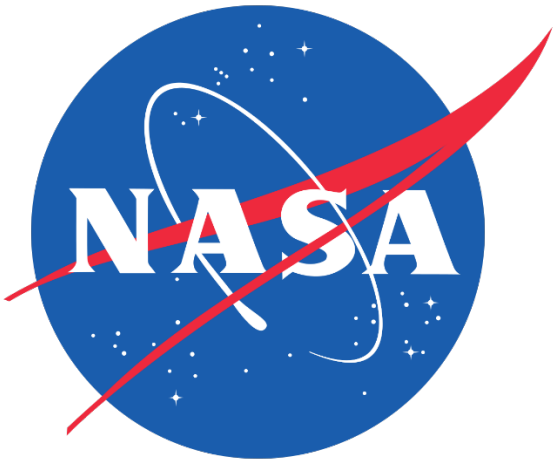
NOTE: THE LAST PAGE IS A CHANGE REQUEST FORM FOR FUTURE REVISIONS

STATEMENT OF WORK
FOR
Vacuum Jacketed LH2 Supply System for CCL-7 , Version 1.0



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

GLENN RESEARCH CENTER

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NEIL A. ARMSTRONG TEST FACILITY
3597 SCHEID ROAD
SANDUSKY, OHIO 44870

Vacuum Jacketed LH2 Supply System for CCL7, Version 1.0

Background

This statement defines the scope, deliverables, and responsibilities for the design, fabrication, testing, delivery, and commissioning of a vacuum-jacketed liquid hydrogen (LH2) supply system. The system will safely transfer LH2 from the source (e.g., tanker or storage vessel) to designated end-use equipment while maintaining cryogenic temperatures and minimizing boil-off losses. The vendor will also provide (2) liquid hydrogen compatible globe valves with actuator and position transmitters to be able to isolate supply and transfer operations within the supply system. Additional ports and fittings have been called out in the drawing to implement instrumentation into the system.

Environmental Impacts

☐Universal waste, recycling
☐Hazardous waste (see Appendix B for details)
☐Air
☐Storm Water
☐Wastewater
☐Species Management
☐Soil
☐Underground/Aboveground Storage tanks
☐Chemical Management
☐Other

No environmental impacts.

Pressure Vessels and Systems

Does this work include pressure vessels and systems? Yes.

Scope of Work Description

<u>Engineering and Design:</u>

- Drawings to be provided and reviewed with NASA personnel to approve before work can begin.
- Design vacuum-jacketed piping and components to ASME B31.12
- Materials should be compatible with LH2

<u>Procurement and Fabrication:</u>

- Procure all required materials and components, including”
    - Vacuum-jacketed piping and transfer lines
    - Cryogenic globe valves, actuators and fittings
    - Specified fittings/ports to implement instrumentation
- System design pressure is 275psig
- (2) Globe Valves:
    - Materials rated for -423°F
    - Flow coefficient of at least Cv=8.3
    - Come with positioner transmitter
        - 4-20mA setpoint and feedback signal
        - NEC Class I, Div 2, Group B
- Fabricate piping assemblies with inner and outer jackets
- Perform vacuum insulation and sealing

- Clean all components for oxygen/cryogenic service

Testing & Quality Assurance

- All testing should comply with ASME B31.12 Hydrogen Service: Inspection, Examination and Testing
    - Hydrostatic testing at 1.5x design pressure, or Pneumatic testing at 1.1x design pressure for a minimum of 10 minutes.
    - Vacuum Retention test of at least 7-days
    - Leak Testing of 1x10^(-8) CC/s
    - Material certifications
    - Cold shock testing using LN2 to check for leaks/cracks
    - Radiography of 10% of total welds on fluid process piping, prior to VJ install

Delivery & Installation

- Package and transport system components to NASA Glenn Research Center
    - 21000 Brookpark Road, Cleveland OH 44135
- Provide installation guidelines for NASA technicians to install hardware

Requirements for Vendor

The Vendor shall provide evidence of successfully completing projects of similar scope, size, complexity, and technical requirements. Such evidence shall include project descriptions, client references, dates of performance, contract values (if permissible), and the Vendor's role in each project. Vendor will need to be approved by NASA facility engineers before work can begin.

