

**STATEMENT OF WORK (SOW)
FOR
ICPSU
VACUUM JACKETED PIPE SPOOLS**

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ENGINEERING AND TECHNOLOGY DIRECTORATE

National Aeronautics and
Space Administration

John F. Kennedy Space Center



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Prepared By:

Carl Exline, LMSSC
Fluids Engineer

Concurrence

Ted Adams, NEF2
NASA Fluids Design Branch Chief

Michael P. Williams, KSC-SMASS
NASA Quality

Ed Thompson, NEF2
Lead LH2 Design Engineer

Christian O'Connor, NEF2
Lead LO2 Design Engineer

Approved by:

Steve Hoyle, ESC
Systems Engineer

Steve N. Kyramarios
Project Manager

This signature page is electronically signed in business system, KDDMS

**K0000146602-GEN
REVISION BASIC**

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ABBREVIATIONS, ACRONYMS, AND SYMBOLS

ACA	After Contract Award
ADP	Acceptance Data Pack
ANSI	American National Standard Institute
AR	Acceptance Review
ASME	American Society of Mechanical Engineers
ASQ	American Society for Quality
ATP	Authority To Proceed
CM	Configuration Management
GMIP	Government Mandatory Inspection Point
GPA	Government Quality Assurance
GSI	Government Source Inspection
ICPO	Inspection Control Point Outline
ISO	International Organization for Standardization
KSC	Kennedy Space Center
LH ₂	liquid hydrogen
LO ₂	liquid oxygen
MIP	Mandatory Inspection Point
MLI	Multi-Layer Insulation
NASA	National Aeronautics and Space Administration
NDE	None Destructive Evaluation
NPD	NASA Policy Directive
PT	Penetrant Testing
QAR	Quality Acceptance Representative
RT	Radiographic Testing
SAE	Society of Automotive Engineers
SLS	Space Launch System
SOW	Statement Of Work
VJ	Vacuum Jacketed

1.0 PURPOSE AND SCOPE

1.1 Purpose

Design, fabricate and deliver LO2 and LH2 vacuum jacketed piping and single wall pipe.

1.2 Contractor Scope

This statement of work (SOW) defines the effort for the design, fabrication, testing, and delivery of VJ pipe and single wall pipe. This SOW does not replace the requirements noted on the referenced specifications.

NASA will specify the basic system piping requirements along with spool drawings showing pipe dimensions, fittings and spacer locations. This information is provided to the Contractor for creation of shop drawings that further detail spacer design, field joint design and MLI/Getter design.

The Contractor shall fabricate the pipe sections from the shop drawing. The Contractor shall provide the design and fabrication details for maintenance, repair or rework of the system/assembly.

The Contractor shall provide the items dictated by specifications and the applicable piping code, e.g. material specifications, weld certs/inspections, dimensional verifications, test results, etc.

2.0 APPLICABLE DOCUMENTS

The following documents are applicable to this SOW:

Specification Number	Revision	Description
ASME B31.3	2012	Process Piping
NPD 8730.5	B with Change 2	NASA Quality Assurance Program Policy

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ISO 17025	2005	General Requirements for the Competence of Testing and Calibration Laboratories
ANSI/ISO/ASQ 9001	2008	American National Standard Quality Management Systems Requirements
ASME Y14.100	Edition 4	Engineering Drawing Practices
ASME Y14.41	Edition 12	Digital Product Definition Data Practices
ASME Y14.5	Edition 9	Dimensioning and Tolerancing
ISO 10012	2003	Measurement Management Systems - Requirements for Measurement Processes and Measuring Equipment - First Edition
SAE AS9003	A	Inspection and Test Quality System
SAE AS9100	C	Quality Systems Aerospace – Model for Quality Assurance in Design, Development, Production, Installation, and Servicing
K0000146598	Basic	Specification, LH2 Vacuum Jacket Pipe
K0000146597	Basic	Specification, LO2 Vacuum Jacket Pipe
K0000147032	Basic	Specification, LO2 Single Wall Pipe
K0000146602-GEN, Attachment 1	Basic	Hardware Deliverable List
K0000146602-GEN, Attachment 2	Basic	Contract Exhibit L - Government Furnished Material

3.0 REQUIREMENTS

The Contractor shall meet the following requirements contained in this section and the procurement specifications for the performance of this procurement.

