 15215

COMPRESSED GAS PIPING - INTERIOR

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CONSTRUCTION STANDARD SPECIFICATION

SECTION 15215

COMPRESSED GAS PIPING - INTERIOR

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Materials and installation required for the installation of interior, low-pressure (below 150-psig) compressed gas piping systems, including argon, helium, nitrogen, oxygen, hydrogen, chlorine, acetylene, and methane piping, fittings, valves, equipment, joints, and tests.
- B. Related Sections: Refer to the following sections for related work:
 - 1. Section 01330, "Submittal Procedures" for administrative requirements for preparing and submitting information on material equipment and methods.
 - 2. Section 07270, "Firestop and Smoke Stop Systems" for sealing of mechanical penetrations through rated walls.
 - 3. Section 09900, "Painting" for painting of mechanical equipment and systems.
 - 4. Section 15050, "Basic Mechanical Materials and Methods."

1.02 REFERENCES

- A. American National Standards Institute (ANSI)
 - B31.1 Power Piping
 - B2.1 Standard Welding Procedure Specification (WPS) Gas Metal Arc Welding of Austenitic Stainless Steel (M-8 or P-8), 10 through 18 Gage, in the As-Welded Condition, With or Without Backing
 - B1.2 Hose Coupling Screw Threads
 - B16.11 Forged Fittings, Socket-Welding and Threaded
 - B16.22 Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

- B31.3 Code for Pressure Piping, Chemical Plant and Petroleum
- B1.1 Unified Inch Screw Threads
- B. American Society of Mechanical Engineers (ASME)
 - Section IX Boiler and Pressure Vessel Code; Welding and Brazing Qualifications
- C. American Society of Testing and Materials (ASTM)
 - A53 Standard Specification for Pipe Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless
 - A269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
 - A334M Standard Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
 - A420M Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service
 - A632 Seamless and Welded Austenitic Stainless Steel Tubing (Small Diameter) for General Service
 - B88 Standard Specification for Seamless Copper Water Tube for Air Conditioning
 - A307 Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
 - B16.18 Cast Copper Alloy Solder Joint Pressure Fittings
 - B819 Standard Specification for Seamless Copper Tube for Medical Gas Systems
- D. American Welding Society (AWS)
 - A5.8 Specification for Filler Metals for Brazing
Brazing Manual, 3rd Edition, 1976
 - B2.2 Standard for Brazing Procedure and Performance Qualifications
- E. Compressed Gas Association
 - G-4.1 Pamphlet - Cleaning Equipment For Oxygen Service

- F. National Fire Protection Association (NFPA)
 - 50 Standard for Bulk Oxygen Systems
 - 50A Gaseous Hydrogen Systems
 - 50B Liquefied Hydrogen Systems
 - 99 Health Care Facilities

1.03 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract documents and Section 01330, "Submittal Procedures."
- B. Product Data: Submit product data for products used in Interior Compressed Gas Piping. Product data shall indicate the maximum allowable operating pressure and temperature of each component and any related manufacturing standard.
- C. As-Built Drawings
 - 1. Upon completion of the work, the Contractor shall revise all drawings to agree with the construction materials, capacities, locations, and routing as actually accomplished. The notation "As-Built" shall be entered in the revision block, dated and initialed.

