

UNITED STATES  
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION  
LANGLEY RESEARCH CENTER  
HAMPTON, VIRGINIA

SPECIFICATIONS  
FOR  
20-INCH MACH 6 CF4 TUNNEL RECLAIMER MODIFICATIONS  
BUILDING 1275

LANGLEY RESEARCH CENTER, HAMPTON, VIRGINIA

SPECIFICATION NO. 1-LAT-19862

DATE: 5-20-04

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SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

1.1 SUMMARY

The Contractor shall utilize these specifications for the design and fabrication of a carbon tetrafluoride (CF4) reclamation system for installation by others at NASA Langley Research Center, Building 1275. The work shall include commissioning of the reclamation system as defined in Section 15230.

The Contractor shall furnish all plant, equipment, tools, materials, labor and services necessary for or incidental to a complete and finished job as shown on the drawings listed below and as specified herein.

All references to the Contracting Officer contained in this specification, or any severable part thereof, shall be determined to mean the Contracting Officer or the Contracting Officer's Technical Representative. If any question arises concerning the "authorization" status of a Contracting Officer Technical Representative, the Contractor shall immediately refer the question, in writing, to the Contracting Officer. Any references to "as directed", "approved by", "witnessed by", or "submitted to", shall be determined to mean the Contracting Officer.

Where "as indicated" and "as specified" are written it shall refer to "as indicated on the drawings," and "as specified in the specifications". The specifications will always take precedence over the drawings.

Where "day" or "days" are written it shall mean calendar day or days, unless otherwise stated in the specification.

Where "hour" or "hours" are written it shall mean clock hours, unless otherwise stated in the specification.

The work to be performed includes, but is not limited to, the following:

The design and fabrication of a complete CF4 reclamation system, including system commissioning.

Provision of PLC controls for CF4 reclamation system with communication interface.

Provision of a human machine interface through the use of touchscreen terminals.

The work is divided into a baseline project and two deductive line items, as follows:

BASELINE PROJECT

- a. Project Management: to include development of project management plans, schedules, submittals, progress meetings, and progress reports; and coordination of all subcontract work.
- b. Engineering and Design: to include studies, design reviews, calculations, analyses, safety design considerations, safety and hazards analyses, drawings, specifications, installation cost estimate and test plans. Work to include the custom design of a new CF4 drier/CO2 removal skid, a cryogenic purifier cold box, a dual high-pressure pump skid and new vaporizer to meet specific performance requirements specified in Section 15230, using off the shelf components wherever possible.
- c. Factory Construction: to include fabrication, assembly, and unit testing of selected components prior to shipment.
- d. Commissioning: to include system and operational tests; operational tests to include system integration test (tunnel running).

Deductive Line Item 1: Provide a single HP liquid pump in CF4 Reclamation System, rather than dual HP liquid pumps.

The baseline project shall include appropriate interfaces to add the second pump at a later date with minimal rework. It is understood that the system reliability is compromised without the use of a second pump.

Deductive Line Item 2: Eliminate the dryer skid in the CF4 Reclamation System.

The baseline project shall include appropriate interfaces to add a dryer skid at a later date with minimal rework. It is understood that the gas CF4 purity requirement cannot be met because the moisture and carbon dioxide contaminant impurities cannot be removed without the dryer skid. All other equipment in the system shall be designed and supplied to meet the original requirements.

1.2 DRAWINGS

Drawings developed under the Technical Specifications shall be used for installation activities which are not part of this contract.

1.2.1 Reference Drawings

The following drawings are provided for information only, to assist the Contractor in performance of the requirements of these specifications:

<u>DRAWING NO.</u>	<u>REV.</u>	<u>SHEET NO.</u>	<u>TITLE</u>	<u>LATEST DATE</u>
1239526	-	P14	CF4 Reclamation System Installation Plan and Notes	4-28-04

1239545	-	E6	Bldg 1275 Electrical New Work Plan, MCC Elevation, and Notes	12-13-02
1239546	-	E7	New One-Line Diagram	12-13-02
1239547	-	E8	Block Diagram Controls	4-28-04
1239548	-	E9	PLC Assembly and List of Materials	12-13-02
1239549	-	E10	New Reclaimer & PLC Control Panel Assembly Details	4-28-04
1239550	-	E11	List of Materials Schedule	4-28-04

1.3 SCHEDULE

1.3.1 General Schedule Requirements

The Contractor shall commence work within ten (10) calendar days after receipt of Notice to Proceed. Except for system commissioning, all work as required by these specifications shall be completed within 365 consecutive calendar days after date of receipt of Notice to Proceed. System commissioning shall be completed within 60 consecutive calendar days, and shall start within 7 days after Contractor is notified by Contracting Officer. Notification to start system commissioning shall occur within two years of contract Notice to Proceed.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

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SECTION 01330

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SECTION 01330

SUBMITTALS

PART 1 GENERAL

1.1 SUMMARY

This section defines and explains the general submittal requirements applicable to all submittals under this contract. Specific submittals required are set forth by the various administrative or technical sections of this specification, the contract drawings, or other portions of this contract. Accordingly, the Contractor shall make timely and complete submittals as required by all applicable contract provisions.

The requirements of this Section apply to, and are a component part of, each section of the specifications.

1.2 SUBMITTAL PREPARATION AND CONTENT

1.2.1 Technical Submittals

All technical submittals, for action of the Contracting Officer, shall be submitted on the Langley Technical Submittal Form (see Attachment 1). The actual transmittal form for this project will be transmitted to the Contractor at the time of Notice to Proceed.

The technical submittal form shall serve as the Contractor's cover sheet and also the Government's approval/review sheet back to the Contractor.

The Contractor shall submit one technical submittal form cover sheet for each package of submittals.

Technical submittals shall be grouped by specification section, limited to eight (8) submittals per cover sheet from one specific specification section.

The Contractor shall complete the item number, specification section and paragraph number, SD number and description for each item submitted.

The Contractor shall note any specification deviation included in the submittal package.

1.2.2 General

All submittals shall be in the English language.

Submittals become the property of the Government. The Government reserves the right to duplicate, use, and disclose, in any manner and for any purpose, shop drawings delivered under this contract. Wording such as



"Confidential", "Do not reproduce", and similar statements shall not be included on the submittals. Submittals that prohibit duplication will be returned to the Contractor for correction and resubmitting. Refer to FAR 52.236-1, Performance of Work by the Contractor, for additional information.

The Contractor shall specifically point out variations of submittal items from contract requirements in transmittal letters. Failure to point out deviations may result in the Contracting Officer requiring rejection and removal of such work at no additional cost to the Government.

The Contractor shall allow 30 calendar days for review of submittals. If the Contractor deems a submittal critical or urgent (e.g., to order long lead-time items; enter into firm subcontracts or supplier purchase orders), it shall so state on the letter or form transmitting such submittal and shall indicate its priority for the items submitted.

The Contracting Officer will, after receipt of submittals, return one copy to the Contractor marked "Reviewed", "Approved," "Approved with corrections as noted," "Reviewed with corrections as noted," or "Returned for corrections," which shall be interpreted as follows:

Submittals marked "Reviewed" authorize the Contractor to proceed with the work covered by such submittals.

Submittals marked "Approved" authorize the Contractor to proceed with the work covered by such submittals.

Submittals marked "Approved with corrections as noted" or "Reviewed with corrections as noted," authorize the Contractor to proceed with the work covered by such submittals in accordance with the corrections indicated thereon. The Contractor shall make the corrections to the submittals and resubmit them to the Contracting Officer within fifteen calendar days after receipt of the marked submittals.

Submittals marked "Returned for correction" require the Contractor to make the necessary corrections and revisions to the submittals and to resubmit them for approval by the Contracting Officer.

Where the submittal is for Information, the Government may indicate recommended corrections, or take no action, at its discretion. The Contractor may proceed with the work without response from the Government.

Government review or approval does not relieve the Contractor of responsibility for the accuracy and correctness of submittal data furnished or for compliance of the submittal's subject items with all applicable contract requirements.

Where review of the submittals is indicated, the Contracting Officer will notify the Contractor of any recommended corrections within 30 calendar days after receipt. If the Government takes no action within 30 calendar days, the Contractor may assume Government acceptance and proceed with the work.