3.1 General

The following general scope applies:

The Contractor shall submit for approval detailed shop drawings in accordance with LH2 VJ pipe specification K0000146598, LO2 VJ pipe specification K0000146597 and LO2 Single Wall Pipe K0000147032.

NASA (or its designated representative agent) reserves the right to witness and inspect any part during the construction, fabrication, assembly and test period at the Contractor or Contractor's suppliers / subcontractor's site.

Table 1 provides a summary of SOW deliverables.

3.2 Monthly Status Reports

The Contractor shall provide a monthly status report to NASA. This report shall provide data for the assessment of monthly cost, technical and schedule progress and summarize the results of the entire contract work. The monthly status report shall include:

- A. Work accomplished for current reporting period, including a report of overall cost, technical and schedule performance.
- B. Work planned for next reporting period.
- C. Current problems which impede performance or impact program schedule or cost, and proposed corrective action.
- D. Other information that may assist NASA in evaluating the Contractor's cost, technical and schedule performance.

3.3 Project Schedule

The Contractor shall develop and maintain a project schedule and use it to track project's progress. The project schedule shall illustrate the schedule that the Contractor intends to follow over the period of performance. The schedule shall be of sufficient detail to ensure that slips to events and product deliveries shall be projected and reported back to NASA in a timely manner. The program schedule shall be expanded if notified by NASA that the level of detail is insufficient. The Contractor shall provide a logic linked project schedule in Microsoft Project 2003 or later. Draft schedule shall be submitted with proposal. Schedule baseline shall be established 30 days after contract award. Schedule of progress after baseline will be required at two week status updates, coincident with bi-weekly teleconference meetings.

3.4 Meetings

The Contractor shall maintain and provide all resources necessary to support the meetings and reviews defined in this SOW. Contractor shall maintain meeting minutes with any action items identified with responsible organizational representative, date action initiated, corrective action and action completion date.

3.4.1 Bi-Weekly Teleconference

The Contractor shall support a teleconference every two weeks (bi-weekly) for schedule and technical status with NASA engineers and the procurement NASA agent. The Contractor shall include, as a minimum, a review of the program schedule, document status, design, development hardware fabrication and test status, problem identification, and any efforts undertaken for corrective action.

3.4.2 Technical Kickoff Review

The Contractor shall conduct a Technical Kickoff Review teleconference not later than one (1) week after contract award. At a minimum this review should cover proposed basic high level concepts, and initial schedule for design and certification testing. This meeting will also serve as first technical exchange of Contractor engineering and NASA engineering for clarification of any technical items.

3.4.3 Drawing Review

The Contractor shall conduct a drawing review teleconference meeting with NASA. Contractor shall deliver drawing review package a minimum of 14 calendar days before the meeting and maintain the drawings and NASA design comments following the review. Vendor shall provide one of the following responses for each NASA design comment within 7 calendar days after drawing review: accept, reject, accept with intent, duplicate. Clarification notes shall be provided to ensure accurate comment implementation.

Deliverables:

The Contractor shall deliver and maintain the following document(s):

- Drawing Review Package
- Design Comments Response

3.4.4 Acceptance Review (AR)

The Contractor shall conduct an Acceptance Review based on the Certification Plan and associated detail Data Requirements Matrix. The AR will be chaired by NASA and with the Contractor supplying all documentation needed to establish acceptability of hardware for its intended use. This review is conducted after as-built design drawings are complete and acceptance and qualification testing and associated reports are complete.

Deliverables:

The Contractor shall deliver and maintain the following document(s):

