

## **PART 1 - GENERAL**

### 1.01 SUMMARY

#### A. Section includes:

1. Piping and tubing work required in the fabrication of the Compressed Natural Gas Station. Work includes:
  - a. Supply, installation and connection of piping and tubing listed herein and as required to accomplish complete and functioning equipment consistent with Owner's requirements.
  - b. Piping and tubing work required in the shop fabrication of the CNG equipment.

#### B. Related Sections:

1. Section 18000 - All

### 1.02 REFERENCES

#### A. Applicable provisions of the following standards shall apply to the work of this Section, except as modified herein, and are hereby made a part of these Contract Specifications to the extent required:

1. ASME Section IX           Welding and Brazing Qualifications
2. ASME B31.3                Process Piping

### 1.03 QUALITY ASSURANCE

#### A. Manufacturer Qualifications: Per Section 18000, General, and the following:

1. Equipment manufacturers shall have at least five years of experience in manufacturing products and accessories similar to those specified for this Project, with a record of successful in-service performance.

#### B. Shop Personnel Qualifications:

1. Tube fitters shall provide a letter from the local Swagelok and/or Parker Seal-Lok representative (as applicable) certifying that they have been adequately trained in the proper make-up and inspection of Swagelok and/or Parker Seal-Lok products (as applicable).
2. Pressure welding shall be performed by certified welders per ASME Section IX to registered welding procedures.

- a. Certification and registration shall be by a National Board (N.B.) registered Agency.
  - b. Each welder shall permanently stamp their welds with the welder's identification number and the pipe spool weld identification number.
  3. Performance test cards shall be copied and submitted to Owner for documentation purposes and shown to the Consultant when requested.
  4. Welding and piping and tube fitting work on site, regardless of pressure, shall use persons possessing current journeyman qualifications in their trade.
- C. Regulatory Requirements: Per Section 18000, General and the following:
1. Notify Owner at least 14 days in advance of any factory pressure testing to allow them the opportunity to witness these tests.

#### 1.04 SUBMITTALS

- A. Submit the following:
1. Qualifications:
    - a. Procedure Qualification Records and Welding Procedure Specification for certified welders.
    - b. Performance test cards.
    - c. Tube fitters' qualification letters.
    - d. Piping subcontractor's qualifications as indicated.
  2. Deferred Submittals: See Section 18000, General.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the following:
1. Pipe and tubing shall be handled in a manner to prevent possible damage to walls or ends or scratching of the tube O.D. Pipe and tubing shall be unloaded by lifting at both ends of any one length to avoid bending and placing the section carefully upon a padded skid such that the entire length is uniformly supported to prevent bending or flexure.

## **PART 2 - PRODUCTS**

### 2.01 GENERAL SYSTEM DESCRIPTION AND PERFORMANCE REQUIREMENTS:

- A. Piping work specifically listed herein and shown or indicated on the Drawings. Work includes supply and installation of the following:
1. Piping and tubing work required in the fabrication of the CNG equipment.
  2. Gas isolation valves (manual and automated), flexible connectors and check valves used in the site installation and piping shall be supplied loose by the Contractor for installation by others and shall be standardized to the similar components used on the equipment.
  3. The following station inlet piping materials are to be shipped crated to site: (Valves shall be sized to be the greater of 4" or the size of the dryer inlet flange)
    - a. Two ANSI 150 rated, two or three piece fire rated (API 607) manually operated carbon steel ball valves with stainless steel trim. The valve shall be lockable in the open or closed position.
    - b. Spring return (normally closed) actuated, two or three piece fire rated (API 607) carbon steel ball valve with stainless steel trim and a remote, explosion proof solenoid on the inlet to the station. This valve shall be ANSI 150 rated. This valve shall open only when any CNG compressor is operating and closed when no compressor is running, or under ESD conditions.
    - c. Two ANSI 150 wafer style check valves.
    - d. One assembly with one service isolation valve, one 0 to 150 psig (or similar) pressure transducer and one 0 to 100 psig pressure gauge.
  4. The following flexible connectors are to be shipped crated to site:
    - a. Two 36-inch long, ANSI 150 rated, stainless steel flexible connectors for connection to the gas dryer. These flexible connectors shall be the same nominal diameter as the dryer inlet piping.
    - b. One 36-inch long, ANSI 150 rated, stainless steel flexible connector for connection to the compressor. These flexible connectors shall be the same nominal diameter of the compressor inlet piping.
  5. Minimum 2-inch Schedule 80 vent piping and required supports and bracketing from the safety relief valves (SRV) on the CNG Dryer and Compressors to a minimum of 15 feet above grade, or five feet higher than the tallest equipment (whichever is higher). Pipe unions shall be provided at each SRV to allow for easy removal and replacement of the SRV. The vent stack shall have a vertical discharge with rain cap (tack welded to the stack and weighted for closure) and be equipped with a drip pocket with a weep hole in

