Specifications and General Information for gas management panels

Background

NASA's Glenn Research Center is currently in the process of building the Extreme Environments Test Chamber, which will be used to simulate the atmospheres of various bodies in the solar system, most notably the atmosphere of Venus; other possibilities include the atmosphere of several of the moons of Jupiter and Saturn. In order to accurately simulate these extraterrestrial environments, the temperature and pressure found on the surface of these environments must be simulated, as well as the gas constituents of these environments. The gases required to generate the atmospheres consist of several different gas species. These species may include, as a minimum, nitrogen, carbon dioxide, and other species consisting of a gas species mixed with nitrogen. For example, some of the gas species required to simulate the atmosphere of Venus include nitrogen, carbon dioxide, hydrogen chloride gas, hydrogen fluoride gas, carbonyl sulfide, sulfur dioxide, nitric oxide, carbon monoxide, and water vapor (in addition to nitrogen and carbon dioxide). Other atmospheres will require gases such as ethane and methane.

All of the gas species will be carefully metered to ensure that the correct concentrations of the gases are present in the final mixture. In addition, due to the safety issues surrounding the more exotic gases such as carbon monoxide, hydrogen fluoride, and hydrogen chloride, the introduction of these gases must be handled with particular care. To safely handle these gases, automated gas management panels will safely control the flow of these gases, as well as the purging, evacuation, and venting of the tubing carrying these gases. This procurement is for the purchase of six automated gas management panels.

The gas management panels being purchased under this procurement will provide the primary function of providing the particular gas species to the gas mixer. In addition to the primary supply function, each gas panel shall provide the functions of evacuating the gas species tubing, purging the tubing with nitrogen, detecting leaks or other abnormalities within the gas management panel or its associated tubing, and safe supply bottle change-out. In order to simplify the design and procurement, as well as to reduce to cost, all of the gas management panels will be identical. The four modes of operation are summarized:

1. Supply gas species through the gas management panel to the gas mixer
2. Vent the gas management panel tubing
3. Purge the gas management panel tubing
4. Evacuate the gas management panel tubing

This procurement consists of two parts. The first part is for the purchase of the six gas management panels that are able to be controlled by an automated control system. The second part, which is optional, consists of the automated control system programming of the gas management panels. Any prospective vendor's bid must contain the cost for the first part (the six gas management

panels); the second optional part may be bid upon if the vendor so desires. The exercise of the second option is at the discretion of the government.

The vendor shall supply six identical gas management panels. Each panel shall contain valves that allow the tubing to be evacuated (with an external vacuum pump) and purged with nitrogen. The vacuum pump for evacuating each panel will be supplied by the government, as will the nitrogen required for purging. The complete, final design for the panels is incumbent upon the vendor. The vendor shall meet all specifications listed unless the vendor takes exception to a particular specification; in this case, the vendor must note the specification being excepted, and provide an explanation of how the vendor's design satisfies the specification in other ways (if at all).

The anticipated operational method of each gas management panel is as follows: First, the panel tubing will be purged with nitrogen. The tubing will be pressurized with nitrogen to a nominal pressure of 100 psig. Panel valves will then be closed, and the pressure decay will be measured to verify the integrity of the panel components. If the rate of pressure decay is within acceptable limits, the panel tubing will then be evacuated using the vacuum source. Once the tubing is evacuated, the panel integrity will once again be verified by closing valves and measuring pressure rise. If the pressure rise is within acceptable limits, the panel can actually begin flowing the gas species from the gas bottle that is connected to the panel. It is anticipated that each gas management panel will incorporate at least one pressure sensor for the pressure rise and decay rates. These operations will all be performed by the automated control system.

One of the goals of the operational method noted above is the detection of leaks in the gas management panel tubing and components. In addition to detected leaks through valves, the detection of leaks to the surrounding environment (the gas cabinet) is also crucial. The gas panel instrumentation and its automated control system shall be designed to reduce the risk of personnel exposure to any of the toxic gases.

Overall specifications

The vendor shall supply six identical gas management panels. The cost for a seventh, spare panel shall also be provided. Each gas management panel shall be able to supply a gas mixture such as the example gases listed above, and repeated here: nitrogen, carbon dioxide, hydrogen chloride gas, hydrogen fluoride gas, carbonyl sulfide, sulfur dioxide, nitric oxide, carbon monoxide, water vapor, ethane, and methane.