- Material Reports

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- ASME B31.3/NASA Fabrication, Assembly, Erection, and Examination reports
- Provide material reports for all materials used in construction to ensure compliance with ASME B31.3 reference paragraph 323.1. Material reports shall contain mechanical and chemical properties.
- Provide impact test results for all materials requiring impact test per ASME B31.3 reference paragraph 323.2.2.
- Material thickness used in calculations shall match actual ordered thicknesses
- Identify heat treatment state for materials
- Material certification of conformance
- Material certification records for all material and components traceable to original vendor
- Provide weld data, WPS, WQs, etc in accordance with ASME B31.3 reference paragraph. 328
- Provide written letter that welding materials are maintained in accordance with ASME B31.3 reference paragraph 328.3, 328.3.2, 328.3.3 as applicable.
- Provide as-built shop drawings showing weld sizes in accordance with ASME B31.3 reference paragraph. 328.5.2.
- Provide as-built shop drawings showing welded branch connection dimension in accordance with ASME B31.3 reference paragraph. 328.5.4.
- Provide examiner's qualifications in accordance with ASME B31.3 reference paragraph 342
- Provide NDE report (RT, PT, VE, etc) for each spool in accordance with ASME B31.3 reference paragraph 344
- Provide leak test report for each spool in accordance with ASME B31.3 reference paragraph 345
- Provide test reports for tests in accordance with the VJ Pipe specification
- Lifting plan for each spool including center of gravity annotated, lifting points and any special lifting or handling equipment.
- Digital radiograph negatives may be used, in lieu of film, provided digital formats satisfy ASME B31.3 for clarity in detecting "severe cyclic" flaw sizes, or have no associated compression algorithm that loses resolution upon file handling. Viewing software program shall be provided with computer operating system requirements. Native files shall be provided Two-dimensional (2-d) graphical data shall be delivered in the following lossless image formats.
 - Portable network Graphics (image/png)
 - Tagged image Format File (Image/tiff)
 - Joint Photographic Experts Group 2000 (Image/zip)
 - Computer Graphics Metafile (image/cgm)
- Packaging protection, and transportation plans to KSC
- Certificate of compliance to the SOW and procurement specification

3.5 Configuration Management

The Contractor shall implement Configuration Management (CM) in accordance with AS9100 on hardware. The government has the right to perform configuration audits at any time during the fabrication process.

3.6 Product Assurance

3.6.1 Quality Plan

The Contractor shall detail their planned quality controls and methods for accomplishing the applicable tasks required to satisfy the quality requirements of NPD 8730.5 for the hardware being procured in a Quality Plan. The Quality Plan shall identify, as applicable, the specific quality activities (implementation) related to the design, procurement of materials/subcomponents, fabrication, test, storage, and shipping to assure the quality of the items delivered. The plan shall reference the Contractor's quality manual and procedures as necessary to fully describe the Contractor's quality system. The Quality Plan overview shall initial be submitted with the Contractor's proposal. The Quality Plan shall be base lined at contract award with additional changes as required. Changes shall be incorporated by change page or complete reissue.

Each quality element of SAE AS9100 in conjunction with either ANSI/ISO/ASQ Q9001-2008 or SAE AS9003 and/or as applicable ISO 17025 shall be addressed to describe the philosophy and approach for implementation. This can be satisfied by Contractor's existing quality manual and procedures. The only exceptions allowed will be processes noted in Section 7 of AS9100 and/or ANSI/ISO/ASQ 9001-2000. A copy of the Quality System Manual and 1st tier procedures shall be submitted with any required quality plan.

Deliverables:

The Contractor shall deliver and maintain the following document(s):

- Quality Plan

3.6.2 Calibration System

The Contractor shall have a documented calibration system that meets the requirements of ISO 10012 Measurement Management Systems - Requirements for Measurement Processes and Measuring Equipment - First Edition, or equivalent standards.

3.6.3 Inspection Control Point Outline

Special inspections, called mandatory inspection points (MIP), will be designated by the Government during the performance of this contract. Prior to the start of work, the Contractor shall provide the NASA KSC Quality Assurance Representative (QAR) a schedule and Inspection Control Point Outline (ICPO) which shows the work sequence(s) to be employed during the performance of this Purchase Order. The contractor's schedule/ICPO must indicate what types of contractor inspections will be performed and

where in the contract's sequence of events they will be accomplished. If applicable, the schedule/ICPO must also indicate the specification(s) (including revisions) and/or other documentation that will be used to perform the indicated inspections. The Government will identify which inspections/tests/work steps require Government Quality Assurance (GQA) witness. These inspections/tests and/or work steps will be designated as GMIPS. The contractor shall notify The NASA KSC QAR at least five (5) working days prior to the occurrence of a scheduled, designated GMIPS. Designation of GMIPS does not relieve the contractor of the obligation to perform all contractually required inspections.

3.6.3.1 Mandatory Inspection Points

Quality Assurance inspection shall be included in contractor procedures and ICPO, but not limited to the following tasks:

- 1) Initial Acceptance test of Hardware (prior to start of certification tests) such as:
 - a) Hydrostatic Leak Test
 - b) Internal pipe leak Test
 - c) Vacuum retention test
 - d) LN2 cold shock test

3.6.3.2 Government Mandatory Inspection Points

In addition to the Mandatory Inspection Points listed in Section 3.6.3.1, NASA inspection shall be included, but not limited to the following tasks:

- 1) Final Acceptance Test

The Government reserves the right to perform inspections at any point in the fabrication process.