the bottom located approximately 24 inches above grade. The pipe rack shall be used to support these vent stacks.

6. Minimum 2-inch Schedule 80 vent piping and required supports and bracketing from the SRVs on each storage assembly to a minimum of 15 feet above grade, or 5 feet higher than the tallest equipment (whichever is higher). Pipe unions shall be provided at each SRV to allow for easy removal and replacement of the SRV. The vent stack shall have a vertical discharge with rain cap (tack welded to the stack and weighted for closure) and be equipped with a drip pocket with a weep hole in the bottom located approximately 24 inches above grade. A separate vent stack shall be provided for each Storage Assembly. The pipe rack shall be used to support these vent stacks.
7. Tubing and piping shall be installed as defined in the approved equipment supplier shop drawings, as indicated in the Specifications and approved drawings. Tubing shall be installed with expansion offsets and “U” bends as required to allow for expansion/contraction and vibration. All tubing and piping shall be laid out/configured and connected in a manner that allows each section to be removed without disassembly of adjacent piping, tubing or equipment.
8. Compressor interstage piping shall utilize flanged connections to the compressor, bottles and cooler, Compressor interstage tubing shall use flanged or face seal fittings to the compressor, bottles and cooler. Compression fittings are not to be used interstage.
9. Pilot Gas Tubing:
  - a. Shall be subject to the same material and fabrication requirements of all other gas tubing.
  - b. All pilot solenoids shall be vented to a vent stack.
10. Signs and labels as specified in the Drawings, Codes and OSHA, including any additional signs required by code but not indicated on the drawings.

## 2.02 MANUFACTURERS AND PRODUCTS

### A. Gas Instrumentation Tube Fittings:

1. Description/Requirements:
  - a. Tube fittings shall be 316 Stainless Steel (SS).
  - b. Compression fittings on the site shall be identical make and series. O-ring face seal fittings used on the site shall be identical make and series.
  - c. Compression fittings shall be dual ferrule design. Both ferrules shall be machined (not stamped) and the rear ferrule is to be hinging design.

2. Manufacturers: Swagelok, or approved equal for compression fittings and Parker "Seal-Lok" or approved equal for face seal O-ring fittings.
  - a. Fittings shall be supported with manufacturing, engineering and parts storage in North America.
- B. Screwed Pipe Fittings: SA 105 forged carbon steel or 316 SS.
- C. Tapered Thread Sealant: A high quality anaerobic liquid Teflon thread sealant, or Teflon tape, that is approved for this application by the tube fitting manufacturer.
- D. Gauges:
  1. Description/Requirements: Stainless steel case and wetted parts. 4:1 safety factor at full scale. Glycerin filled with blow out plug.
  2. Manufacturers: Swagelok, Ashcroft, WIKA, or approved equal.
- E. Low Pressure (less than 500 psig) Ball Valves (including actuated ball valves):
  1. Description/Requirements: two-piece or three-piece, carbon steel ball valves with stainless steel trim. Valves larger than 1 inch must include flanged raised face ends.
  2. Manufacturers: Worchester, Watts, Habonim, SVF, or approved equal.
- F. High Pressure (greater than 500 psig) Ball Valves (including actuated ball valves):
  1. Description/Requirements: Stainless steel ball valves with stainless steel trim. Manual valves shall include locking kit.
    - a. Valves up to and including 3/4-inch: Approved for Alternative Fuel applications with a minimum  $C_v$  of 12 for 3/4 inch and  $C_v$  of 7 for 1/2 inch valves. Pressure rated to be minimum 5,800 psig. End connections shall be compression fittings of the same manufacturer (brand and series) as used in the station.
    - b. Valves greater than 3/4-inch: Bodies shall be three piece, six bolt design with a minimum pressure rating of 6000 psig and female SAE ends.
    - c. Check Valves on Compressor Interstage Drains and equipment located Downstream of the Compressor High Pressure Cylinder: 316 stainless steel poppet style with compression ends.  $C_v$  shall be minimum 2 on 1/2-inch valves and 6 on 3/4- and 1-inch valves.
  2. Manufacturers: Swagelok, Habonim, SVF, Hoke, or approved equal as indicated below:
    - a. Valves up to and including 3/4-inch: Swagelok "SS-AFS series."

