PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. The control system work required in the manufacturing of the Compressed Natural Gas Station.

2. The Work includes but is not limited to, the supply, installation and connection of electrical and control equipment and materials to accomplish a complete and functioning facility. The Work consists generally of the complete fabrication and programming of the natural gas fueling equipment and control systems.

B. Related Sections:

1. Section 18000 - All

1.02 QUALITY ASSURANCE

A. Manufacturer Qualifications: Equipment manufacturers shall have at least 10 years of experience in manufacturing products and accessories similar to those specified for this Project, with a record of successful in-service performance.

1.03 SUBMITTALS

A. Submit in accordance with Section 18000, General:

1. Product data for all components of control system.

2. Qualification: Manufacturer's project list.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION AND PERFORMANCE OF ELECTRICAL AND COMPUTER CONTROLS

A. Panels shall be **designed and equipped to interface, control and accommodate all current equipment as well as one additional two hose dispenser and one additional compressor—**except where specifically stated otherwise.

B. Control panels are to be NEMA 4, or NEMA 3R.

C. Power Distribution and Control Panels: Panel shall meet seismic requirements of site location.

1. Panel shall be sized and equipped to service all current and future equipment as outlined herein.

2. MCC to be minimum 1000 A, 480 V, 3 phase, 4 wire. Secondary distribution and control to be minimum sizes as indicated in these specifications and drawings. Breakers shall be provided for all compressor motors and for CNG dryer. CNG Dryer will be fed from the CNG MCC. Breakers shall be lockable in the off position.

3. MCC shall provide a control transformer sized to handle at least twice the fully built out station load. This panel will provide all 120 VAC power for the MCP and all other CNG station controls.

4. SCR starters for the CNG main compressor motors. SCRs shall be heavy duty rated with an integral bypass contactor to engage once motors reach full operating speed.

5. Disconnects and cross-line starters for fans, air compressors, and pumps except as noted elsewhere.

D. Equipment Suppliers are to provide a Unit Control Panel (UCP) on each compressor and a Master Control Panel (MCP) to provide overall station control.

1. General:

a. The Master Control Panel or Master PLC Panel (MCP) shall be designed to provide centralized station monitoring and control functions. The panel shall be generously sized to allow it to be used as a central pull point for control systems in the facility. (Note requirements for open, unused space to be provided in the panels as outlined in Section 18160, Electrical Equipment Fabrication and Installation).

b. The Master Control Panel shall control all dispensing operations, normal compressor start/stop and the utilization of all compressors.

2. MCP and UCP Requirements:

a. An off/on selector switch shall be provided for two compressors on the face of the MCP hard wired to the MCP PLC and its status communicated to the respective UCP PLC via the Ethernet Network.

b. A local/remote hardware or soft (programmed in the operator interface) selector switch shall be provided for each compressor on the face of the respective UCP. Its status communicated to the MCP PLC via the Ethernet or Modbus Network. In local mode, the priority fill and dispenser ESD valve solenoids are to be powered open.

c. An off/on selector switch shall be provided for each fast fill dispenser hose on the face of the MCP. This shall include provision for future hoses.

d. A hardware or soft (programmed in the operator interface) alarm acknowledge pushbutton shall be provided on the face of the MCP hard

wired to the MCP PLC. A reset pushbutton shall be provided on the face of the MCP hard wired to the MCP PLC.

e. A horn strobe to indicate station fault shall be installed at an elevation of approximately 15 feet above grade at the MCP.

f. The MCP PLC shall have provision to email and text up to five Owner programmable email addresses and phone numbers to notify the Owner and CNG station maintenance personnel of any station fault or emergency.

g. MCP shall include a minimum 7 inch color touchscreen operator interface.

h. All Operator Interfaces are to be web accessible to allow remote viewing and paging through screens via laptop or tablet computer. The Contractor shall provide two 10 inch tablet computers configured for this function.

i. The MCP shall include a network hub with at least 8 ports.

j. The MCP PLC shall include an RS485 communication card sufficient to address two dual hose dispensers.