Where Approval of submittals concerning materials, drawings, or other

submittals is required prior to work execution, the Contractor shall not proceed with the affected work until such approval is received from the Contracting Officer. Government action will be taken within 30 calendar days.

Partial Submittals will not be accepted for expediency of the contract's completion.

#### 1.2.3 Calculations, Drawings, Data, and Other Contractor Submittals

The Contractor shall collect the required data submittals for each specific material, product, unit of work, or system into a single submittal and marked for choices, options, and portions applicable to the submittal. Marking of each copy of product data submitted shall be identical.

##### 1.2.3.1 Calculations and Drawings

As required by these specifications, the Contractor shall prepare all calculations and/or drawings to fabricate, assemble and install all parts of the work, in such detail that will enable the Contracting Officer to understand and check conformity with the contract specifications.

The Contractor shall collect copies of the calculations and computations in booklet form, arranged to show electrical, mechanical, and structural/architectural divisions.

When action on submittals is taken by the Contracting Officer, each copy of drawings/calculations will be identified as having received such action by being so stamped and dated. The Contractor shall make any corrections required by the Contracting Officer. If the Contractor considers any correction indicated to constitute a change to the contractual requirements, the Contractor shall promptly notify the Contracting Officer and shall not proceed with the work covered thereby until directed to do so. The approval of the drawings by the Contracting Officer shall not be construed as a complete check, but will indicate only that the general method of construction and detailing is satisfactory. The Contractor shall be responsible for the dimensions and design of adequate connections, and details, and satisfactory construction of all work.

The drawings shall be made by using the AutoCAD drafting program and be of such quality of workmanship to permit the making of legible reproductions and revisions without impairing their usefulness. Drafting standards employed shall permit reducing the drawing to a 35mm negative from which a full size enlarged print can be reproduced without loss of resolution of the information contained thereon.

The drawings shall be submitted on white bond paper, not less than 8½ by 11 inches in size, not larger than 22 by 34 inches in size, except for full size patterns or templates.

Shop drawings shall be prepared in accurate size, with scale indicated, except where other form is required. A responsible representative of the Contractor shall sign all drawings.

Drawing reproducibles shall be suitable for microfilming and reproduction and shall be of a quality to produce clear, distinct lines and letters. Drawings shall have dark lines on a white background.

Copies of each drawing shall have the following information clearly marked thereon:

- a. The job name, which shall be the general title of the contract drawings.
- b. The date of the drawings and revisions.
- c. Name of Contractor.
- d. Name of Subcontractor and/or manufacturer.
- e. The name of the item, material, or equipment detailed thereon.
- f. The number of the submittal (e.g., first submittal) in a uniform location adjacent to the title block.

The Contractor shall submit drawings in a sequence that will permit the work to proceed in an orderly manner consistent with the sequence of events as scheduled on the Contractor's scheduling technique required by this contract.

#### 1.2.4 Submittal Descriptions (SD)

Submittal Description (SD): These are drawings, diagrams, layouts, schematics, catalog cuts, descriptive literature, illustrations, schedules, performance and test data, and similar materials to be furnished by the Contractor explaining in detail specific equipment and portions of the contractually required work. Drawings, diagrams, layouts, schematics, schedules, performance, test data and similar materials shall be submitted in hard copy and electronic files. Manufacturer catalog cuts, descriptive literature, illustrations and similar materials shall not be required to be submitted as electronic files.

The following items are descriptions of data to be submitted for the project. Additional requirements to actually furnish the applicable items will be called out in each specification section.

#### SD-01 Data

##### General:

Submittals which provide calculations, descriptions, or other documentation regarding the work.

##### Manufacturer's Catalog Data:

Data composed of catalog cuts, brochures, circulars, specifications and product data, and printed information in sufficient detail and scope to verify compliance with requirements of the contract documents.

#### SD-04 Drawings

Submittals which graphically show relationship of various components of the work, schematic diagrams of systems, detail of fabrications, layout of particular elements, connections, and other relational aspects of the work. Drawings may include the types of graphically depicted information discussed below.

Original shop drawings including Connection Diagrams and Schematics shall be created using the current or immediately previous release of AutoCAD.

The drawings shall be coordinated with the wiring diagrams of the equipment furnished under sections of Division 16. The original tracings of the submitted shop drawings, including electronic files in AutoCAD format, shall be forwarded to Langley Research Center for retention.

#### Connection Diagrams

Connection diagrams shall indicate the relations and connections of devices and apparatus. They shall show the general physical layout of all controls, the interconnection of one system, or portion of system, with another, and all internal tubing, wiring, and other devices.

#### Control Diagrams

Control diagrams shall show the physical and functional relationship of equipment. Electrical diagrams shall show size, type, and capacity of the systems. Process and Instrumentation Diagrams (P&ID) shall be furnished where fluid, air or gas systems are used.

#### Elementary Diagrams

Elementary diagrams shall indicate, in straight-line form, without regard for physical relationship, all supporting systems and elements of equipment and associated apparatus.

#### Interconnection Diagrams

Interconnection diagrams shall indicate, to scale, interface between associated units of equipment and between equipment and systems.

#### Schematics

Schematic drawings shall depict the functional flow of systems and their interfaces with facilities and other systems. Functional and physical interfaces shall be indicated. Schematics need not be to scale. Schematics may be structural, mechanical, electrical, or a combination of these.

#### Fabrication/Erection/Installation Drawings

Fabrication, erection, installation, and checkout drawings and specifications shall indicate equipment arrangement, with elevations, sections, and enlarged details. Details shall indicate proper methods of fabrication, construction, and installation.

Pressure Systems Drawings:

Pressure systems drawings shall be an isometric depiction of the pressure piping system as installed. The drawing shall include all system components, each uniquely numbered, including supports and all other specific elements that represent the as-built configuration. Component numbering shall be continuous throughout the system.

SD-06 Instructions

Preprinted material describing installation of a product, system, or material, including special notices and material safety data sheets, if any, concerning impedances, hazards, and safety precautions.

SD-07 Schedules

Tabular list of data or tabular list including location, features, or other pertinent information regarding products, materials, equipment, or components to be used in the work.

SD-08 Statements

A document, required of the Contractor, or through the Contractor by way of a supplier, installer, manufacturer, or other subcontractor, to further the quality or orderly progression of a portion of the work by documenting procedures, acceptability of methods or personnel qualifications, or other verification of quality. This shall include plans or other documentation to ensure compliance with local, state, and federal safety laws and regulations.

SD-09 Reports

General:

Reports of inspections and/or laboratory tests, including analysis and interpretation of test results. Each report shall be properly identified. Test methods used and compliance with recognized test standards shall be described.

Test Reports:

A report signed by an authorized official of a testing laboratory that a material, product, or system identical to the material, product, or system to be provided has been tested in accordance with requirements specified by naming the test method and material. The test report must state the test was performed in accordance with the test requirements; state the test results; and indicate whether the material, product, or system has passed or failed the test. Testing must have been within 3 years of the date of award of this contract.

Factory Test Report:

A written report which includes the findings of a test required to be performed by the Contractor on an actual portion of the work or prototype prepared for this project before it is shipped to the job site. The report must be signed by an authorized official of the manufacturer or an independent testing laboratory and must state the test results. The report shall also indicate whether the material, product, or system has passed or failed the test. These reports shall be subject to approval of the Contracting Officer, unless otherwise specified herein, before delivery of the materials or equipment. This approval shall not relieve the Contractor of the obligation to meet all the requirements of the contract.

Field Test Report:

A written report which includes the findings of a test made at the job site, in the vicinity of the job site, or on a sample taken from the job site, on a portion of the work, during or after installation. The report shall be signed by an authorized official of a testing laboratory or agency, must state the test results, and indicate whether the material, product, or system has passed or failed the test.

SD-13 Certificates

Statements signed by responsible officials of a manufacturer of a product, system, or material attesting that the product, system or material meets specified requirements. The statements must be dated after award of contract, name the project, and list the specific requirements.

SD-19 Operation and Maintenance Manuals (O&M)

The technical specifications identify requirements for operation, maintenance instructions, and parts, and describe specific testing requirements for certain items of equipment and/or systems. Where such requirements exist, the Contractor shall furnish commercially available standard operation and maintenance data, including operating instructions, maintenance instructions and parts listings. Testing procedures shall be furnished as required to demonstrate full compliance with the technical provisions. Detailed requirements for these items follow.