- b. Valves greater than 3/4-inch: Habonim, SVF H7 series.
  - c. Check Valves: As recommended by equipment manufacturer.
- G. Drain Valves on Filters, Vessels and Throttling Valves:
- 1. Description/Requirements: Valves shall be “Gauge Style” bar stock stainless steel body and trim. Needle/plug shall be non-rotating. Seat shall be replaceable soft seat. Pressure rated to 6,000 psig minimum. Swagelok “Rising Plug” series SS-4PD with replaceable seats—or approved equal.
  - 2. Manufacturers: Swagelok, or approved equal.
- H. Safety Relief Valves (SRVs):
- 1. Description/Requirements: Carbon steel or stainless steel bodies with stainless steel trim and “UV” stamped N.B. rated.
  - 2. Manufacturers: Anderson Greenwood, Mercer, or approved equal.
- I. Pressure Transducers:
- 1. Description/Requirements: 316 SS for wetted parts and explosion proof or intrinsically safe. Transducer shall be rated for a minimum 10 percent higher range than the relief valve protecting the system.
  - 2. Manufacturers: Swagelok, Ashcroft, Wika, or approved equal.
    - a. Transducers shall be supported with engineering and parts storage in North America. .
- J. Mass Flow Meters:
- 1. Description/Requirements: Stainless steel case and wetted parts. Coriolis type with minimum pressure rating of 5,000 psig. Meter shall have type approval in the United States for retail sale of CNG.
  - 2. Manufacturers: Meter shall be supported with manufacturing, engineering and parts storage in North America.
  - 3. Products: Rosemount-Micromotion CNG 50, or approved equal.
- K. Bleed Valves Required for Service:
- 1. Description/Requirements: Stainless steel with minimum design equal to 6,000 psig for high pressure applications and 1.5 times the relief valve setting for station inlet and interstage pressure applications.
  - 2. Manufacturers and Products: Swagelok BV series, Hoke 6600 series, or approved equal.

L. Air Compressors: **Not in scope.**

1. Description/Requirements:

- a. Compressors shall be supported with manufacturer owned or approved representative located within 100 miles of the site. This support shall include 24 hour 7 day per week parts and technician support.

2. Manufacturers: Quincy QR Series or approved equal.

2.03 MATERIALS

- A. Valves, fittings, instrumentation and other mechanical components (except internal compressor components) that are not specifically called out in this Section, shall be non-proprietary, third party supplied.

B. Gas and Lubricating Oil Flow Piping and Tubing:

1. Components containing gas shall be carbon steel or stainless steel as indicated below. The vehicle filling hoses are considered to be the only exception to this rule.
2. Compressor and Dryer Carbon Steel Piping: ASME SA106B seamless pipe of appropriate diameter and schedule.
3. ASME SA179 carbon steel tubing of diameter and wall thickness as required by ASME B31.3 may be used in the compressor interstage piping only.
4. Tubing: ASME SA213 TP316 seamless, cold drawn stainless steel. This includes gauge lines, pressure transducer sensing lines and pilot pressure gas lines. TP316L and TP316N stainless steel tubing is not permitted. Surface hardness shall not exceed Rockwell B80. Diameters and wall thickness as follows:
  - a. 1 inch O.D. x 0.120 inch minimum wall – this can be verified using an ultrasound meter and checking tubing along the continuous length at 90 degree intervals around the perimeter.
  - b. 3/4 inch O.D. x 0.109 inch average wall
  - c. 1/2 inch O.D. x 0.065 inch average wall
  - d. 3/8 inch O.D. x 0.049 inch average wall
  - e. 1/4 inch O.D. x 0.035 inch average wall
5. Flared fittings shall not be permitted.
6. Zero clearance fittings or pipe “U-bends” shall be used where actuated ball valves, safety relief valves, check valves, and the like, need to be removed for