3. The MCP shall be equipped with its own Programmable Logic Controller (PLC) based control system which shall be linked to each compressor UCP PLC, and dryer PLC via Ethernet. Each compressor UCP PLC shall accept discrete and analog inputs and effect control on its respective compressors—there will be one PLC for each compressor package.

4. Compressor and dryer UCPs shall be equipped with a minimum 7 inch panel mounted, NEMA 4 and Class 1, Division 2, Group D rated, color LCD displays, suitable for the ambient temperature range, readable in sunlight or darkness, and installed such that the panel electrical rating is not compromised. The display used in all outdoor control panels shall be of the same manufacturer and model number. Outdoor displays are to include a sun and rain shield. Displays shall be connected to the Ethernet network. Note that the use of the operator interface on the dryer is optional provided the dryer provide all status outputs as required in Section 18510, Single Tower CNG Dryer.

5. The MCP display shall show the status of compressors; the current pressure, status and flow rate and total dispensed quantity of each dispenser; the station inlet pressure; the ambient temperature; the cascade pressures; pilot gas pressure; hours of each air compressor and the status of the gas dryer.

6. The compressor UCP displays shall indicate suction, interstage and discharge pressures, interstage and discharge temperatures, and machine status

(operation, or shutdown mode, full capacity or reduced capacity, type of fault or ready).

7. UCP and the gas dryer control panels shall be NEMA 4 panels, factory mounted and wired on the end of the equipment skid. The UCPs and the MCP panels shall be equipped with a fluorescent light on the inside top with a manual switch.

8. PLC power and power to displays shall be protected by an uninterruptible power supply (UPS) and surge suppression. PLC CPUs, operator interfaces and ESD circuits must be maintained for a minimum of 30 minutes under a power outage event and must automatically restart the system if power is restored within that time unless a fault is present. Power to dispenser meters and display heads, intrinsic barriers, power supplies and transformers and solid state control devices must be protected with surge suppressors across hot, ground and neutral, at its source.

9. The MCP PLC shall control lead-lag start and stop control of gas compressors which are "on-line". This system shall be designed to equalize operating hours on all machines, by starting the machine with the fewest hours first.

10. The MCP PLC shall start an additional "on-line" compressor, when available, to replace a machine which has been automatically shut down for fault conditions.

11. The MCP Operator Interface shall allow the operator to select 0, 1, or 2 compressors allowed to operate, however, the MCP shall have the ability to override the automatic operation and manually select the number of compressors to be operating.

    The startup logic for compressors should not start any compressor until the cascade is sufficiently depleted (for example-high bank pressure less than 3500 psig) and at least one vehicle still fueling and below the target pressure.

    A second compressor shall not be started unless the cascade is below a preset lower start limit, there are at least two vehicles actively fueling and so on—the goal of this logic is to limit the number of compressors operating to avoid unloading between vehicle fills.

    The sequence must time delay the start of a subsequent compressor by approximately two minutes under any compressor start scenario.

12. The PLC shall use data input from the Operator Interface to determine the maximum number of compressors allowed to operate each of the 24 hours per day for seven day week intervals (24 x 7 matrix). This is intended to allow Owner to minimize demand charges particularly in high peak periods.

13. Standby Power System Interface:

a. The CNG Contractor shall supply PLC I/O, wiring terminations, programming and testing to interface to the standby generator system as follows:

1) A signal from the ATS to indicate that the switch is on standby power and ready to accept load.

2) A signal from the ATS to indicate that the switch is on utility power.

3) A signal from the ATS to indicate a switch from standby to utility power is imminent in some timed period (10 to 30 seconds).

4) Two spare discrete inputs to address other undefined standby power system status relays.

b. The station shall be configured and programmed to:

1) Match the station load to the power source available.

2) Automatically, safely shut down in the event of a power outage, without causing relief valves to vent or any damage to any equipment.

3) Automatically restart the equipment when standby or utility power is available. All restarts should be staged so there is a programmable interval of one to five minutes between the start of each compressor.

4) Shut down the system when a transition back to line power is imminent.

5) Automatically restart the system when line power is restored.

14. Status lights shall be provided on the MCP Operator Interface to indicate if:

a. Each compressor is ready, faulted, or running.

b. The CNG dryer requires regeneration.