1.04 QUALITY ASSURANCE

- A. Qualify welding/brazing processes and welder/brazer performance in accordance with AWS B2.2 or ASME Boiler and Pressure Vessel Code, Section IX. Certify that each welder/brazer has satisfactorily passed AWS or ASME qualification tests for welding/brazing processes involved and, if pertinent, has undergone re-certification.
- B. Welding and brazing procedures shall address cleaning, joint clearance, overlaps, internal purge gas, purge gas flow rate, and filler metal.
- C. Certification of procedures and operators applies for both shop and job site welding and brazing of pipe work.
- D. Soldering is to conform to ANSI/ASME B31.1, Power Piping.
- E. Operators shall have completed the Sandia National Laboratories Welding Safety Class.
- F. Performance qualification of welders/brazers shall remain in effect indefinitely unless the welder/brazer does not weld or braze with the qualified procedure for a period exceeding 12 months, or there is a specific reason to question the ability of the welder/brazer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the job site in good condition and properly protected against damage to finished surfaces.
- B. Storage on Site: Store materials in a location and in a manner to avoid damage. Stacking shall be done in a way that will prevent bending.
 - 1. Store metal components and materials in a clean, dry location. Cover with waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the cover.
- C. Keep handling on-site to a minimum. Exercise care to avoid damage to finishes of material.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General: Materials shall be as follows unless otherwise indicated on the applicable Contract drawings. Valves of equal quality and characteristics may be substituted for those listed in this specification.
- B. Piping, fittings, valves, and other components that are required to be “Cleaned and Capped/Packaged for Oxygen Service” shall be per CGA Pamphlet G-4.1.
- C. Pipe and fittings to be used for modifications or additions shall be the same material (steel or copper) as the existing systems being modified but shall conform to the following unless otherwise indicated on the applicable Contract drawings.
 - 1. Argon, Helium, and Nitrogen Systems (150-psig and under):
½-inch Diameter and Larger:
 - a. Piping: Cleaned for oxygen service, Type L, hard drawn copper tubing, ASTM B88 or ASTM B819, and conforming to ANSI/ASME B31.3. Steel piping for modifications to existing systems, schedule 40 black steel, seamless or welded, ASTM A53.
 - b. Fittings: Wrought copper brazed-joint, ANSI/ASME B16.22. Cast copper fittings in sizes over 3-inch diameter (where wrought copper is not available), ASTM B16.18. All fittings shall be cleaned and packaged for oxygen service. Steel fittings for modifications to existing systems, 2000-pound forged steel socket weld, ANSI B16.11.
 - c. Ball Valves: Worcester No. 416T, brass body, stainless steel ball and stem, Teflon seat, cleaned and packaged for oxygen service, 250-psig maximum working pressure.

Less than ½-inch Diameter:

- a. Piping: Seamless, Type 304 stainless steel, ASTM A269, fully annealed with a hardness of Rb 80 or less, cleaned and capped. Minimum tube wall thickness shall be 1/8-inch O.D. – 0.028-inch w.t., ¼-inch O.D. – 0.028-inch w.t., 3/8-inch O.D. – 0.035-inch w.t.
 - b. Fittings: Stainless steel compression-type tube fittings, Swagelok. Compression tube fittings from different manufactures shall not be used.
 - c. Ball Valves: Whitey 40 Series, 316 stainless steel.
2. Oxygen Systems (50-psig and under): NOTE: Oil and oxygen may combine with explosive violence.
- a. Piping: Type L hard drawn copper tubing, ASTM B88; or for existing steel systems only, Schedule 40 black steel, seamless, ASTM A53, and conforming to ASME B31.3. Comply with NFPA 50.
 - b. Fittings: Wrought copper and bronze brazed-joint, ANSI/ASME B16.22; or for existing systems only, 2000-pound forged steel socket weld, ANSI/ASME B16.11 (cast iron not permitted).
 - c. Ball Valves: Worcester No. X416T, brass body, stainless steel ball and stem, Teflon seat, cleaned and packaged for oxygen service, 250-psig maximum working pressure.
3. Hydrogen Systems (50-psig and under):
- a. Piping: Schedule 40 seamless pipe, 316L stainless steel per ASTM A312. Comply with NFPA 50A and 50B.
 - b. Fittings: 3,000-pound forged 316L stainless steel, socket welded per ANSI B16.11.
 - c. Ball Valves: Worcester No. 466TM 316L stainless steel body, stainless steel ball and stem, socket weld ends, Teflon seat, forged schedule 80 carbon steel socket weld ends, 250-psig maximum working pressure.
 - d. Globe Valves: Crane No. 222 H, bar stock, steel, 3000 psig.
4. Chlorine Systems (50-psig and under):
- a. Piping: Schedule 80 black steel, seamless Grades A or B, ASTM A53.
 - b. Fittings: 2000-pound forged steel socket weld, ANSI/ASME B16.11.
 - c. Needle Valves: Matheson No. 104, screwed, monel construction, 3000 psig.
5. Acetylene Systems (15-psig and under): NOTE: Contact between acetylene and unalloyed copper should be avoided, since the explosive compound, copper acetylide, might be formed.