servicing. Zero clearance fittings must be verified to meet the design pressure of the system they are installed in.

7. Thread-o-lets, flanges, swaged nipples, plugs and bushings shall be ASME SA105. All butt weld pipe fittings including elbows, returns and reducers shall be ASME SA234 WPB. Socket weld fittings are not acceptable except on the Gas Dryer. Bolts and studs shall be ASME SA193 Grade B7. Nuts shall be ASME SA194 Grade 2H.
8. Socket weld fittings are not acceptable except on the CNG dryer skid equipment.
9. Pipe unions shall only be used on vent lines. Weld neck flanges are the approved method of connecting pipe spools to equipment—slip on flanges are not approved except on the CNG dryer. Raised Face (RF) flanges shall be used on ANSI Class 900# and lower flanges as well as on any ANSI Class 1500# and higher flanges requiring a flange isolation kit. Ring Type Joint (RTJ) flanges shall be used on ANSI Class 1500# and higher flanges not requiring a flange isolation kit.
10. Screwed pipe and fittings shall be used only where a transition to tubing is required, or for gas service two inches or smaller with pressures below 15 psig, or for vent lines. The use of stainless steel threaded fittings in combination with compression fittings shall be minimized. Seal welding of threaded fittings is prohibited.
11. Where threaded fittings are necessary on gas piping, the fittings shall be selected and arranged such that positioning of the fitting is flexible. The use of tees or elbows with compression ends and threaded ends on the same fitting is prohibited. In such a case, a union tee or elbow shall be used in conjunction with a male or female tube adapter.
  - a. Some female pipe thread fittings cannot be used downstream of the compressor as they are not rated to high enough pressures. In addition, safety relief valves must be installed so they can be removed and replaced without having to turn the SRV to loosen or tighten it. A flange, compression fitting or zero clearance fitting on the inlet and outlet, in compliance with the above shall be used. Pipe unions may also be used on the SRV vent piping only.
12. Tube fittings in the station shall all be of the same manufacturer and shall be of the same material as the tubing.

C. Gas Vent Lines:

1. Gas vent lines shall be of the same materials as specified for gas flow lines. Each line shall be Schedule 80 minimum and sized to match the outlet size or maximum flow capacity of the Safety Relief Valve (SRV) it serves, whichever is greater. Each vent stack shall be sized to match the total maximum flow capacity of the relief valves it serves. The compressor vent stack is to be a

minimum of the same size as the compressor suction piping (2-inch Schedule 80 minimum).

2. Air and gas safety relief valves shall be piped to discharge vertically a minimum of 5 feet above the roof of the shelter (if applicable) and a minimum of 12 feet above surrounding grade, whichever is greater. Vent pipes shall be provided with a drip pocket to trap liquids and/or solids. This pocket shall be located within the enclosure (if applicable) and shall be equipped with a manual drain valve. Vent lines shall be securely fastened and vent stacks shall be given sufficient support to prevent pipe movement during a discharge event. Vent stacks shall also be equipped with rain caps to prevent airborne rain and snow from contaminating the vent piping. Note that gas and air vent systems shall be piped such that mixing cannot occur.
3. Compressor packings shall be externally vented and shall be piped separately from safety relief vent piping and provided with a drip pocket to trap liquids and/or solids. This pocket shall be located within the enclosure and equipped with a manual drain valve.