Information required for the preparation of Operation and Maintenance Manuals (O&M) may be furnished in the form of manufacturers' standard brochures, schematics, and other printed instructions. Data shall include as a minimum the following items:

Recommended procedures and frequencies for preventive maintenance, inspection, adjustment, lubrication, and cleaning.

Special tools and equipment required for testing and maintenance.

Parts lists reflecting the true manufacturer's name, part number, and

nomenclature.

Recommended spares by part number and nomenclature and spare stocking levels.

Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system.

Troubleshooting, checkout, repair, and replacement procurement procedures.

Operating instructions including start-up and shutdown procedures.

Safety considerations including load limits, speed, temperature, and pressure

Four copies of the above data shall be submitted 30 calendar days prior to onsite delivery, and shall be updated and submitted for final approval not later than 30 calendar days prior to contract completion. Test data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear and legible. Pages for vendor data and/or the manuals shall be bound in three-ring, loose leaf binders and have 3/8-inch holes. Data shall be organized by separate index and tabbed sheets. Caution and warning indications shall be clear and well labeled.

### 1.3 MARKING

Marking shall be provided for each submittal to identify it by contract number, transmittal date, Contractor's, Subcontractor's, and supplier's name, address(es) and telephone number(s), submittal name, specification section and paragraph reference, drawing reference, and similar information to distinguish it from other submittals and to identify its contractual requirement source(s).

### 1.4 SUBMITTAL REQUIREMENTS

The following submittal summary chart itemizes the general and specific submittal requirements under this contract. The following letter codes designate the Government addressee(s) and Mail Stop(s):

- A - Contract Administrator, Mail Stop 126
- B - Contracting Officer Technical Representative, (COTR), Mail Stop 465
- C - Safety and Facility Assurance Office, Mail Stop 429
- D - Construction Services Unit, Mail Stop 428
- E - Accounts Payable and Employee Services Branch, Mail Stop 175
- F - Environmental Management Office, Mail Stop 418

The number following the letter code, as shown in the submittal summary chart, specifies the number of copies to be provided, (e.g., B-6). The required number of all submittals shall be delivered prepaid to Langley Research Center, Hampton, Virginia 23681-2199 addressed to the appropriate recipient and Mail Stop number as shown above.



## SUBMITTAL SUMMARY

<u>TITLE</u>	<u>FIRST SUBMITTAL</u>	<u>UPDATE</u>	<u>LTR CODE AND DISTRIBUTION</u>	<u>GOVERNMENT ACTION</u>	<u>SECTION</u>
SD-01, Data					
Manufacturer's Catalog Data	---	---	B-6	Approval	15230,16905 16960,16965
Design Calculations	**	---	B-6	Review	15230
Installation Cost Estimate	**	---	B-6	Review	15230
SD-04, Drawings					
Connection Diagrams	**	---	B-6	Approval	15230
Control Diagrams	**	---	B-6	Approval	15230
Elementary Diagrams	**	---	B-6	Approval	15230
Schematics	**	---	B-6	Approval	15230
Detail Drawings	**	---	B-6	Approval	15230,16960
Fabrication/ Erection/ Installation Drawings	30 Days Prior to Installation	---	B-6	Approval	15230
SD-06, Instructions					
Manufacturer's Instructions	**	---	B-6	Review	16905,16960
SD-07, Schedules					
Material and Equipment Lists	**	---	B-6	Review	15230
SD-08, Statements					
Test Plans/ Procedures Schedules	30 Days Before Test	---	B-5, C-1	Approval	15230
Test Procedures/ Mfg	30 Days Before Test	**	B-5, C-1	Approval	15230,16960

SUBMITTAL SUMMARY

<u>TITLE</u>	<u>FIRST SUBMITTAL</u>	<u>UPDATE</u>	<u>LTR CODE AND DISTRIBUTION</u>	<u>GOVERNMENT ACTION</u>	<u>SECTION</u>
SD-09, Reports					
Test Reports	10 Days After Test Completion	---	B-6	Review	15230
Factory Test Report	Prior to Installation	---	B-6	Review	16905,16960
SD-13, Certificates					
Certificates of Compliance	30 Days Before Installation	---	B-6	Review	15230
SD-19, Operation and Maintenance Manuals	30 Days Prior to Onsite Const.	30 Days Prior to Contract Completion	B-4	Review	15230

Quality Assurance Program

NOTE: Submittal Summary requirements are listed in Calendar Days.

- \* Calendar days after date of receipt of Notice to Proceed
- \*\* As required by specifying section with updates when significant changes occur

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

-- End of Section --

# Technical Submittal Form

Date Received:

TO:

FROM:

Distribution:

Contract No.:

Title:

**TO BE COMPLETED BY CONTRACTOR**

Submittal

New

Previous

Submittal Number:

Previous Submittal Number:

Item #	Specification Section Para No./Dwg. No.	SD No.	Description of Material (Include Type, Model No., Catalog No., Mfg., Etc.)	Action Code	Initials

Contractor Representative:

Signature:

Date:

Government Action Codes:    A-Approved;                      AC-Approved with corrections as noted;    RE-Reviewed  
    R-Returned for corrections;    RC-Reviewed with corrections as noted;

**FOR GOVERNMENT USE ONLY**

To Reviewer:

M/S:

To Reviewer:

From Reviewer:

Date:

Date:

Comments

Reviewer:

Signature:

Date:

Approval (Name and Title):

Signature:

Date:

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DIVISION 15 - MECHANICAL

SECTION 15003

GENERAL MECHANICAL PROVISIONS

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  - 1.4.2 Service Labeling
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PART 2 PRODUCTS

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- 2.2 PAINTING

PART 3 EXECUTION (Not Applicable)

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SECTION 15003

GENERAL MECHANICAL PROVISIONS

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this section to the extent referenced:

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 123 (2002) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM B 766 (1986; R 1998) Standard Specification for Electrodeposited Coatings of Cadmium

MILITARY SPECIFICATIONS (MS)

MS MIL-T-704 (Rev K) Treatment and Painting of Material

UNDERWRITERS LABORATORIES (UL)

UL 6 (2000) UL Standard for Safety - Rigid Metal Conduit

UL-02 (2001) Building Materials Directory

1.2 SUBMITTALS (Not Applicable)

1.3 COORDINATION

Contractor shall coordinate the work of the different trades so that interference between piping, equipment, structural, and electrical work will be avoided. All necessary offsets in piping and all fittings required to install the work properly shall be furnished complete in place at no additional cost to the Government.

1.4 MECHANICAL SYSTEMS IDENTIFICATION

1.4.1 Identification Tags

Identification tags made of brass or aluminum indicating function of a control or similar component shall be installed on such system devices. Tags shall be 2 inches in diameter and marking shall be stamped.

Equipment shall be provided with metal identification tags displaying an

equipment designation number matching drawing or control diagram designation.

Tags shall be wired to valve or equipment items with No. 12 AWG 0.0808-inch diameter corrosion-resistant steel wire.

1.4.2 Service Labeling

All piping, including that concealed in accessible spaces; exposed, bare and painted; and insulated, shall be labeled to designate service. Each label shall include an arrow or arrows to indicate flow direction. Labels and valve tag schedule shall be in accordance with the typical examples below:

<u>SERVICE</u>	<u>LABEL AND TAG DESIGNATION</u>
Instrument air (100 psig)	INST. AIR (100 PSIG)
CF4 Vacuum	CF4 VACUUM

Similar services with different temperatures or pressures shall be identified. Where pressures may exceed 125 pounds per square inch, gage, the maximum system pressure shall be included in the label.

Piping shall be labeled and arrowed in accordance with the following:

Each change in direction, e.g., elbows, tees

In congested or hidden areas and at all access panels at each point required to clarify service or indicated hazard.

In long straight runs, labels shall be located at distances within eyesight of each other but in no case shall the distance between labels exceed 75 feet. All labels shall be visible and legible from the primary service and operating area.

<u>For Bare or Insulated Pipes for Outside Diameters of</u>	<u>Lettering</u>
1/2 thru 1-3/8 inch	1/2 inch
1-1/2 thru 2-3/8 inch	3/4 inch
2-1/2 inch and larger	1-1/4 inch

Labels shall be made of self-sticking, plastic film designed for permanent installation.