- a. Piping: Schedule 40 black steel, seamless Grades A or B, ASTM A53.
 - b. Fittings: 2000-pound forged steel socket weld, ANSI/ASME B16.11 (cast iron not permitted).
 - c. Valves: Crane No. 1652 (Underwriters' Approved) 15-psig rating, 180 degrees F maximum.
6. Methane Systems (50-psig and under):
- a. Piping: Schedule 40 black steel, seamless Grades A or B, ASTM A53.
 - b. Fittings: 2000-pound forged steel socket weld, ANSI/ASME B16.11.
 - c. Ball Valves: Worcester No. 446T, carbon steel body, stainless steel ball and stem, Teflon seat, forged schedule 80 carbon steel socket weld ends, 250 psig, maximum working pressure.

2.02 EQUIPMENT

- A. All major items of equipment required for installation on this Contract shall be as specified on the applicable Contract drawings and shall be furnished complete with all accessories normally supplied with the catalog item listed and all other accessories necessary for a complete and satisfactory operating system.
- B. Relief Valves: Shall be ASME constructed and stamped. Size, capacity, and setting shall be as indicated on the drawings. Discharge from relief valves shall be piped full size and extended to the outside where required by code, standard, or drawings.
- C. Identification and Labels: All piping systems shall be labeled and identified in accordance with Section 15050, "Basic Mechanical Materials and Methods."
- D. Gages: Gages shall be safety-type with rear blowout plug or panel, clear plastic cover, and sides and front consisting of one integral part. Range shall be at least 1.2 times the system relief pressure. Gages shall be installed with snubbers and 1/4-inch bronze needle valves. All gages shall be rated for the specific gas, pressure rating, and ambient conditions.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Materials for copper and stainless steel piping systems that are required to be "cleaned for oxygen service", including pipe, valves, fittings, and components, shall be cleaned and prepared in a facility equipped to clean, rinse, and purge the material in accordance with CGA Pamphlet G-4.1, "Cleaning Equipment for Oxygen Service," and shall be delivered to the job site capped, bagged, or plugged as necessary to protect materials from contamination.
- B. On-site cleaning of the interior surfaces of materials in copper and stainless piping systems shall be limited to recleaning surfaces in the immediate vicinity of the joints that have become contaminated prior to brazing or welding.

1. Surfaces shall be cleaned by washing in a clean, hot water/alkaline solution of 1 lb. tri-sodium phosphate to 3 gallons of water (protective gloves required). Scrubbing shall be employed as required to assure removal of dirt, metal filings, oil, and grease. After washing, materials shall be rinsed in clear, hot water. Dry using Argon purge to <10 ppb moisture level. After drying, materials shall be plugged or capped until assembly.
- C. Black steel lines, before assembly, shall be hammered to loosen scale and wire brushed inside as required. Following scale removal pipe shall be cleaned and stored as described for copper until assembly.

3.02 INSTALLATION – GENERAL

- A. General: Piping installation shall be coordinated with all trades with respect to space available with heating, ventilating, and electrical installation. In every instance where there is a conflict in the routing of the piping and the ducting, the routing of the ducting shall govern. Installed piping shall not interfere with the operation or accessibility of doors or windows; shall not encroach on aisles, passageways, or equipment; and shall not interfere with the servicing or maintenance of equipment.
1. Pipe shall be cut accurately to measurements established at the construction site and shall be worked into place without springing or forcing, properly clearing all openings and equipment.
 2. Cutting or weakening of structural members to facilitate piping installation is not permitted.
 3. Pipes shall have burrs removed by reaming and shall be so installed as to permit free expansion and contraction without damage to joints or hangers.
 4. Piping above ground shall be run parallel with the lines of the building unless otherwise noted on the drawings. Piping connections to equipment shall be in accordance with details shown on the drawings. Service pipe, valves, and fittings shall be kept a sufficient distance from other work to permit finished covering not less than ½ inch from such other work, and not less than ½ inch between finished covering on the different services.
 5. Any penetrations through fire walls should be firestopped in accordance with Section 07270, “Fire Stop and Smoke Stop Systems.”
- B. Reducers: Reduction in pipe sizes shall be made with one-piece reducing fittings. Bushings reducing at least two pipe sizes will be acceptable only when there is no room for reducing couplings or swaged nipples.
- C. Unions: All piping unions shall be of the ground joint type constructed from materials equivalent in alloy composition and strength to other fittings specified with which they are used. Union pressure classes and end connections shall be the same as the fitting used in the lines with the unions. Steel unions shall have hardened stainless steel seating surfaces on both faces.