D. Pilot Gas Lines:

1. ASME SA213 TP316 tubing as specified in Subparagraph 2.03 above or A106B carbon steel pipe as indicated herein.
2. Valves shall be two piece, minimum 600 WOG rated ball valves with steel handles and locking kits.

E. Miscellaneous Piping Components

1. Flange gaskets shall be spiral wound metallic with centering ring (up to ANSI 900# RF, non-isolation), malleable iron (ANSI 1500# RTJ and higher, non-isolation), or phenolic (up to ANSI 2500# RF flange isolation kits only) or a material approved by the Consultant. Gasket materials shall be non-flammable, non-asbestos materials.
2. Threads shall be NPT if tapered, or SAE if straight, unless otherwise specified.
3. Bolts, tubing, piping, and fittings shall be to SAE (i.e. non-metric) standards. Bolts shall be threaded UNF or UNC.
4. Swivel hose ends and fittings shall be 37 degree flare cadmium or zinc plated carbon steel.
5. Gauges shall be equipped with stainless steel wetted parts and rated at 4:1 safety factor (minimum). Gauges shall be equipped with a blow out disc in the case. Gauges shall be selected to provide normal operating pressure (at maximum suction and discharge conditions) at approximately 60 percent of their range. All gauges shall be glycerin filled.

6. Station inlet and compressor inlet valves shall be rated fire safe to API 607. Lever operated valves must be equipped with locking kits capable of securing the valve in either an open or closed position. Actuated and manual ball valves shall be equipped with high cycle life stem and seals and shall be positionable in any orientation. Actuators shall be mounted to ISO or equivalent standards using a minimum of 1/4-inch wall square steel tubing or valve manufacturer supplied bracket. The mounting bracket shall be fastened to the ball valve and the actuator with a minimum of four stainless steel bolts with split lock washers. Actuator/ball valve assemblies shall be factory tested for proper alignment and operation.
  7. Safety relief valves, actuated valves (valve stem vertical, actuator above or below valve), and filters shall be mounted in their normal vertical orientation. Mass flow meters shall be mounted to be self draining.
- F. Pilot system:
1. Bidders shall provide a pilot gas panel to provide regulated pilot gas to actuate valves in the station as follows:
    - a. This approach and system is approved by the Consultant.
    - b. The system shall include two pilot regulators in series, each designed to allow an inlet pressure of up to 5000 psig. The first cut regulator shall be set higher than the final cut regulator to account for pressure drop through the final regulator.
    - c. The system includes a small (minimum 20 gallon) ASME 200 psig buffer tank with 300 psig gauge and 200 psig ASME UV stamped safety relief valve.
    - d. The system includes at least two 200 psig ASME UV stamped safety relief valves in parallel each sized for at least twice the flow of a failed pilot regulator.
    - e. The system requires a pressure transducer to monitor the pilot pressure and fault the system if a regulator malfunction is detected.
    - f. The system shall include an isolation valve and 300 psig gauge at each machine or panel.

### **PART 3 - EXECUTION**

#### **3.01 INSTALLATION, APPLICATION AND ERECTION**

- A. Piping and Tubing Bending and Fitting Practices:
1. Piping and tubing shall be installed in a manner consistent with the Contract Documents; in straight, evenly spaced, parallel runs and properly insulated if indicated on the Drawings. Piping systems shall be built, supported and

pitched to provide suitable venting and draining. The piping shall be run true to the vertical and horizontal axis of the facilities wherever possible. If the type of installation requires a slope on the pipe, the slope shall remain even along the pipe. Valves shall be accessible for ease of operation, maintenance and overhaul/replacement. Bends shall be minimized wherever possible. Pipe bends shall not be permitted. Tubing shall be bent using benders which minimize radial distortion. This distortion shall not exceed code requirements.