1.5 APPROVAL REQUIREMENTS

Except as otherwise specified, approval of materials and equipment will be based on manufacturer's published data.

Where materials and equipment are specified to conform to the standards of the Underwriters Laboratories, the label of or listing with reexamination in UL-02, and UL 6 will be acceptable as sufficient evidence that the items

conform to Underwriters Laboratories requirements. In lieu of such label or listing, the Contractor may submit a written certificate to the Contracting Officer from any nationally recognized testing agency, adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the specified requirements. Methods of testing used by the specified agencies shall be outlined.

Where materials or equipment are specified to be constructed or tested, or both, in accordance with the standards of the American Society for Testing and Materials (ASTM), or other standards, a manufacturer's certificate of compliance of each item will be acceptable as proof of compliance.

Conformance to such agency requirements does not relieve the item from compliance with other requirements of these specifications.

#### 1.6 PREVENTION OF CORROSION

Metallic materials shall be protected against corrosion. Equipment enclosures shall be given rust-inhibiting treatment and standard finish by the manufacturer. Aluminum shall not be used in contact with earth, and where connected to dissimilar metal, shall be protected by Contracting Officer approved fittings, barrier material, or treatment. Ferrous parts such as anchors, bolts, braces, boxes, bodies, clamps, fittings, guards, nuts, pins, rods, shims, thimbles, washers, and miscellaneous parts not of corrosion-resistant steel or nonferrous materials shall be hot-dip galvanized in accordance with ASTM A 123 for exterior locations and cadmium-plated in conformance with ASTM B 766 for interior locations.

### PART 2 PRODUCTS

#### 2.1 ANCHOR BOLTS

Anchor bolts shall be provided for equipment placed on concrete equipment pads or on concrete slabs. Bolts shall be of the size and number recommended by the equipment manufacturer and shall be located by means of suitable templates. Installation of anchor bolts shall not degrade the surrounding concrete.

#### 2.2 PAINTING

Equipment units shall be painted in accordance with MS MIL-T-704 or in accordance with equipment manufacturer's standards unless specified otherwise. Field retouching shall be accomplished only if Contracting Officer approved; otherwise equipment shall be returned to the factory for refinishing.

### PART 3 EXECUTION (Not Applicable)

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DIVISION 15 - MECHANICAL

SECTION 15230

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SECTION 15230

CARBON TETRAFLUORIDE (CF4) RECLAMATION SYSTEM  
(PERFORMANCE SPECIFICATIONS)

PART 1 GENERAL

1.1 SYSTEM DESCRIPTION

The 20 Inch Mach 6 Tunnel uses CF4 (carbon tetrafluoride) gas as the test medium. The tunnel is a hypersonic blowdown tunnel. During a tunnel run the CF4 gas is exhausted into evacuated vacuum spheres. Between tunnel runs the CF4 gas is evacuated from the vacuum spheres using mechanical vacuum blowers and pumps. The pumps discharge into the CF4 Reclaimer, where the CF4 gas is purified and reclaimed. The reclamation system separates any impurities from the CF4 gas and then pumps the purified CF4 gas into a high-pressure bottle field. The reclamation process liquifies the CF4 gas, purifies it, pumps it up to 5000 psi, and vaporizes it back to a gaseous state. The existing reclamation system operates well below its design efficiency and is only reclaiming approximately 75 percent of the test gas.

This specification section establishes the performance requirements to upgrade the 20 Inch Mach 6 Tunnel by replacing the existing reclamation system with a new CF4 gas reclamation system with a greater throughput rate, increased reliability, higher efficiency and higher outlet gas purity.

1.2 SCOPE/WORK INCLUDED

This section covers the design, fabrication, testing, and commissioning of the Carbon Tetrafluoride (CF4) Reclaimer and control system for the 20-Inch Mach 6 CF4 Tunnel at NASA Langley Research Center. The CF4 reclamation system consists of four major pieces of process equipment: 1) drier/CO2 removal skid, 2) cryogenic purifier cold box, 3) dual high pressure cryogenic pump skid and 4) vaporizer.

The manufacturer shall provide a complete designed and furnished CF4 reclamation system. The manufacturer shall provide all materials, labor, and resources to design, engineer, procure, fabricate, inspect, test, deliver, commission, and document the complete CF4 reclamation system. The CF4 Reclaimer shall be a complete system including all necessary piping, valves, related equipment, and remote and local controls necessary to meet the required system performance requirements. Installation shall be provided under a separate Government contract.

The purpose of this CF4 reclamation system is to accept CF4 gas, which has been contaminated with up to 10 percent by volume of air, water vapor, and vacuum pump oil from the discharge of the four-stage blower-mechanical vacuum pump pumping system. The system shall be designed and commissioned to produce a minimum product purity of 99.99 percent with a concurrent

minimum recovery efficiency of 95 percent.

### 1.3 REFERENCES

The publications listed below form a part of this section to the extent indicated by their references. The exclusion of a publication from this section will not relieve the Contractor from complying with the publication referenced elsewhere in this section:

#### AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- |             |  |
|-------------|--|
| ANSI B31.3  | (1999) Process Piping  |
| ANSI C78.23 | (1989) Electric Lamps - Incandescent Lamps-Miscellaneous Types |

#### INSTRUMENT SOCIETY OF AMERICA (ISA)

- |               |  |
|---------------|--|
| ISA RP60.6    | Nameplates, Labels, and Tags for Control Centers |
| ISA S26       | Dynamic Response Testing of Process Control      |
| ANSI/ISA 55.1 | Instrumentation Symbols and Identifications      |
| ANSI/ISA 55.3 | Graphic Symbols for Distributed Control Systems  |

#### NASA LANGLEY HANDBOOK (LHB)

- |             |  |
|-------------|--|
| LHB 1710.40 | Langley Research Center Standard, Evaluation of Socket and Branch Connection Welds |
| LHB 1710.41 | Langley Research Center Standard, Safety Regulations Covering Pressurized Systems  |

#### NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

- |            |  |
|------------|--|
| NEMA ICS 1 | (1993) Industrial Control and Systems General Requirements   |
| NEMA ICS 2 | (1993) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC |

#### NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

- |         |                                 |
|---------|---------------------------------|
| NFPA 70 | (1999) National Electrical Code |
|---------|---------------------------------|

NFPA 79/JIC (2002) Electrical Standard for Industrial Machinery and JIC Symbols

UNDERWRITERS LABORATORIES, INC. (UL)

UL 50 (1995) Standard Safety Enclosures for Electrical Equipment Elevation Edition

UL ECMD (1998) Electrical Construction Materials Directory Supplement

#### 1.4 GENERAL REQUIREMENTS

Section 15003, "General Mechanical Provisions," applies to work in this section.

Section 16905, "Control Wiring", Section 16960, "Control Systems" and Section 16965, "Industrial Instrumentation" applies to work specified in this section.

#### 1.5 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

##### SD-01 Data

The manufacturer shall submit Manufacturer's Data and Catalog Cuts for all components listed in Part 2, "Products", of this section and used in the fabrication of the Reclaimer prior to assembly of the system, for approval.

Design Calculations - The manufacturer shall submit for review, design calculations which show that the complete CF4 Reclaimer is capable of meeting the system performance requirements as given in Part 3 of this section. The calculations shall show, as a minimum, the following information:

Mechanical Equipment Selections  
Process Simulations to verify system performance

The manufacturer shall submit an installation cost estimate 5 calendar days prior to the Preliminary Design Review and an updated estimated 5 calendar days prior to the Final Design Review.

##### SD-04 Drawings

Submit Shop and Fabrication Drawings including assemblies with complete Materials Lists, Control and Connection Diagrams for the CF4 reclaimer, accessories, Process and Instrumentation Diagrams (P&ID) wiring diagrams, power and grounding requirement, equipment layouts, and equipment dimensional drawings. Certified prints from the manufacturer of the controls and electrical/electronic

components, etc., shall be used in the preparation of shop drawings. Drawings and certified material shall be submitted for review and approval.

Interconnection and Wiring Diagrams shall be submitted indicating the relations and connection of, but not limited to, the following items by showing the general physical layout of all controls, the interconnection and wiring with labeling, routing and drawing references of one system (or portion of system) with another, and internal wiring and other devices. Drawings for the following items shall be submitted 30 calendar days prior to fabrication.