Inspections

- Drawing review with NASA personnel
- Visual Examination of the build per ASME B31.12 Normal Fluid Service
- Radiography of 10% of total welds on fluid process piping, prior to VJ install

Deliverables

- Certificates of Conformance
- Drawings (which are approved before manufacturing)
- Inspection Reports
- Material Certifications of piping system
- Testing Reports including:
    - Hydrostatic (150% MAWP) or Pneumatic (110% MAWP) Test
    - Vacuum Retention report
    - Leak Check report
    - Cold shock testing report
    - Radiography of 10% total welds report
- Vacuum Jacketed Piping System

Government Acceptance

POC will accept pending receipt of satisfactory deliverables.

VERSION HISTORY

Version #	Purpose (Original or CR #)
1.0	*Original*

VACUUM JACKETED PIPE INNER LINE:
1/2" ODT X .035W A269-304SS
1/2" SCH5 A312 304SS SEAMLESS
1"SCH5 A312 304SS SEAMLESS
EXPANSION JOINTS AS REQUIRED

OUTER JACKET:
2" SCH5 A312 304SS WELDED
3" SCH5 A312 304SS WELDED

INSULATION:
MULTI-LAYER SUPER INSULATION

TESTS PERFORMED:
HELIUM LEAK TEST ENTIRE ASSEMBLY FOR A MAX. LEAK RATE OF 1 X 10-8 CC/SEC

THE INSTALLER SHALL PERFORM A FIELD PNEUMATIC LEAK TEST ON THE COMPLETED PIPING SYSTEM AT 110% OF THE DESIGN PRESSURE AS REQUIRED BY ASME B31.12