2. Pipe and tubing shall be cut with a cutter intended for the application. The use of a hand hacksaw is prohibited (unless a Swagelok tube vise and guide is used). The use of a power hacksaw or bandsaw shall be allowed for pipe and one-inch and larger tubing only, provided cuts are square. Cuts shall be deburred externally and internally. Tubing shall be free of scratches subsequent to cutting and deburring. Filings and cuttings shall be removed prior to assembly. Compression fittings and threaded fittings shall be bench made wherever possible (i.e. factory or field preassembled before installation to minimize leaks due to poor or misaligned connections). A hydraulic swager shall be used for 3/4-inch and larger tubing.
3. All sections of tubing and piping shall be designed to allow safe and controlled depressurization. This will require that bleed valves be installed at various points in the system that could be captive. Drain valves on filters are considered to be acceptable depressurization points. As with other valves, these valves shall be identified and tagged with a unique identification number and standard depressurization procedures shall be provided describing in detail by reference to valve numbers how to safely depressurize, purge and re-pressurize all systems in the station.
4. The use of tube unions shall be minimized by using long sticks of tubing—unions will only be allowed where a bulkhead is required, or where the length of tubing without the union will exceed a 20 foot stick. The use of tube union elbows shall be minimized by using bends where feasible.
5. Any piping or tubing that penetrates concrete must be sleeved through the concrete and for an additional 6 inches on either side of the concrete with rigid PVC conduit.

**B. Pressure Welding and Fitting Practices:**

1. Fabrication - General Requirements:
  - a. Provide welding materials, equipment, tools and supplies of a size, grade and quality approved by the Consultant.
  - b. End Preparation and Fit up: End preparation or beveling shall be made by hand filing, machine tool or flame cutting device. Cut surfaces shall be smooth and regular. Free hand torch beveling shall not be permitted unless previously authorized on a case-by-case basis by the Consultant. Rust, scale, mill slag, primer, moisture, oil or other material which may be detrimental to the finished weld shall be completely removed from the

weld area. The ends of pipe, fittings, valves, and the like, shall be cleaned beyond the beveled edges at least 2 inches both internally and externally to assure no foreign material enters the weld puddle. Cleaning of weld bevels shall be done with power or hand tools.

- c. Line up Clamps: The abutting edges of weldments shall be held in alignment by an approved type of line up clamp where practical. When welding fitting to fitting where an approved type of line up clamp is not practical, each fitting shall be properly supported so as to minimize movement and strain during welding. Short runs of station piping or runs of pipe of limited distances shall demand an approved external line up clamp. When using an external line up clamp, the clamp shall not be removed until the stringer bead segments have been uniformly spaced around the circumference of the pipe and shall have an accumulative length of at least 50 percent of the pipe circumference.
- d. Alignment: The alignment of the abutting ends shall be such as to minimize the offset between surfaces. For pipe of the same nominal wall thickness, the offset shall not exceed 1/16 inch. Any greater offset, provided it is caused by dimensional variations, shall be equally distributed around the circumference of the pipe or fitting.

2. Electrodes:

- a. Electrode Protection: Welding electrodes shall be kept dry and protected from any mechanical damage or deterioration. They shall not be used if found or suspected to be defective.
- b. Burned or defective electrodes shall not be dropped on the ground or in the raceway, but shall be discarded in a proper container.

3. Welding:

- a. After a weld has been started, no movement (other than rolling on a fixture) of the piping shall be permitted until after the weld has been completed.
- b. Dirt, scale and slag shall be removed from each bead and groove, between passes, and after the weld has been completed with either hand or power tools.
- c. The cover of cap pass shall be raised a maximum of 1/16 inch above the pipe wall, with a width sufficient enough to cover at least 1/16 inch on each side of the weld groove. A concave cap shall be repaired by the addition of another pass.
- d. Welds shall be spaced a minimum of one and a half nominal pipe diameters away from any adjacent weld.

- e. Ground Clamps Welding of ground clamps to pipe or fittings shall not be permitted. Ground clamps shall be constructed in such a manner as to fit uniformly and securely enough to eliminate any possibility of arc burns on the pipe or fittings. Ground clamps shall be kept in a good state of repair, lubricated regularly and cleaned when required of rust, slag, spatter, scale, primer, coating materials, and the like, so as to prevent arc burns.
- f. Weather Protection: Welding shall be performed within a weather proof enclosure to prevent rain, or foreign objects from contaminating the work. The glare from arc welding shall be blocked by the use of commercially available weld curtains.
- g. Exposed Pipe Joints: Pipe joints for buried pipe shall remain exposed until inspected. Where the exposed pipe is in an area where vehicles need to cross, the inspection process shall be expedited to minimize disruption in traffic flow.