CF4 Reclaimer Schematics for complete system and all subsystems - schematics shall give flow directions, and component positions and setpoints.

CF4 Reclaimer Assembly Drawing - with overall dimensions and parts list.

Control and Wiring Diagrams for all systems and subsystems

Controls Enclosures and Motor Starters and Controller Enclosures

P&ID symbols shall be in accordance with ANSI/ISA-55.1 and 55.3.

Electrical wiring, connection, and schematic diagram symbols shall be in accordance with NFPA 79 and JIC standards.

#### SD-07 Schedules

Submit Equipment and Material Lists, which include catalog numbers, manufacturer's style, and reference numbers for all manufacturer furnished components.

#### SD-08 Statements

Thirty calendar days prior to testing, the manufacturer shall submit the following test procedures:

System Final Shop Test  
Final On-site Testing of Complete Reclaimer System  
Manufacturer's Service Representative's Qualifications  
Personnel Qualifications

Test plans that include detailed step-by-step procedures for the CF4 Reclaimer shop and onsite tests shall be submitted.

#### SD-09 Reports

Documented Test Reports shall be submitted, assembled by the manufacturer in a three-ring binder, showing test results for the following tests:

System Final Shop Testing

Final On-site Testing of Complete CF4 Reclaimer

Test Reports shall be submitted for review within 10 calendar days after completion of test.

SD-13 Certificates

Certificates of Compliance shall be submitted demonstrating the manufacturer's compliance with the applicable codes and standards for materials and equipment.

SD-19 Operation and Maintenance Manuals (O&M)

Thirty calendar days prior to final Shop Testing of the CF4 Reclaimer System, six (6) copies of an Operational Startup and Maintenance Manual for the complete CF4 Reclaimer System shall be submitted in three ring binders. All manuals shall be updated after the final on-site testing of the CF4 Reclaimer System.

Operation and Maintenance Manuals shall be consistent with manufacturer's standard brochures, schematics, printed instructions, general operating procedures, and safety precautions. The data shall be legible and of good quality. Light-sensitive reproduction techniques are acceptable provided finished pages are clear, legible, and not subject to facing. Pages for vendor data and manuals shall be bound in 3-ring, loose-leaf binders. Data shall be organized by separate index and tabbed sheets. Caution and warning indications shall be clearly labeled.

The manual shall include the following sections as a minimum:

- Installation Procedures / Requirements
- Description of Controls
- Start-Up Instructions
- Operational Instructions
- Emergency, controlled, and normal shutdown procedures
- Safety considerations including load limits, speeds, temperatures, and pressures
- Recommended procedures and frequencies for preventive maintenance, inspection, adjustment, lubrication, and cleaning
- Special tools and equipment required for testing and maintenance
- Parts lists reflecting the original manufacturer's name, part number, and nomenclature
- Recommended spares by part number and nomenclature and spare stocking levels
- Integrated mechanical and electrical system schematics and diagrams to permit operation and troubleshooting after acceptance of the system
- Troubleshooting, checkout, repair, and replacement procurement procedures
- System Drawings
- System Catalog Cuts

- Application Software electronic files on 3-1/2 inch floppy disks or CD-ROM format in IBM-PC format
- Software User Programming and Configuration Manuals
- PLC Ladder Logic
- Control Panel

#### 1.6 TRANSPORTATION AND HANDLING

Components shall be delivered from the manufacturer in crates or boxes, with all ports capped and with vapor sealants for products sensitive to moisture or exposure.

#### PART 2 PRODUCTS

The components shall meet the system performance requirements given in Part 3, "Performance Requirements", of this section. Requirements given below are minimum requirements for the design of the system. All products used in the fabrication of the reclaimer system shall have a design life of 25 years, maintenance necessary to achieve this design life shall be specified. All products shall be rated for a sheltered outdoor environment with an ambient temperature range of 0 degrees F to plus 100 degrees F, sea level and 100 percent humidity. Control equipment with specified minimum operating temperatures greater than 0 degrees F shall be provided for installation in areas with controlled environment conditions. Control equipment that must be installed as part of reclaimer system in areas that do not meet equipment environmental specifications shall be provided installed in environment controlled enclosures meeting equipment specifications. All materials in contact with CF4 shall be compatible with CF4 (non-corrosive).

#### 2.1 OIL REMOVAL FILTERS

Oil removal filters shall be coalescing filters capable of removing Fyrquel, Grade 550 vacuum pump oil at approximately atmospheric pressure and temperature. Filter housings shall be 304 stainless steel. The oil removal filters shall be sized for 359 SCFM (CF4). Filters shall have a minimum removal efficiency of 99.9 percent for particles of 0.1 micron and larger. Oil vapor shall be removed using a disposable carbon bed system.

#### 2.2 DRIER/CO2 REMOVAL SKID

Drier/CO2 removal skid shall be a single bed, solid adsorbent drier. Drier shall have a 12 hour adsorption time (minimum) at maximum feed flowrate and a minimum 8 hour (maximum) regeneration time. The unit shall be designed to operate continuously for 12 hours per day, 5 days per week. System shall be capable of regeneration without operator intervention, once the regeneration cycle is initiated. Regeneration shall be achieved using gaseous nitrogen (GN2). Unit shall be provided as a skid mounted system capable of both local and remote operation. All necessary safeties and interlocks required for safe operation of the absorber skid shall be provided as part of the local controls.

#### 2.3 CRYOGENIC PURIFIER COLD BOX

Cryogenic purification shall be achieved using an insulated cold box and liquid nitrogen(LN2). The insulated cold box shall consist of a feed condenser, feed drum, and stripping column. The feed condenser shall be tubular (shell and tube) heat exchanger. The stripping column shall include an electric reboiler. The cold box shall be designed to allow for product purity control and freeze protection. System shall also be designed to prevent the back flow of atmospheric air into the system during standby operation. The feed condenser, feed drum and stripping column shall be 304 stainless steel.

#### 2.4 DUAL HIGH PRESSURE PUMP SKID

Pure liquid CF4 shall be drawn from stripping column using a cryogenic pump. The pump skid shall contain one operating and one spare pump on a single skid. The pump skid shall include features to provide enhanced reliability, including slow speed operation, vacuum insulated pump housing, heavy duty bearings, and self adjusting shaft seals. High pressure pump skid shall be supplied with all necessary instrumentation, interlocks and safety devices (relief valves). Relief valve capacity shall be coordinated with capacity of storage system to ensure storage system is not over-pressurized. Pumps shall be rated for 6000 psig and shall be sized for the capacity necessary to meet the system design and performance requirements given in Part 3 of this specification. The unit shall be capable of local operation and remote operation from a signal provided by the reclamation system PLC.

#### 2.5 VAPORIZER

The vaporizer shall be a free standing aluminum ambient vaporizer, sized to meet the system design and performance requirements given in Part 3 of this section.

#### 2.6 CONTROLS

Section 16905, "Control Wiring", Section 16960, "Control Systems" and Section 16965, "Industrial Instrumentation" applies to work specified in this section.

The Reclamation system shall be provided with a completely installed and configured control system. This system shall include all necessary control equipment such as relays, motor starters, power supplies, programmable logic controllers and operator interfaces.

The control of the reclamation system shall be accomplished with the use of a programmable logic controller (PLC). The PLC shall govern all electrical relay logic, switch inputs, sensor inputs, indicator outputs, and machine control outputs. Operator interface shall be provided through the use of a touch screen terminal. The operator interface shall provide a means to send control inputs to the PLC and display indicator outputs from the PLC. The operator interface shall communicate with the PLC through a high-bandwidth open network protocol. This network shall also allow remote monitoring, control, programming and communication with the vacuum system PLC.



### 2.6.1 Programmable Logic Controller

The programmable logic controller shall consist of a processor, power supply, communication module, input modules and output modules. The input and output modules shall be analog and/or binary as required by the application.

The PLC shall conform to the requirements of section 16960, "Control Systems".

### 2.6.2 Operator Terminal

The operator touch screen terminal shall be supplied by the reclamation system manufacturer. The touch screen shall be installed in a control cabinet and shall be remotely mounted from the reclaimer. This terminal shall be used as the primary control of the reclamation system. A second touch screen shall be supplied by the reclamation system manufacturer for installation by others, in a rack in the facility control room. This panel will be used for remote monitoring of the reclamation system. The operator interfaces shall be provided fully programmed, tested and ready for operation when delivery is made. Back-up source-code for setting up the operator interface shall also be provided by the equipment supplier.