15. Status lights shall be provided on the MCP to indicate if:

a. A station ESD or power failure has occurred.

16. Audible alarms and strobes shall be silenced/disabled when a keyed momentary contact switch on the MCP is activated. The maximum time lag between alarm generation and alarm activation shall be one second.

E. PLC Requirements:

1. All PLCs shall be the same model and shall include the same CPU. The dryer shall be exempt from this requirement; however, it shall communicate with the MCP PLC by Ethernet.

2. PLC power supplies shall be the largest output available.

3. PLC racks shall be the largest card capacity available (except in dryer where small racks are permitted). The primary rack of each PLC shall include the CPU, communications modules and any "smart cards". The expansion rack(s) shall be used for all I/O.

4. I/O cards shall be selected to provide a minimum of 20 percent additional, unused channels which shall be wired to the terminal strip. A minimum of four spare slots shall be provided on each PLC for future needs.

5. The PLC and MCP need to be sized to provide the required spare capacity after the station is fully built out with an additional compressor package.

F. PLC Controlled CNG Station Fault Shutdowns:

1. Dryer Shutdowns:

   a. Dryer outlet high humidity

   b. Blower motor overload

   c. High cooler discharge temperature

   d. High heater bundle

   e. High heater chamber temperature

   f. High blower differential pressure

   g. Transducer, thermocouple or RTD failure (i.e. broken wire or shorted)

   h. Heat detector alarm

2. Compressor Shutdowns:

   a. Low oil pressure

   b. High oil temperature

   c. Low suction pressure

   d. High suction pressure

   e. High interstage and discharge temperature set at or below 325 °F

f. High crankcase pressure (if applicable)

g. High interstage and recovery tank pressure

h. Normal discharge pressure 0-6,000 psig range set at 4,500 psig

i. High discharge pressure 0-6,000 psig range set at 4,700 psig

j. Transducer, thermocouple or RTD failure (i.e. broken wire, or shorted)

k. High vibration in compressor

l. High vibration in cooler fan

m. Low lube flow rate (if applicable).

3. Electric Motor Shutdowns:

   a. High winding temperature

   b. Overcurrent

   c. Contactor/SCR fault

4. Dispenser Shutdowns:

   a. Excess flow rate

   b. Excess fill amount

   c. Sudden loss of pressure

   d. Transducer, thermocouple or RTD failure (i.e. broken wire or shorted)

   e. High vibration in dispenser (causes an ESD with annunciation)

5. Cascade Storage System Shutdowns: Transducer, thermocouple or RTD failure (i.e. broken wire or shorted). High bank pressure—causing an alarm if no equipment is operating but not preventing dispensing and causing all compressors to unload if the cascade is being refilled.

6. General Shutdowns:

   a. Emergency shutdown buttons.

   b. Low or high station inlet pressure—a transducer is required on the inlet piping downstream of the station ESD valve.

   c. Pilot gas system low or high pressure.

d. Earthquake switch-mounted to top of pipe rack**.—not required on this project.**

G. Additional Control System Design Requirements:

1. Inputs shall be wired fail-safe (circuit to open on fault condition).

2. In the case of 4-20mA inputs, the PLC shall be configured for 0-20mA inputs to determine if an input is a zero drift (typically 3.6 to 4 mA) or if there is a broken wire (<3.6mA). A reading of 20 mA shall be interpreted as a short circuit.

3. Thermocouple inputs shall be configured so that a broken wire situation is identified and annunciated.

4. Output channels on PLC cards shall be de-energized in the event of an ESD, causing devices such as valves and contactors/motor starters to go to their safe, unpowered condition.

5. Controls shall be organized in a "first out" sequence. The controls react to the first of a possible series of sequential faults, shut the equipment down and lock out subsequent faults.