- D. Valves: Valves shall be installed at the locations shown on the drawings and where specified. All valves shall be installed with their stems horizontal or above.

3.03 HANGERS AND ANCHORS

- A. All piping shall be rigidly supported from the building structure by means of adjustable ring-type hangers. (WELDING TO BUILDING STRUCTURE WILL NOT BE PERMITTED.) Where pipes run side by side, support on rod and angle iron or Unistrut trapeze hangers. Hanger spacing shall be as follows:

1. Horizontal:

<u>Steel Piping</u>	<u>Maximum Spacing</u>
½ inch and smaller	6 feet
¾ inch through 1 inch	8 feet
1¼ inch and larger	10 feet
<u>Copper Piping</u>	<u>Maximum Spacing</u>
½ inch	4 feet
¾ inch through 1 inch	6 feet
1¼ inch and larger	8 feet

2. Vertical: Steel and copper shall be supported at 10-foot intervals, maximum, or at every floor level, whichever is less.

3. Round rods supporting the pipe hangers shall be of the following dimensions:

3/8-inch to 2-inch pipe	3/8-inch rod
2½-inch to 3-inch pipe	½-inch rod
4-inch to 5-inch pipe	5/8-inch rod

4. Rods for trapeze hangers shall be a minimum of 3/8 inch and shall have the equivalent cross section, listed in 3.03 A.3, per pipe supported. The use of pipe hooks, perforated iron strapping or wire for pipe supports will not be permitted.
5. Hanger rods shall be galvanized carbon steel per ASTM A307, Grade B, threaded per ANSI B1.1 coarse thread series, Class 2A fit:
- a. Hanger rods shall have minimum 6-inch threaded ends.
 - b. All hanger rod connections shall use double nut fastening.
6. Hanger rods shall be installed vertically. No offset in hanger rod will be permitted.
7. Place a hanger within 1 foot of each horizontal elbow.

8. Use hangers that are vertically adjustable 1½-inch minimum after piping is erected.
9. Use copper straps on copper pipe and ferrous hangers on ferrous pipe. Steel to copper contact is not allowed.
10. Soft copper tubing, where permitted, shall be fastened to the building structure with Unistrut type clamps with cushion, spaced not more than 4 feet apart.
11. On 4-inch and larger piping, install hangers adjacent (within 1 foot on each side) to all horizontal elbows, strainers, check valves, valves, and all flanged items.