C. Pipe and Tubing Support and Fastening Techniques:

- 1. Pipe and tubing shall be adequately supported per ASME requirements to prevent bending, sagging and excessive vibration or damage to threads or flanges. When placing the pipe on to the supports, care shall be exercised so as not to jerk the pipe or impose any stresses that may kink or put a permanent bend or stress in the pipe or crack a thread.
- 2. Swagelok or Stauff block/saddle style pipe clamps with aluminum inserts or approved equal shall be used within the compressor package on compressor flow lines and Swagelok or Stauff block/saddle style pipe clamps with plastic inserts may be used on all instrumentation and drain lines. As a minimum, clamps on the compressor package shall be placed no greater than 48 inches apart and 12 inches from both sides of any bends. Where the requirements of any codes, or manufacturer or the vibration and pulsation study are more stringent, that clamping interval shall apply. Pipe and tubing shall not be used to support external devices. Clamps and fasteners shall be adequate for the application intended.
- 3. Clamps and fasteners shall be secured by mechanical means (e.g., welded, bolt with lock washer). The use of adhesives and self-tapping screws shall be approved by the Consultant.
- 4. All other piping and tubing in the station shall be clamped and fastened with Swagelok or Stauff block/saddle style pipe clamps with plastic inserts. Clamps shall be installed at the spacing as recommended by the clamp manufacturer, and a clamp shall be provided within 12 inches of each side of any bend or elbow. Where the requirements of any codes, or manufacturer or the vibration and pulsation study are more stringent, that clamping interval shall apply. Pipe and tubing shall not be used to support external devices. Clamps and fasteners shall be adequate for the application intended.

5. Clamp spacing shall be as per governing code or the clamp manufacturer's specifications, whichever is more stringent. Unistrut style conduit clamps will not be acceptable for piping and tubing.

D. Identification:

1. Weld Identification: After completing a weld, the welder shall mark it to identify their work. Where two or more welders are employed to produce a single weld, the joint shall be marked to identify the portion made by each welder. No notch stencils shall be used. Paint sticks are acceptable so long as the identification will last until the weld has been deemed satisfactory.
2. Valve Identification:
  - a. Valve Identification: Manual and automated valves (including ball, drain, safety and check valves) shall be equipped with stainless steel or brass labels with a unique valve number clearly indicated in 1/2-inch high letters and permanently affixed to the valve with stainless steel wire or chain.

### 3.02 QUALITY CONTROL

- A. As per other Section 18000, General, and following.

B. Non-Destructive Examination of Weld Joints:

1. All welds shall be visually examined for uniform appearance and finish.
2. Butt welds shall be subjected to 10 percent full circumference radiographic testing by a N.B. certified agency or as required by governing code, whichever is greater. Acceptability of weld is based on ANSI B31.3. Radiographic test reports and films on shop fabricated piping shall be forwarded to Owner at time of shipping. Testing shall include 10 percent of each welder's welds and 10 percent of each pipe size and thickness.
3. Pipe spool sketches referenced to each X-ray to allow later identification of a particular X-ray to a particular weld must be provided along with the X-ray reports and films. These sketches must also identify the welder that performed each weld.
4. Thread-o-lets and weld-o-lets must be die penetrant or mag particle tested.

C. Pressure Testing:

1. General:
  - a. Gas piping and all gas and air tubing shall be pressure tested to a value of 1.5x (hydrostatic) the relief valve setting for 60 minutes, or 1.1x (pneumatic) the relief valve setting or to higher standard if required by the local inspection agency. Extreme care shall be used due to the inherent risk of a catastrophic failure which could cause serious injury.

Nonessential personnel shall leave the area of the test and protection from injury shall be provided for those left on site.