H. Emergency Shut Down (ESD) System Requirements

1. Hardware Requirements:

a. The ESD system shall operate on 120VAC.

b. Buttons shall be red maintained contact mushroom type. Each ESD button shall be equipped with two Normally Closed (NC) contacts. The first NC contact shall be hardwired in series with the other station ESDs and the master start pushbutton located on the face of the MCP. The second NC contact shall be hardwired as an independent input to the MCP PLC—the PLC will display and log which button was pressed.

c. One manual keyed reset momentary contact switch shall be provided on the Master Control Panel (MCP).

d. A hard wired, Master Control Relay (MCR) shall be provided in the MCP and in each compressor UCP and the dryer UCP.

2. ESD Buttons shall be provided as follows:

a. One button on the MCP, one on each of the compressor UCPs, one on the gas dryer UCP, and one on priority fill/ESD panel.

b. One button at each dispenser which is of the type that is protected to prevent accidental activation (recessed button). Each dispenser shall be

equipped with an internally installed earthquake/vibration switch in series with the ESD button.

c. One button outside each mangate from the CNG Equipment Compound.

d. Other buttons as indicated on the drawing set.

3. The system shall perform as follows:

a. Power is removed from all motor contactors and the main motor starters.

b. The power is removed from all solenoid valves, and hence the following valves close automatically:

1) Station inlet valve

2) Compressor inlet valves

3) Storage panel high pressure line valves

4) Dispenser end high pressure line valves

c. The following valves open automatically:

1) Compressor drains (unloaders) and/or compressor bypass valves.

d. In the event of a 40 percent LEL, the Master control PLC will cause an ESD. This feature will require a manual reset.

e. The station inlet valve will be controlled by the PLC and will open only when one or more compressors are required to operate. The valve will remain closed when no compressors are operating.

I. Combustible Gas Detection System Requirements:

1. Detectors are to be Class I, Division 1 rated.

2. One self-contained combustible gas detection unit shall be installed in each compressor enclosure and wired to the UCP for that compressor package.

3. The combustible gas detection unit shall be an Infrared (IR) type, and shall include internal diagnostics to confirm that the lens is not dirty.

4. The unit shall have a local LED or LCD readout (suitable for outdoor use) in percent LEL.

5. Detectors are to be addressable through an RS 485, Modbus, or other standard network protocol and connected to the station PLC system.

6. The unit shall have 120V rated relay contacts for 20 percent and 40 percent LEL.

    a. A 20 percent LEL signal from the detector to the UCP in a compressor will cause the immediate shutdown of these compressors and starting that compressor's enclosure exhaust fan. Annunciation shall be provided.

    b. The above events shall be displayed and logged on the MCP.

7. The unit shall have a 4-20 mA output in percent LEL.

8. One calibration kit shall be included.

J. Systems Control And Data Acquisition (SCADA) System Requirements: **--not in scope.**

1. The system shall include a Dell Precision or Optiplex desktop computer with: (computer to be mounted in the garage in a location as directed by the Owner)

    a. Dell or equal 24" LED monitor with speakers—1920 x 1080 resolution

    b. Wireless keyboard and mouse.

    c. Intel i7 Quad Core processor with 16 GB of on board RAM.

    d. One 1 TB internal hard drive-7200 rpm.

    e. One 1 TB external hard drive.

    f. Graphic video card meeting the requirements of the SCADA software manufacturer.

    g. Windows 7 Pro Operating system.

    h. Microsoft Office 2012 Professional.

    i. Rockwell RSView (or approved equal) runtime and development license with 100 percent more tags than required in the current configuration.

    j. All required software and hardware to connect to the Owner corporate network and the CNG station MCP PLC.

2. The status of subsystems including Emergency Shut Down (ESD), each compressor, gas dryer, the dispensing and defueling system, air compressors and dryer, valves, fans and motors shall be displayed on a monitoring computer to be networked to the station equipment by Ethernet. The SCADA computer may be mounted on site or remote from the other equipment in another Owner building.