7-DAY VACUUM RETENTION TEST

COLD SHOCK TESTED

CODES:
ASME B31.12 FOR PRESSURE PIPING

LH2 AND LOX USAGE

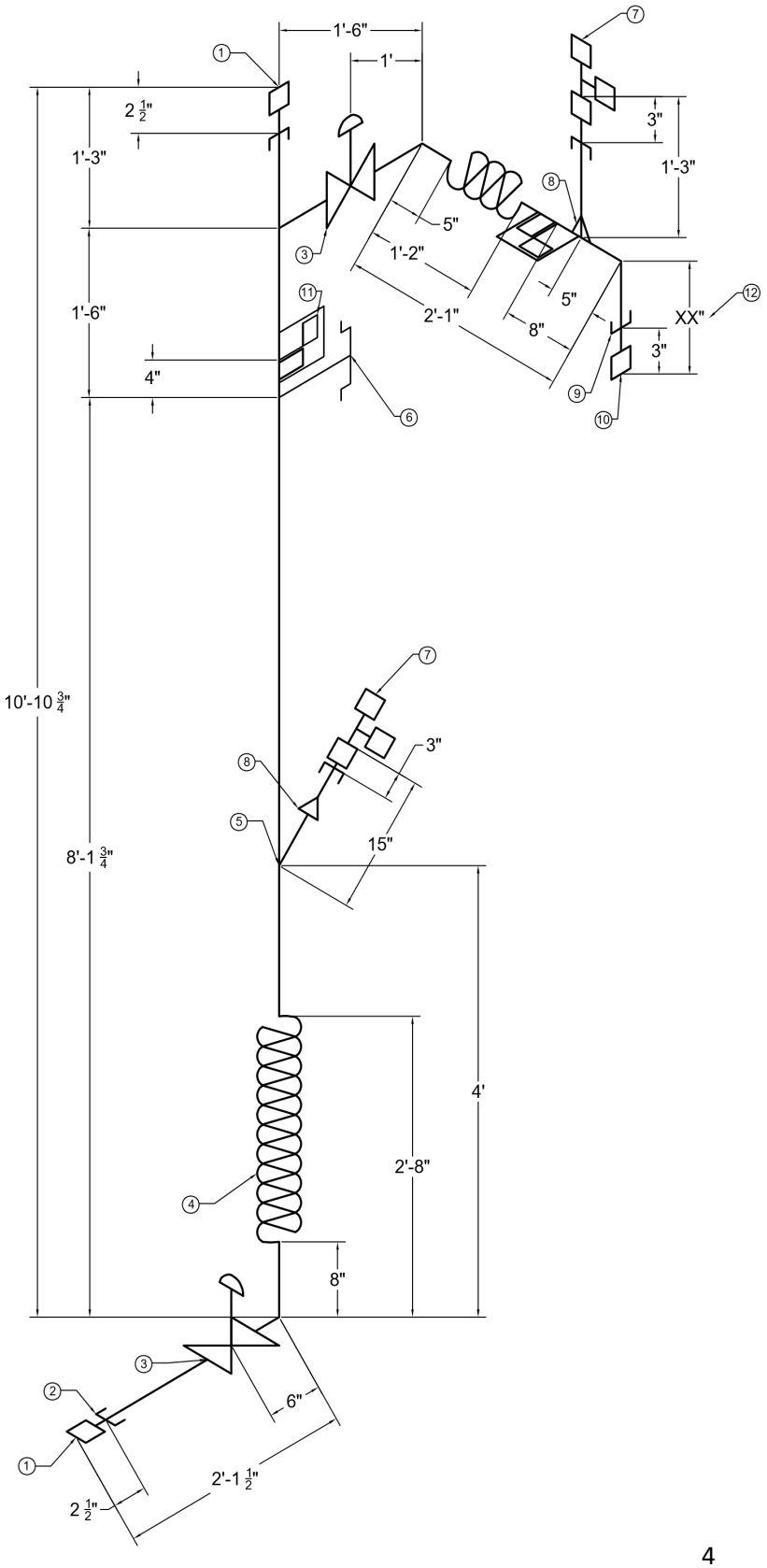
MATERIAL CERTS REQUIRED FOR INNER PRESSURE PIPING

PIPING CLEANED FOR OXYGEN SERVICE PER QA 103

ALL DIMENSIONS ARE TO CENTERLINE OF PIPE UNLESS NOTED OTHERWISE

LEGEND:

1. 1" AN FEMALE SWIVEL CONNECTOR (QTY. 2)
2. END OF VACUUM JACKET
3. 1" ACTUATED VJ GLOBE VALVE (QTY. 2)
4. 1" X 3" VJ FLEX W/ OUTER BRAID (QTY. 2)
5. 1" "Y" BRANCH
6. 1" X 2-1/2" LH2 MALE BAYONET CONNECTION
   - 6.1. CAP WITH 1" X 2-1/2" LH2 FEMALE BAYONET AND CAPPED PORT
7. 1/2" UNION TEE (QTY. 2) (SWAGELOK SS-810-3)
8. 1" X 1/2" REDUCING TEE (QTY. 2)
9. SS 1/4-20 BOLT TACKED TO OUTER JACKET
10. 1" VCR GLAND W/ MALE NUT (QTY. 1) (SWAGELOK SS-16-VCR-4)
11. 1/2" PUMPOUT/VACUUM RELIEF PORT AND DV-6R VACUUM GAUGE TUBE W/ ISOLATION VALVE (QTY. 2)
12. MAKE DIMENSION AS SHORT AS POSSIBLE. TERMINATE FROM VJ-ELBOW INTO VCR CONNECTION



APPENDIX A: GROUND-BASED PRESSURE VESSEL AND SYSTEMS PURCHASES

NASA policy requires that the Pressure Systems Manager (PSM) review ground-based pressure vessel and systems (PVS) design and procurement specifications for compliance with NPD 8710.5 and NASA Standard 8719.17, which require that all new PVS be designed, acquired, fabricated, inspected, tested, installed, repaired, altered, operated, and maintained in accordance with the applicable codes, standards, guides, and regulations. Further, all flexible hose purchases shall conform to Glenn Safety Manual Chapter 7, paragraph 6.3.