3.04 JOINTS

- A. **Screwed Joints:** Screwed pipe joints shall have American Standard Taper Pipe Threads ANSI/ASME B1.2. Burrs formed when cutting pipe shall be removed by reaming. Care shall be taken that the inside of the pipe is thoroughly clean and free of cutting oil and foreign matter before installation. Joints shall be made perfectly tight by the use of Teflon tape or approved Teflon thread sealing and lubricating compound.
- B. **Solder-Joints:** (Soldered joints may only be used in existing systems where soldered joints were used originally.) Tubing shall be cut square and burrs removed. Both inside of fittings and outside of tubing shall be well cleaned with sand cloth or wire brush before sweating. Care shall be taken to prevent annealing of fittings and hard drawn tubing when making connections. Joints for sweated fittings on low-pressure piping (150-psig and below) shall be made with a noncorrosive paste flux and solid wire solder composed of 95 percent tin and 5 percent antimony or similar solder of equal characteristics. Cored solder will not be permitted. Conform to AWS A5.8. Joints shall comply with ANSI/ASME B31.1 Power Piping.
 1. Solder containing antimony SHALL NOT be used to join metals containing zinc (e.g., galvanized iron, galvanized steel, and brass).
 2. Solder end valve: Use two-piece gate or globe valve or three-piece ball valve for solder end valves. When joining a gate or globe solder end valve, ensure valve is fully open. Apply heat to tube first. Transfer as much heat as possible through the tube to the valve. Avoid prolonged heating of valve. Use a non-corrosive paste flux and solid wire solder suitable for the service temperatures and pressures expected.
 3. Use sand cloth or a stainless steel wire brush to clean surfaces to be joined. Steel wool IS NOT permitted.
- C. **Brazed Joints:** New copper systems shall be installed per CGA Pamphlet G-4.1, "Cleaning Equipment For Oxygen Service," with brazed socket type fittings and with an argon or nitrogen purge applied. Flux shall not be used except where joining specialty items and fittings that are not available in copper. Brazing filler metals shall comply with ANSI/AWA A5.8, "Specification for Filler Metals for Brazing." Copper-to-copper joints shall be brazed using a copper-phosphorus or

copper-phosphorous-silver brazing filler metal (BCuP) without flux. Dissimilar metals, such as copper and bronze or brass, shall be brazed using an appropriate flux with a silver (BAg series) brazing filler metal.

1. Tube ends shall be cut square using a sharp tubing cutter. The wheel shall be free from grease, oil, or other lubricant not suitable for oxygen service. The cut end of the tubing shall be deburred with a sharp, clean deburring tool, taking care to prevent chips from entering the tube or pipe.
2. The surfaces to be brazed shall be mechanically cleaned with a stainless steel wire brush. The use of steel wool is prohibited due to the possible presence of oil. After mechanical cleaning the surfaces shall be wiped using a clean, lint-free white cloth. Joints shall be re-cleaned if contaminated prior to brazing. Joints shall be brazed within 1 hour of being cleaned.
3. Where dissimilar metals, such as copper and bronze or brass, are being brazed, flux shall be applied sparingly to minimize contamination of the inside of the tube with flux. Where possible, short sections of copper tube shall be brazed to the noncopper components and the interior of the subassembly shall be cleaned of the flux prior to installation in the piping system. Flux-coated brazing rods may be used in lieu of the application of flux to the surfaces to be joined for tubes $\frac{3}{4}$ -inch size and smaller.
4. While being brazed, joints shall be continuously purged with oil-free dry nitrogen or argon to prevent the formation of copper oxide on the inside surface of the joint. The flow of the purge gas shall be maintained until the joint is cool to the touch.

Exception: A final connection to an existing system shall be permitted to be made without the use of a purge gas.

5. During and after installation, openings in the piping system shall be kept capped or plugged to avoid unnecessary loss of purge gas and to prevent contamination. While brazing, a discharge opening shall be provided on the opposite side of the joint from where the purge gas is introduced. During brazing, the purge gas flow rate shall be maintained at a level that will not produce a positive pressure in the piping system. While welding, the minimum purge rate shall be 15 scfh for $\frac{1}{4}$ -inch tubing, and 25 scfh for all tubing $\frac{3}{8}$ inch and larger.
 6. After brazing, the outside of all joints shall be cleaned by washing with water and a stainless steel brush to remove any residue and permit clear visual inspection of the joint. Where flux has been permitted, hot water shall be used.
- D. Swagelok Compression Fittings: Follow the manufacturer's installation instructions for assembly tubing and tube fittings. Use a sharp clean tube cutter wheel to cut tubing. Remove burrs, chips, and scratches from the end of the tubing. **Ensure that the tubing is fully bottomed in the fitting before final tightening.** After

assembly, check that the fitting is properly tightened by using a Gap Inspection Gage.