Deliverables:

The Contractor shall deliver and maintain the following document(s):

- Inspection Control Point Outline (ICPO)

3.6.3.3 Government Source Inspection (GSI)

The Contractor shall notify the responsible QAR at least five (5) working days in advance of the date goods or services will be ready for tests, inspections, or other MIP's, as required. Evidence of GSI must be indicated by the QAR's stamp or signature on the Contractor's shipping document. In the event the QAR cannot be contacted, notify the NASA Contracting Officer immediately. All work on this Purchase Order/Contract is subject to inspection and test by the Government at any time and any place.

3.6.4 Acceptance Data Package

The Contractor shall develop, maintain and deliver, for each VJ pipe spool end item assembly, an Acceptance Data Package in accordance with SOW paragraph 3.4.4. One electronic ADP 10 days delivered to CO for review. And then one updated electronic and one hardcopy with shipment. Any units shipped without ADP will not be considered acceptable for receipt.

3.6.5 Report Format

All documents submitted shall contain the following:

1. Unique document number
2. Document revision level and date
3. Title page with Subcontractor's name and address, document number, revision level, date, title, part number, nomenclature of the part, and Contract number
4. Revised documents shall have a revision summary detailing the changes and pages affected
5. Table of contents (does not apply to sheet drawings)
6. All pages, appendices, figures and tables shall be numbered and listed in the table of contents
7. All data deliverables shall be delivered electronically in common computer formats such as Word, Excel, Acrobat, etc. unless otherwise specified. All engineering records - drawings, reports, calculations, etc shall be provided to the government in root file format as well as an image file such as PDF and two clean, hard copies. All Contractor detail proprietary documents shall be appropriately marked per individual sheet.

3.6.6 Drawings and Associated Lists

Engineering drawings and associated lists shall be provided to meet the requirements of ASME Y14.100 and ASME Y14.41. This documentation shall define the detailed design to support manufacturing and testing of the hardware. In addition, Geometric Dimensioning and Tolerance is required and shall be in accordance with ASME Y14.5. In addition, 2D and 3D CAD models shall be submitted between milestones as requested by NASA.

4.0 GOVERNMENT FURNISHED MATERIAL

The Contractor shall be provided with government furnished material in support of the contract identified in Contract Exhibit L (K0000146602-GEN, Attachment 2). The property to be provided, including the property description and availability dates, shall be as specified in the contract exhibit. The terms and conditions governing the furnishing of said property and property accounting requirements shall also be specified in the contract document. The Contractor shall identify their internal process for management and control of government furnished material.

5.0 HARDWARE DELIVERABLES

All pipe sections upon successful completion of required tests are the property of the government. SOW Hardware deliverables are listed in K0000146602-GEN, Attachment

1. Items to be shipped to KSC at the following address:

NASA - John F. Kennedy Space Center

Kennedy Space Center, Florida 32899

6.0 OWNERSHIP / RIGHTS TO DESIGN

NASA is requesting full release of all drawings, calculations, procedures, processes, etc. for review / approval to fabrication / test to NASA and any of NASA's subcontract teams associated with the SLS Program integrated design, interfaces, and operations of the LO2 and LH2 VJ system. NASA may potentially later utilize in troubleshooting or emergency response, or in the event the Contractor became insolvent during the life of program without the rights of these components being sold or transferred to another company representing the Contractor. The government does not request ownerships/rights to have the marked proprietary components manufactured by others.

Table 1: SOW Deliverables Summary

SOW Paragraph	Description	Initial Submittal	Frequency
3.2	Monthly Status Reports	ATP + 1 month	Monthly
3.3	Project Schedule	ATP +30 days	Every 2 weeks
3.4.1	Teleconference	ATP + 2 weeks	Every 2 weeks
3.4.2	Technical Kick-off	ATP + 1 week	None
3.4.3	Drawing Review	Per Negotiated Schedule	As Required
3.4.4	Acceptance Review	Per Negotiated Schedule	None
3.6.1	Quality Plan	ATP	As Required
3.6.3	Inspection Control Point Outline	Prior to start of fabrication	As Required
3.6.4	Acceptance Data Package	10 days prior to product shipment	Final 1 electronic and 1 hard copy delivered with shipment