- b. Pressure testing is intended to verify the integrity of all materials and connections and thus, the pipe and tubing spools must include all final connections that will be used to interconnect the pipe and tubing spools in the final assembly.
  - c. Shop reports shall be signed by an Engineer of Record and shall include:
    - 1) Spool number
    - 2) Spool description
    - 3) SRV setting
    - 4) Test pressure(s)
    - 5) Test duration (starting and ending times)
    - 6) Test date
    - 7) Signature of Technician
    - 8) Calibration data for gauges, meters, transducers, telemetry equipment, and the like.
    - 9) Ambient temperature
  - d. Prior to performing tests, SRV's and filter cartridges shall be removed from the system. Subsequent to the pressure tests, the SRV's and filter cartridges shall be reinstalled.
  - e. Pressure testing shall be witnessed to the satisfaction of Owner.
2. Hydrostatic Testing:
- a. Pipes shall be removed or isolated to prevent water from entering the compressor or other piping spools. The hydrostatic test shall be performed with clean water only. Pre-testing to approximately 60 psig is required, to locate major deficiencies. Subsequent pressure increases shall be made gradually to prevent "shocking" of the pipe system, increasing the pressure gradually to full test pressure (1.5 times the SRV setting) and holding it for 60 minutes.
  - b. At the end of the test, a visual inspection of all joints (welded, threaded, compression and flanged) shall be made to determine if any visible leakage has occurred. Immediately after the water has been fully drained from the system, a high velocity dry nitrogen purge shall be made throughout the system until no water remains.

3. Tie-Ins: Piping or tubing tie-ins shall be removed from the system and pressure tested in accordance with the above requirements. After re-installation, the tie-ins will be leak tested at the working pressure of the system.
4. Purging and Pressurizing:
  - a. Purging and pressurizing shall be performed by the Contractor and witnessed by the Consultant or Owner's designate.
  - b. Before pressurizing with natural gas commences, the ESD system shall be tested and fully operational. Natural gas shall not be introduced into the system without prior approval of the local gas utility and the express authorization of the Consultant. Air shall be purged from the entire system to the satisfaction of the Consultant prior to pressurizing the system.
  - c. Before natural gas is introduced into any piping system, fabrication, testing and work requiring flame or sparking devices shall be complete. After natural gas has been introduced, welding or other work which could ignite natural gas vapors shall be performed only upon express authorization by Owner on a case-by-case basis.
5. Leak Test:
  - a. Subsequent to pressure testing and final shop installation of all pipe and tubing spools, completed piping and tubing assemblies with all spools and other pressure retaining components in place shall be leak tested before being placed in operation to ensure that it does not leak.
  - b. All piping and tubing shall be pressurized with natural gas or air (as applicable) to its normal operating pressure (4500 psig downstream of the CNG compressors) and tested with a suitable liquid leak detector such as "Snoop" (by Swagelok Company). All leaks are to be repaired by depressurizing and reassembling the spools and fittings as required to correct the leak. No specific hold time is required on this leak test, however, the test must be repeated so that the entire piping and tubing system is leak tested a minimum of three times during startup and commissioning.
  - c. The following locations shall be tested:
    - 1) Flanged joints
    - 2) Threaded joints
    - 3) Tube joints
    - 4) Accessible butt joints

### 3.03 CLEANING

#### A. Pipe and Tube Cleaning:

1. Subsequent to pipe fabrication and testing, mechanical cleaning with wire brushes and/or swabs or pigs shall be performed where possible, then the pipe shall be cleaned internally with a non-residual, degreasing and slag removing solution. A high velocity dry nitrogen purge shall be made to remove any loose scale, filings, water or other foreign material. Once slag, mill oil and cleaning solution have been removed, the piping shall be coated internally (within 24 hours of the cleaning) with a light coating of the synthetic oil used in the compressor. (Dryer piping is exempted from this requirement but must be shipped with 15 psig dry nitrogen charge with a gauge and sealed valve).
2. Subsequent to tubing fabrication a high velocity nitrogen purge shall be made to remove any loose scale, filings, water or other foreign material.

## **PART 4 - MEASUREMENT AND PAYMENT**

### 4.01 GENERAL

- A. No separate measurement or payment will be made for the work required by this section. The cost for this portion of the Work will be considered incidental to, and included in the Lump Sum price bid for the Project.

End of Section
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