- E. Welded Joints: Joints between sections of pipe and between pipe and fittings may be welded using either gas or electric welding equipment. Stainless steel welding shall conform to ANSI/AWS B2.1.005. All pipe surfaces shall be thoroughly cleaned before welding. Each joint, except socket-weld joints, shall be beveled before being welded. The Contractor shall provide a non-flammable mat or blanket to protect the structure and adequate fire protection equipment at all locations where welding is done. All elbows shall be long radius where space conditions allow. Wherever tee connections are made to piping systems on the main run, welding sockets or weld-o-lets may be used in lieu of reducing outlet tees for branch connections up to one-half the size of the main run. On connections larger than one-half the size of the main run, welding tees shall be used. The use of fittings formed from welded pipe sections will not be permitted. All welding shall conform to the requirements of Section 15050, "Basic Mechanical Materials and Methods."

Any welding work being done requires:

- a. A hot works permit from Firemark, Inc., located in MO119.
- b. A dedicated fire watch during work through thirty (30) minutes after operation.
- c. A minimum 2-A rated fire extinguisher located near the welding site.
- d. Any other requirements listed on the permit.

3.05 FIELD QUALITY CONTROL

- A. General: All piping, equipment, and accessories installed under this Contract shall be inspected and tested by the Contractor in the presence of the Inspector, and approved before acceptance. The Contractor shall furnish all labor, material, and equipment required for testing. The Contractor shall be responsible for all repairs and retesting as required. All instruments and other equipment whose safe pressure range is below that of the test pressure shall be removed from the line or blanked off before applying the tests.
- B. Brazed Joints: Each brazed joint shall be visually examined after cleaning of the outside of the joint. The following conditions shall be considered unacceptable:
1. Flux or flux residue
 2. Excessive oxidation of the joint
 3. Presence of un-melted filler metal
 4. Failure of the filler metal to be clearly visible all the way around the joint at the interface between the socket and the tube
 5. Cracks in the tube or component

- 6. Cracks in the braze filler metal
- 7. Failure of the joint to hold test pressure

Brazed joints that are found to be defective under conditions 1, 3, 4, 6, and 7 shall be permitted to be repaired except that no joint shall be repaired more than once. Brazed joints that are defective under 2 and 5 shall be replaced.

- C. Blow Down and Purge Test: In order to remove particulate matter in the pipelines, a heavy, intermittent purging of each outlet shall be performed with oil-free nitrogen. The outlet shall be allowed to flow until the purge produces no discoloration in a white cloth.
- D. Pressure Tests: Compressed gas piping shall be tested at the test pressures specified and shall not exceed the following drop in pressure (temperature compensated) in a 24-hour period. All system leaks shall be located by soap testing.

<u>Compressed Gas</u>	<u>Test Pressures</u>	<u>Test Gas</u>	<u>Max. Pressure Drop (24 hrs)</u>
Nitrogen Systems	225 psig	Nitrogen	5 psi
Argon Systems	225 psig	Nitrogen	5 psi
Helium Systems	225 psig	Nitrogen	5 psi
Oxygen Systems	150 psig	Nitrogen	5 psi
Hydrogen Systems	200 psig	Nitrogen	P.D. = Zero
Chlorine Systems	200 psig	Nitrogen	P.D. = Zero
Acetylene Systems	200 psig	Nitrogen	P.D. = Zero
Methane Systems	150 psig	Nitrogen	P.D. = Zero

- 1. The pressure test shall be conducted as follows:
 - a. Equipment that is not to be tested such as relief valves and gauges shall be removed and the openings plugged or capped.
 - b. The system shall be filled with the test gas to 25 psig and held while all joints are visually inspected for leaks.
 - c. The pressure shall be slowly increased to 150 psig and held while all joints are soap tested.
 - d. The system shall be increased to the test pressure and held for 24 hours and the pressure drop recorded for acceptance.
 - e. Pressure shall be relieved from the system and equipment that was removed shall be reinstalled. The system shall be pressurized to the operating pressure and joints at previously removed equipment shall be soap tested.
 - f. Leaks, if any, shall be located, repaired, and retested.

- g. For the test the contractor shall provide a calibrated 4-inch diameter pressure gauge of maximum 1% full scale accuracy, maximum 300 psig range and maximum 2 psig graduations. If the system is in an area where the temperature will fluctuate more than 10 degrees F over the test period, then the contractor shall also furnish an 8-inch temperature chart recorder or a combination temperature/pressure chart recorder.

END OF SECTION