Each gas management panel shall be able to be purged with nitrogen from a nitrogen source supplied by the government. Each gas management panel shall be able to withstand a purge pressure of at least 150 psig. In addition to purging the panel, the panel shall also be able to use the nitrogen for leak detection by closing valves and measuring the rate of pressure decay.

Each gas management panel shall also provide the ability to evacuate the tubing in the panel via a government-supplied vacuum pump. The tubing in each gas management panel shall be able to be evacuated to a pressure of at most 1 Torr; the inlet pressure to the vacuum pump will be at most 100

millitorr. In addition to evacuating the gas management panel, the panel shall be able to use the vacuum for leak detection by closing valves and measuring pressure rise.

All components on each gas management panel shall be mounted on a flat panel. Two of the gas management panels shall be able to be mounted in existing government-owned gas cabinets, which are Matheson Tri-Gas model number 1170. The layout of the components on the panel shall be designed such that the components may be easily removed for servicing or replacement. All measurement devices such as pressure transducers shall be able to be easily removed for calibration. All relief valves shall be able to be easily removed for setting and verification.

The design of the gas management panels shall be such that the un-purged volume of the panel's tubing is minimized. Of particular concern is the length of tubing from the panel to the gas bottle sourcing the gas species. The vendor shall provide the volume of any un-purged tubing volume. The government may request that the vendor design be modified to reduce any un-purged volume.

Mechanical specifications:

Each panel shall provide a flexible hose connection with the related CGA fitting for each of the six gasses listed (HCL, HF, COS, CO, SO_2 & NO) for connection to the gas bottles. Each panel shall provide a VCR fitting for connection to the government-supplied vacuum pump (for tubing and component evacuation), as well as a VCR fitting for connection to the government-supplied nitrogen supply (for tubing and component purging).

The panels shall incorporate valves that can be actuated (open/close) pneumatically via manufacturer-supplied solenoid valves. The valves shall be able to be actuated with either nitrogen or service air at supply pressures of 80 to 120 psig, filtered to 0.5 microns. The solenoid valves shall be able to be actuated by 120 VAC or 24 VDC.

Each panel shall include relief valves at the locations noted in the representative diagram. The relief valve vents shall be tied to a common point for venting of each gas panel, i.e. only one vent for each panel is required.

The material of any component in each panel that may be exposed to the gas being managed by the panel shall be SS-316.

Each panel shall be constructed of orbital-welded tubing that has been leak-checked. The leak check shall consist of a helium leak test to 5.0 x 10 e-9 SCC/S He, and shall be performed by the gas management panel manufacturer. All results of the performance testing, including leak checking and pressure testing, shall be furnished to the government for review and acceptance. All testing shall be performed using NIST-traceable standards. The serial numbers and NIST calibration records shall be supplied with the leak testing results.

Each panel shall be designed such that gases can be supplied to the mixer can be supplied at a rate of 15 slpm for the flow through the panels.

Electrical Specifications:

All instrumentation shall have a standard 4-20 mA analog output signal. Pressure transducers shall be the PTM series of pressure transducer from STS Sensors. Allowable temperature sensors include type T thermocouples and 100-ohm platinum RTDs. It is the government's desire that the pressure sensors be isolated from the toxic gas species via the use of diaphragm barriers.

Solenoid valves shall be actuated by 24 VDC or 120 VAC, and shall be able to be energized by a standard PLC output. Each solenoid valve shall draw a maximum of 300 mA in the energized state, and a current of at least 5 mA shall be required to energize each solenoid valve.

Each gas panel shall have all discrete device wiring terminated to a terminal strip located either on the panel or within 3 feet of the panel, so that personnel can check the state of devices with standard voltmeters. Instrumentation may be terminated with standard connectors, such as type T thermocouple mini-connectors and PT06A-10-6S connectors for pressure transmitters.

The wiring for all devices for the gas management panels shall be strain-relieved according to standard acceptable manufacturing standards.

Each gas management panel shall have a means to ground the panel to the gas cabinet or other grounding (bonding) means per NEC requirements.

All analog instrumentation wiring shall be twisted-pair cabling, with each pair individually shielded. The vendor shall connect the shield wire of each pair to a connector pin or terminal strip. NASA personnel will properly terminate the shield wires at the PLC.

The vendor should note that the government-owned PLC is already equipped to control 24VDC solenoid valves, read limit switches (24 VDC) and read analog input voltages and currents.