3. Monitored Parameters and Shutdowns: The following list indicates parameters which shall be monitored, and fault conditions for which the PLC control system shall shut down the equipment. The master control PLC shall have the ability to provide (via the network) this data.

    a. Status—SCADA Monitored Parameters:

        1) Dryer status—if available on the dryer PLC:

            a) Inlet pressure

            b) Outlet pressure

            c) Blower differential pressure during regeneration

            d) Regeneration chamber gas inlet temperature during heating

            e) Regeneration chamber gas discharge temperature during heating

            f) Regeneration chamber internal temperature during heating

            g) Status of tower (regeneration in progress, or in use)

            h) On-line or fault condition

            i) Outlet dewpoint--MANDATORY

        2) Compressor Status (each compressor):

            a) Suction, interstage, discharge, final discharge, recovery tank, pilot air pressure and oil pressure

            b) Interstage, discharge, enclosure, ambient, crankcase oil temperature

            c) Status of discrete I/O

            d) On-line or fault condition

            e) Idle or compressing

            f) Total hours of operation, loaded hours of operation, number of starts in total

            g) Hours of operation in last 24 hours, number of starts in last 24 hours

            h) Status of control valves

3) Electric Motor Status:

a) Temperatures of windings

b) Motor faults (overcurrent, contact failure and the like)

4) Dispenser Status (for each fast fill dispenser):

a) Ambient temperature

b) Initial Vehicle pressure (psig)

c) Running and final gas pressure

d) Maximum and running flow rate

e) Running and final mass dispensed (Therms or as directed by Owner)—this will require a high speed counter/frequency input from each dispenser head to the MCP PLC.

f) Status of control valves

5) Storage System Status:

a) Pressure in each of the storage banks

b) Status of valves

6) General Status:

a) Date and time

b) Ambient temperature (precision thermocouple)

c) Gas service pressure.

d) Air system pressure.

e) Status of station inlet fire valve.

f) Utility or standby power.

4. SCADA Logging:

a. The SCADA shall be configured to log operations and faults automatically as outlined below. These logs shall be in Excel and should be individual files for each category, not a composite file. Given the size limitations of the files, it is required that the system automatically create a new folder and files each month.

b. Individual Log: Log entries shall include the time and date and the ambient temperature: (Dryer logging can be limited to those parameters available on the PLC or by discrete signal.)

c. Dryer Dewpoint: Trigger-once daily and log: (Mandatory)

    1) Dewpoint

d. Dryer Regeneration: Trigger regeneration. Log:

    1) Start and end time.

    2) Each thermocouple maximum reading during heating cycle (if available)

e. Dryer Fault: Trigger dryer fault. Log:

    1) Type of fault.

    2) Dryer status-drying or regeneration

    3) All pressures and temperatures immediately prior to fault (if available)

f. Compressor Operations (for each compressor individually). Trigger-each time a compressor reaches a target pressure such as 4,200 psig, log:

    1) Compressor loaded and unloaded hours

    2) Compressor starts (total and within last hour)

    3) Gas, oil, enclosure and motor temperatures

    4) Gas, air and oil pressures

    5) Status of valves and status of compressor

    6) Gas detector reading (percent LEL)

g. Compressor Fault (for each compressor individually). Trigger shall be any compressor fault then log:

    1) Type of fault

    2) Data Recorded from Compressor Operations Log: Data shall be captured immediately prior to shutdown

h. Dispenser Transactions (for each dispenser individually). Trigger shall be each fill or attempted fill, then log:

1) Start time and end time of fill

2) Air Pressure

3) Initial and final vehicle pressure.

4) Maximum flow rate

5) Quantity of gas dispensed—note that the dispenser head will need to communicate with a high speed counter on the MCP PLC.

6) Type of termination—automatic or operator switched

i. Dispenser Fault (for each dispenser individually). Trigger shall be any dispenser fault, then log:

1) Type of fault

2) Data from Dispenser Transaction Log: Data shall be captured immediately prior to shutdown

j. CNG Station Gas Detection. Trigger shall be any gas 20 percent, 40 percent or fault event, then Log:

1) Type of fault or alarm

2) Which detector

3) Time acknowledged

4) Status of dryer, each compressor, each dispenser (operating or standby)

k. ESD: Trigger shall be any ESD event, then log:

1) Which button caused the ESD

2) Time acknowledged

3) Status of dryer, each compressor, each dispenser (operating or standby)

PART 3 - EXECUTION

3.01 INSTALLATION

A. Refer to Section 18000, General, for general installation requirements.

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