The operator terminals shall conform to the requirements of section 16960, "Control Systems".

## PART 3 PERFORMANCE REQUIREMENTS

### 3.1 SYSTEM REQUIREMENTS

The manufacturer shall provide a complete replacement CF4 reclamation system for the CF4 Tunnel. The CF4 reclamation system shall be a liquid nitrogen (LN2) cooled cryogenic cold box system, functionally similar to the existing reclamation system, and capable of achieving the performance requirements specified below. The manufacturer shall develop a design, which is customized for this application, using standard off-the-shelf components whenever possible.

#### 3.1.1 Design and Performance Requirements

##### **Feed Specification (CF4 Reclaimer Inlet)**

- a. Design Flow: The reclamation system shall be capable of processing 120% of the maximum flow rate obtained by evacuating the 72,000 cubic foot vacuum spheres from a pressure of 21 torr to 0.5 torr in within 30 minutes using a four-stage mechanical vacuum pumping system. This represents a variable process of 359 SCFM (4,914 lb/hr) CF4 to 8.5 SCFM (114 lb/hr) CF4.
- b. Gas Composition: Carbon Tetrafluoride (CF4) gas contaminated with up to 10 percent impurities by volume. Contaminants are vacuum pump oil, water vapor, air and CO2.

- Vacuum Pump Oil (Fyrquel, Grade 550)

- c. Design Pressure: 14 psia to 19 psia from the vacuum pumping system at the inlet to the reclaimer.
- d. Total mass to be purified per full run cycle: 425 lbs. of CF4.

**System Product Specification Requirements**

- a. Outlet Gas Purity: 99.99% pure CF4
- b. Efficiency: Recovery efficiency of reclaimer system alone shall be a minimum of 95 percent
- c. Pressure (design): 5,000 psig (outlet to bottlefield)

**Operational Time Frame Requirements**

- a. Maximum 2 hour startup time at the beginning of a work week
- b. Maximum startup time of 45 minutes for any subsequent work day
- c. Shutdown at the end of any work day shall not exceed 30 minutes
- d. The reclamation system shall be capable of 12 hours of continuous operation.

3.1.2 Reliability Requirements

The reclamation system shall be conservatively designed and constructed using industrial grade components for high reliability and long life (8 runs per single shift day, 5 days per week, 50 weeks per year for 25 years). It is anticipated that the reclamation system will be activated in the morning, remain active through the remainder of the day, and be shutdown at night.

Design features shall provide for overall preventive maintenance that can be accomplished once a year, during a planned facility shutdown period with a maximum duration of two weeks.

3.1.3 Facility Integration Requirements

The replacement reclamation system shall be completely integrated into the existing facility, with minimal changes to the existing facility or operations.

3.2 ENGINEERING AND DESIGN

3.2.1 Scope

The manufacturer shall provide all engineering and design personnel, equipment, and materials for the reclamation system design.

3.2.2 Design Criteria and Methods

The following criteria identify various aspects of the design that will be required, but is not all-inclusive of details needed for a completely operational system.

#### 3.2.2.1 System Configuration

The manufacturer shall engineer and design a replacement reclamation system that meets all the requirements set forth in this specification. The manufacturer shall consider performance, reliability, simplicity, space constraints, installation requirements, tunnel downtime, maintainability, implementation of the latest proven state-of-the-art technical designs and material developments.

#### 3.2.2.2 Site Visits and Field Verification

The manufacturer shall make sufficient site visits to ensure that all information required to design and engineer a reclamation system for the CF4 Tunnel system has been obtained. Required information may include dimensional details, operational details, system interface details and documentation in addition to that provided in the contract documents.

Any available facility documentation requested by the manufacturer during site visits, which may enhance understanding of the existing system or aid in design efforts for the reclamation system, will be provided. Documents requested during site visits will be provided within 7 calendar days and shall be for information only. The manufacturer shall field-verify all information critical to the design and installation of the reclamation.

#### 3.2.2.3 Manufactured Components and Materials

Components and materials provided shall be products of manufacturers regularly engaged in the manufacture of the specified products. Where two or more units of the same equipment class or items are furnished, the equipment shall be from the same manufacturer and shall be interchangeable.

Manufactured items and materials to be incorporated into the work shall be handled, stored, applied, installed, serviced, and used in accordance with the manufacturer's instructions and recommendations.

#### 3.2.2.4 General

The design shall coordinate location and size of the new reclamation system, including all new lines, piping, supports, and valves for the new reclamation system.

The design shall include provisions for satisfactory free space surrounding all mechanical and electrical equipment as appropriate to the overall system design. Convenient access space clearance and accessibility for repair and maintenance shall be provided.

The design shall address the structural and rigging concerns related to the installation of the reclamation system.

#### 3.2.3 Engineering Calculations and Data

The design shall include all calculations required to size the new reclamation system and to properly integrate the new reclamation system with the existing tunnel control systems and utility systems.

As a minimum, the following calculations are required:

- a. Process Simulations to verify system performance
- b. Mechanical Equipment Sizing calculations
  - Cryogenic pump sizing
  - Relief Valve sizing
  - Control Valve sizing
  - Vaporizer sizing
- c. Pressure rating calculations (piping and vessels)
- d. Pressure drop (loss) calculations
- e. Flow sizing calculations

#### 3.2.4 Design Reviews

##### 3.2.4.1 General

Formal Design Reviews shall be scheduled at the 35 percent completion point and at the 100 percent completion point of the project design. For each review, the manufacturer shall submit the meeting agenda and technical materials, for review by the Contracting Officer, 14 calendar days prior to the meeting. The manufacturer shall be flexible in modifying the design based upon the Contracting Officer's review comments, and some design iterations are to be expected; however, the manufacturer is not required to stop design work to administer the design reviews.

##### 3.2.4.2 35 Percent Design Review

The manufacturer shall conduct a Preliminary Design Review, (PDR) when the design is approximately 35 percent complete. The review will be held at the NASA Langley Research Center no later than 45 calendar days after contract award. The PDR shall be a formal review led by the manufacturer and shall include preliminary design information. The manufacturer shall submit a complete set of all design documentation to be used as the review material, including review material as required per Langley Policy Directive 7000.2, Review Program for Langley Research Center (LaRC) Facility Projects (see <http://ldms.larc.nasa.gov/LAPD7000-2.pdf>). The design material shall include the following types of information:

- a. Description of system operation including system interlock logic.
- b. Calculations and analysis
- c. List of drawings
- d. Control system block diagrams

- e. Electrical schematics and one-line diagram(s)
- f. Process and Instrumentation diagram(s) (P&ID)
- g. Redline markups of reference drawings
- h. Piping, conduit, and control routing layouts
- i. Control panel details
- j. Installation details and schedule
- k. List of all reclamation safety interlocks
- l. Installation cost estimate

#### 3.2.4.3 100 Percent Design Review

The manufacturer shall conduct a Critical Design Review, (CDR) when the design is approximately 100 percent complete. The review will be held at the NASA Langley Research Center no later than 120 calendar days after contract award. The CDR shall be a formal review led by the manufacturer and shall include complete drawings, equipment specifications, design and construction details, programming, and updates to any previously submitted information, and be conducted in accordance with applicable standards in Section LAPD 7000.2, Review Program for Langley Research Center (LaRC) Facility Projects (see <http://ldms.larc.nasa.gov/LAPD7000-2.pdf>).

#### 3.2.5 Reclamation System Documentation

##### 3.2.5.1 Scope

In addition to documentation required in other sections of this Specification, the manufacturer shall submit all reclamation system documentation required to describe the system design, manufacture, installation, commissioning, operation, and maintenance. All documentation, including drawings, manuals, catalog cuts, and all manufacturer submittals, shall be in the English language.

All drawings, calculations, and analyses shall be prepared under the supervision of experienced, licensed professional engineers with direct experience related to the specific requirements of this specification. All documentation shall be checked and approved by the appropriate engineering supervision prior to submittal to the Contracting Officer. Documentation shall utilize conventional symbols as recognized in the applicable standards.

Reclamation system documentation shall be submitted, for review by the Contracting Officer. All documentation will become the property of the Government.