Documentation:

For the purposes of bid evaluation, each prospective bidder shall include the following documentation:

Basic panel design and layout, including dimensions and approximate weight of each panel

Catalog sheets of proposed commercial products such as solenoid valves, relief valves, pressure sensors, etc. These sheets will show each component's compatibility with the required gasses and rated temperatures and pressures.

Basic theory of operation

Procedures for evacuation, purge, bottle change-out, and gas supply to the gas mixer

Basic dimensions of the panel

Expected performance specifications: gas flow to the mixer (output flow), evacuation pressure versus time, rate of pressure rise during evacuated leak test, rate of pressure decay during pressurized leak test.

The contract awardee (the vendor) shall supply the following documentation within 14 days of contract award:

Changes to catalog sheets of commercial equipment used in the gas management panels

Design performance specifications: gas flow to the mixer (output flow), evacuation pressure versus time, purge pressure, rate of pressure rise during evacuated leak test, rate of pressure decay during pressurized leak test.

Detailed theory of operation of the panels

Expected maintenance required for each gas panel

Expected installation instructions for each gas panel, including mounting required, interface points to external equipment (mechanical, electrical, and tubing).

All technical details allowing a proficient PLC programmer to program the logic required for the automated control system

Troubleshooting guide

Procedures for purging the gas panels with nitrogen, evacuating the gas panels (with the vacuum source), and supplying the gas species through the gas panels

Procedures for changing gas bottles supplying the gas panels

NASA personnel will supply comments within 7 days of receipt of the documentation. If any deficiencies are noted, the vendor may correct them within 7 days of notice.

Upon delivery of the gas management panels to NASA, the vendor shall supply the following documentation:

Complete list of commercial equipment used in each panel, as well as catalog sheets of commercial equipment.

Material certifications and/or mill test reports.

Welder certifications for the materials and type of orbital welding used.

Any hydrostatic or pneumatic pressure test reports.

Any inspection and non-destructive examination (NDE) reports.

Data from the orbital welder that shows the proper settings for each weld to verify that a quality weld was obtained.

Final measured performance specifications: gas flow to the mixer (output flow), evacuation pressure versus time, purge pressure, rate of pressure rise during evacuated leak test, rate of pressure decay during pressurized leak test.

Detailed theory of operation of the panels, including panel layout with dimensions, and piping and instrumentation diagram (P&ID).

Maintenance required for each gas panel.

Installation instructions for each gas panel, including mounting required, interface points to external equipment (mechanical, electrical, and tubing).

Electrical specifications for each panel, including wiring diagrams, connector pinouts, and power required.

Technical details allowing a proficient PLC programmer to program the logic required to design the logic for the automated control system.

Troubleshooting guide.

Procedures for purging the gas panels with nitrogen, evacuating the gas panels (with the vacuum source), and supplying the gas species through the gas panels.

Procedures for changing gas bottles supplying the gas panels.

Part 2 (optional):

Part two of this procurement, which is optional, is for the PLC programming of the gas management panels. This option will be exercised at the discretion of the government. This part is for the PLC programming for the automated control of the gas management panels, as well as the HMI programming. The specifications in this section pertain to optional part 2.

The PLC programming shall be performed using Schneider Automation's Unity Pro software, version 6.0 service pack 1. The PLC that will be controlling these gas management panels will be a Square D Modicon Quantum controller.

The HMI software programming shall be performed using Schneider Automation's Vijeo programming software version 6.0. The HMI code will be downloaded to government-owned Magelis XBGTB6340 touchscreens.

The vendor shall provide the source code for the PLC programming and HMI programming.

The PLC software shall incorporate all functionality for the gas management panels. All functionality, including valve operation, leak detection via pressure rise, and leak detection via pressure decay, shall be incorporated into the PLC code.

The PLC software shall be programmed such that it can be imported into an existing PLC program. It is NASA's strong preference that the PLC software be programmed with derived function blocks (DFBs), which can then be used in the main PLC code (once for each gas management panel). NASA personnel can supply example code if the vendor so desires.

Acceptance testing:

Upon delivery of the gas management panels, NASA personnel will perform acceptance testing of each panel. This testing will consist of at least the following minimum steps:

Verification of correct valve operation, pressure sensor functionality

Verification of purge function, evacuation function, bottle change-out function, and gas supply function

Verification of rate-of-pressure decay (purge function) and rate of pressure rise (evacuation function)

Verification of correct PLC software functionality (optional part 2)