The GRC PSM grants technical review authority to the PVS owner's organization. However, to avoid potential cost and schedule delays resulting from PVS that are not compliant with NPD 8710.5 and NASA Standard 8719.17, PVS requesters are strongly encouraged to involve the Pressure Systems Office (PSO) as early in the project effort as possible (e.g. – invite the PSO to participate in all reviews, seek the feedback of the PSO on specifications prior to the purchase of significant PVS), instead of waiting to obtain PSO concurrence during the safety permitting and recertification process.

If a PVS requester is unsure regarding the PVS's code compliance, and/or proper application of the PVS in an existing or new system (i.e. design pressure/ Maximum Allowable Working Pressure (MAWP), minimum design metal temperature, maximum design temperature, commodity compatibility, etc.) it is best to request a PSO review prior to initiating a procurement activity.

A PSO review may be requested by calling the Contact the PSO Help Line at (216) 433-2973 or by e-mail at grc-pso@mail.nasa.gov. All requests should include the following pertinent information: http://pso.grc.nasa.gov/DocumentFiles/PSODocs/7330/New Construction Documentation Checklist 6-1-2010.pdf. Electronic files can be transmitted via e-mail and hardcopies can be sent to the PSO at MS 6-8. Where the review request involves the replacement of existing recertified PVS, please provide the recertification tag numbers of the PVS being replaced.

APPENDIX B: Common Waste Collected Via the GRC260A Waste Disposal Request

1. The following are examples of waste not suitable for trash dumpsters that must be disposed of via the C260a Waste Disposal Request. https://shedapps.grc.nasa.gov/cms/DisposalRequests/WasteC260DataEntry.cfm

   - Liquids—any material that is a liquid or releases a free liquid
   - Corrosives (e.g. nitric acid, hydrochloric acid, sulfuric acid, sodium hydroxide, potassium hydroxide, zinc chloride, aluminum chloride, etc.)
   - Batteries
   - Chemicals (Note: If it has a barcode or needs reviewed for approval prior to purchase it needs to be disposed of via the GRC260A Waste Disposal Request).
   - Combustible or ignitable materials (e.g. fuel oil, paint, kerosene etc.)
   - Compressed gas cylinders
   - Compressors
   - Fuels
   - Lighting bulbs—including, but not limited to, fluorescent, LED, metal halide, mercury, vapor, or sodium vapor
   - Lighting ballasts
   - Lumber or wood—other than tiny incidental pieces included in floor sweepings, etc.
   - Metal that can be recycled
   - Combustible or pyrophoric metals (e.g. alkyl metals [t-butyllithium, trimethylaluminum], alkyl metal halides [diethylaluminum bromide], organometallics [organolithium], white phosphorous, super fine metal powders [iron, lead, nickel, aluminum], silanes)
   - Oil
   - Oil-soaked rags that have free liquid, including solvents or fuels
   - Painted or treated wood pallets (untreated/unpainted wood pallets can be recycled in the LTID wood dumpster)
   - Paint cans—if they are not empty and if they contain liquid paint of any type or solid (dried-out) oil-based paint
   - Powdered metals (e.g. iron, aluminum, cobalt, any metal in powder form)
   - Solvents (e.g. ethanol, isopropanol, acetone, MEK, acetonitrile, etc.)
   - Empty aerosol cans (there should be a stand-alone collection container for these, if not contact Code FE)

If you are not certain if the waste is suitable for trash dumpsters contact Code FE, Lisa Ramsey.