##### 3.2.5.2 Drawings

The reclamation system documentation drawings shall include, as a minimum, layout drawings, component drawings, installation drawings, and wiring drawings for the systems, subsystems, and components of the reclamation system. This shall include, but not be limited to, the following drawing details:

- a. Plan and Elevation Installation Views
- b. Reclamation Assembly and Details
- c. Reclaimer Process System Schematics (P&IDs)
- d. Control System Wiring
- e. Operator Panel Layout and Wiring
- f. The electrical and electronic drawings shall include:
  1. Programmable logic controller (PLC) ladder logic diagrams,
  2. Elementary, ladder schematic diagrams, connection, and interconnection wiring diagrams for motor control center(s), control devices, PLC, and control panels,
  3. Equipment arrangement, conduit and control cable routings from control room to reclamation electrical, control, and monitoring equipment.
  4. Equipment safety interlock logic diagram.

The manufacturer's drawings shall use identical backgrounds wherever possible. Final submittal drawing size shall be D size (22 X 34 inches). All drawings including shop drawings shall be compatible with AutoCAD Version 2000 or later, and in AutoCAD drawing format using standard symbols and drawing practices as specified. All drawings shall be properly prepared, scaled, and field checked for accuracy. Existing utilities shall be included on the appropriate drawings in order to identify and eliminate possible interferences.

Drawings shall be prepared to facilitate the review of all disciplines and to ensure that the new reclamation system equipment fits into the real estate limitations applicable to each work area. Major equipment shall be accurately drawn to scale so that all design disciplines can identify space allocations and restrictions. The design shall allow for service, removal, code compliances, and shall not cause interference with any existing equipment.

Final drawing submittals shall include a software copy of all manufacturer generated AutoCad drawings.

#### 3.2.5.3 Drawing Definitions

For the purpose of this contract, the following drawing/diagram definitions

shall apply:

Connection diagrams shall indicate the relationships and connections of devices and apparatus. They shall show the general physical layout of all controls, the interconnection of one system (or portion of a system) to another system, and all internal wiring and devices.

Interconnection diagrams shall indicate (to scale) power and control interface between associated units of equipment and systems.

Elementary diagrams shall indicate, in straight-line form, without regard for physical relationship, all supporting systems and elements of equipment and associated apparatus.

Control diagrams shall show the physical and functional relationship of equipment. Electrical diagrams shall show size, type, and capacity of the systems. Safety interlock logic diagrams shall show any ladder diagram format, sequential equipment conditions, states a positions needed to provide safe operation of system and interlocked with other facility equipment.

Schematic drawings shall depict the functional flow of systems and their interfaces with facilities and other systems. Functional and physical interfaces shall be indicated. Schematics need not be to scale. Schematics may be structural, mechanical, electrical, or a combination of these.

As-built drawings shall provide current actual information including deviations from, and amendments to the Contractor-provided design drawings.

#### 3.2.5.4 Engineering Data

The manufacturer shall submit Engineering Data, for Review by the Contracting Officer, as part of the final project documentation. The Engineering Data shall include, but not be limited to the following details:

- a. Analyses, calculations, reports, and other documentation as required in this and other sections of this Specification.
- b. Nameplate ratings and sub-system component ratings for the reclamation system equipment.
- c. Details shall include a process schematic, a description of the control scheme, and a list of equipment and instrumentation to be utilized.

#### 3.2.5.5 Test Procedures

The manufacturer shall submit, for Review by the Contracting Officer, all test procedures and plans for the factory and site testing of the reclamation system equipment, components, or materials. Test procedures shall be submitted 30 calendar days prior to the start of testing.

#### 3.2.5.6 Test Reports

The manufacturer shall submit Test Reports, for review by the Contracting Officer, for all tests of the reclamation system equipment, components, and materials. Test Reports for factory tests, on site sub-system tests, and commissioning tests shall be included. Test Reports shall be submitted within 10 calendar days after completion of the test.

#### 3.2.5.7 Certificates of Compliance

The manufacturer shall submit Certificates of Compliance, for Review by the Contracting Officer, which demonstrate that the manufacturer's equipment and materials comply with the applicable standards, codes, and specifications.

#### 3.2.5.8 Installation of Cost Estimate

The manufacturer shall provide an installation cost estimate for the new reclaimer system that includes, but is not limited to, the following:

- a. Disassembly, removal, and disposal of the existing reclamation system and associated equipment.
- b. Installation of the new reclamation system and associated equipment.
- c. Installation of piping and valves as required for the utilities to operate the new reclamation system.
- d. Installation of new conduit and wiring as required.
- e. Installation of new local control operator panel.
- f. Installation of new control room operator panel.

### 3.3 FACTORY CONSTRUCTION

#### 3.3.1 Scope

The manufacturer shall provide all factory engineering, materials, equipment, and labor to manufacture the new reclamation system in the factory, and test the reclamation system prior to its shipment. Factory testing shall include pressure and leak testing of the cold box.

Low pressure piping, less than 125 psig, and welded ancillary fabrication shall fabricate, assemble, weld/braze/solder in accordance with ASME B31.3 Process Piping Code requirements.

#### 3.3.2 Documentation and Factory Components for Installation of Reclamation System

##### 3.3.2.1 General

The manufacturer shall provide all engineering and factory materials needed



to assemble the new reclamation system. Installation and set-up labor shall not be under the manufacturer's scope of work.

### 3.4 SYSTEM COMMISSIONING

#### 3.4.1 Scope

The manufacturer shall supply all materials, test equipment, and personnel to demonstrate that the new reclamation system meets the performance requirements of Part 3.1. The reclamation system commissioning shall include the following:

- a. Commissioning Plan.
- b. Sub-system inspections and tests.
- c. Systems tests.
- d. Commissioning test reports and final documentation.
- e. Technical support/training.

#### 3.4.2 Commissioning Plan

The manufacturer shall submit a Commissioning Plan, for Review by the Contracting Officer. The Commissioning Plan shall outline the testing procedure to bring the reclamation system on line in a safe and orderly sequence. The plan shall be written to progressively and conservatively increase the level of system complexity, and integration with the existing tunnel systems. It shall also be devised to progressively reduce risk and eliminate areas of uncertainty.

The Commissioning Plan shall include the following items:

- a. Personnel, equipment, and facilities required by the manufacturer to perform commissioning.
- b. Subsystem verification test plans.
- c. Pre-operations checklists.
- d. Systems performance verification tests.
- e. Test procedures and instruction plans.
- f. Operator training.
- g. Performance verification and sign-off.

#### 3.4.3 General Commissioning Requirements

##### 3.4.3.1 Commissioning Personnel

The system commissioning personnel shall oversee and coordinate all

commissioning activities and shall be on-site whenever commissioning tests are performed.

System commissioning personnel shall have requisite experience in the checkout and startup of systems. Facility personnel shall be trained on the specific type of equipment used on this project, and shall be educated by the manufacturer as to the operational requirements and performance criteria.

#### 3.4.3.2 Test Equipment

All test equipment shall be provided by the manufacturer. The equipment shall be calibrated and maintained in accordance with the manufacturer's Quality Assurance Program (See Part 4 of this section, Performance Assurance). Any data recorded on untraceable or expired calibration certified equipment will not be accepted.

#### 3.4.3.3 Commissioning Parts

The manufacturer shall replace or repair all damaged parts, consumables, and defects associated with the system during commissioning.

#### 3.4.3.4 System Measurements

The manufacturer shall perform and document system measurements on the installed system to verify that the required system performance parameters have been met.

#### 3.4.4 Factory Verification Inspections and Tests

##### 3.4.4.1 General

Prior to shipping the reclamation system to NASA for installation, the manufacturer shall perform factory inspections and verification tests to verify that the components of the reclamation system function properly.

##### 3.4.4.2 Factory Verification Inspection and Testing Requirements

The manufacturer shall perform component inspections and tests in accordance with the applicable industry standards and codes, and the manufacturer's Quality Assurance Program. The manufacturer shall submit, for Review by the Contracting Officer, all procedures for inspections and tests at the factory. The manufacturer shall notify the Government 15 calendar days in advance of the factory inspections and testing, so that the Government can send a representative to witness these inspections and tests.

The manufacturer shall submit Certified Inspections Reports and Certified Test Reports no later than 10 calendar days after completion of the inspections or tests. All discrepancies found shall be repaired or equipment replaced and retested prior to shipping the reclamation system.

##### 3.4.5 On-Site Subsystem Verification Inspection and Testing Requirements

3.4.5.1 General

After installation of the reclaimer (by others), the manufacturer shall perform inspections and testing of the individual system components and subsystems in order to verify that the components of the reclamation system function properly, before starting the integrated systems tests.

3.4.5.2 On-Site Subsystem Verification Inspections and Tests

The manufacturer shall perform subsystem inspections and tests in accordance with the applicable industry standards and codes, and the manufacturer's Quality Assurance Program. These tests shall include, but not be limited to, point-to-point verification of site installed wiring for control panels and controls interconnection, in the presence of the Contracting Officer. All initial tests shall be conducted at the lowest energy level required to perform the test. The Contracting Officer and the manufacturer shall agree when each phase has been completed, and the new reclamation system is ready for the next level of testing.

The manufacturer shall submit, for Review by the Contracting Officer, all procedures for on-site inspections and tests, 30 calendar days prior to the start of inspections and testing. The manufacturer shall submit Certified Inspections Reports and Certified Test Reports no later than 10 calendar days after completion of the inspections or tests. All discrepancies found shall be repaired or equipment replaced and retested prior to starting of the system verification inspections and tests.

3.4.6 On-Site Integrated System Verification Inspections and Tests

3.4.6.1 On-Site Integrated System Verification Inspection and Testing Requirements

This phase of testing shall be conducted to prove that the reclamation system meets performance requirements, and to demonstrate the proper operation and integration of the reclamation system. The manufacturer shall perform system inspections and tests, covering the topics below, as a minimum, in accordance with the applicable industry standards and codes, and the manufacturer's Quality Assurance Program. The manufacturer shall submit, for Review by the Contracting Officer, all procedures for onsite inspections and tests.

The Government will provide test engineers, tunnel operators, and facility technicians to support running the reclamation system under actual operating conditions. NOTE: If specified conditions cannot be obtained at the facility, it is expected that the parameter shall be measured at the most stringent conditions possible and then results extrapolated to the specified condition, to verify conformance to the performance requirements.

Measurements shall be taken during testing to demonstrate that the system meets the performance requirements.

The manufacturer shall submit Certified Inspections Reports and Certified Test Reports no later than 21 calendar days after completion of the inspections or tests. All discrepancies found shall be repaired or

equipment replaced and retested prior to acceptance of the reclamation system.

#### 3.4.7 Special Tools

All special tools and special test equipment (one each) not otherwise commercially available, but required for the maintenance, troubleshooting, testing, and repair of the new reclamation system, shall be provided by the Contractor, for retention by the Government, at the completion of commissioning.

#### 3.4.8 Operator Training

The manufacturer shall conduct a 3-day, on-site, training course in the operation, configuration and maintenance of the complete system. This training shall be customized to the system configuration, and instructional materials shall be provided for 10 participating Government personnel, 10 calendar days in advance of the training.

### PART 4 PERFORMANCE ASSURANCE

#### 4.1 SCOPE

The manufacturer shall develop, submit, and implement an approved Quality Assurance (QA) Program. The manufacturer shall implement all facets of the program, and maintain the QA documentation. The manufacturer shall submit, for review by the Contracting Officer, QA documentation 30 calendar days after contract award.

The manufacturer's Quality Assurance Program will be reviewed and approved by the Contracting Officer based on the guidelines and criteria established in this section. The Quality Assurance Program criteria and provisions identified herein should be satisfied, in addition to all detailed technical and performance requirements contained in the contract documents.

The activities, materials, and execution of the specifications by the manufacturer are subject to audit through review, witness, surveillance, monitoring, examination, testing and other means by the Contracting Officer and/or his Technical Representative. These audits will be conducted to determine that:

- a. Functional activities that control the quality are performed in accordance with established requirements.
- b. The work complies with technical, functional, performance, and quality requirements as stated in the Specifications.
- c. Quality assurance documentation is complete and adequate.

#### 4.2 CONTRACT QUALITY ASSURANCE PROGRAM

The manufacturer shall develop a Quality Assurance (QA) Program that describes in detail how the manufacturer intends to implement its internal quality assurance activities into an integrated approach to perform the

requirements of this specification. The manufacturer's facility shall be ISO 9002 registered.

The manufacturer's Quality Assurance Program will be reviewed and approved by the Contracting Officer based on the guidelines and criteria established in this section. The manufacturer shall establish, implement and maintain a documented and effective quality system that shall be fully compliant with the requirements of ISO 9000. ISO 9000 registration of the manufacturer's engineering facility is not required.

The manufacturer shall submit the documents and procedures referenced in its internal quality assurance program for review.

The manufacturer shall establish and use a documented metrology system to control and calibrate measurement processes to provide objective evidence of quality conformance. Measures shall include the following:

- a. Identification and calibration status of equipment.
- b. Measurement standards traceable to the National Institute of Standards and Technology.
- c. Procedures for the calibration and proper use of measures and test equipment.
- d. Identification and maintenance of calibration and metrology records.
- e. Remedial and preventive actions taken relative to non-conforming measurement standards or equipment used on contract deliverables.

The manufacturer's QA Program shall address appropriate handling, packaging, and shipping requirements, and assure that components meet these requirements prior to leaving the point of manufacture. In addition, these requirements shall be maintained throughout all subsequent shipping.

The manufacturer's QA Program shall include a component release system that incorporates all QA activities on the component, and verifies its readiness to be shipped.

The following factory inspections shall be performed by the manufacturer for each reclamation system component, sub-system, and assembly:

- a. Dimensions.
- b. Alignment and Fit.
- c. Device Functionality.
- d. Sub-system components.
- e. Marking and Identification.
- f. Wiring.

g. Workmanship.

#### 4.3 PERFORMANCE MONITORING

The Contracting Officer will monitor the Contractor's performance. Work performed shall be subject to Contracting Officer review and inspection at any time and place. None of these review, approval, and inspection activities shall be considered as part of replacing, or enhancing the manufacturer's Quality Assurance plans or implementation.

#### 4.4 DOCUMENTATION

The manufacturer shall establish, maintain, and implement procedures and policies for the identification, collection, indexing, storage, maintenance, distribution, and disposition of contract documentation, forms, and QA records. This shall include all inspection records, test reports, and field documentation.

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SECTION 16905

CONTROL WIRING

PART 1 GENERAL

1.1 SUMMARY

The Contractor shall provide, install, and test control wiring as required herein.

1.2 REFERENCES

The publications listed below form a part of this section to the extent referenced:

ASTM INTERNATIONAL (ASTM)

ASTM B 33 (1994) Standard Specification for Tinned Soft Or Annealed Copper Wire for Electrical Purposes

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA WC-5 (1992) Thermoplastic-Insulated Wire and Cable For the Transmission and Distribution of Electrical Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NFPA 79 (1997) Electrical Standards for Industrial Machinery

UNDERWRITERS LABORATORIES (UL)

UL 13 UL Standard for Safety Power-Limited Circuit Cables

UL 62 (1997) UL Standard for Safety Flexible Cord and Fixture Wire

UL 1581 (1997; 3rd Ed) UL Standard for Safety - Reference Standard for Electrical Wires, Cables, and Flexible Cords

UL 758 (2000) Standard for Appliance Wiring Material

UL 83 (1998) Standard for Thermoplastic-Insulated Wires and Cables



### 1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

#### SD-01 Data

Manufacturer's Catalog Data shall be submitted for the Control Wiring. The data shall include a complete list of parts, special tools, supplies with current unit prices, and source of supply.

#### SD-06 Instructions

Manufacturer's Instructions shall be submitted indicating the type of tools to be used and the procedures to be followed for installation, including the calibration of tools.

#### SD-09 Reports

Test Reports shall be submitted for wires and cables required for installation of system components as indicated in "Factory Testing" of this section.

### 1.4 GENERAL REQUIREMENTS

Section 16960, "Control Systems", and Section 16965, "Industrial Instrumentation", apply to work specified in this section. Wiring methods and practices as described in NFPA 70 and NFPA 79 shall apply to work specified in this section.

## PART 2 PRODUCTS

### 2.1 WIRE AND CABLE TYPES

#### 2.1.1 Single Conductor Wire

Unless indicated otherwise on contract drawings single conductor wire shall be sized in accordance with NFPA 79. Conductor sizes No. 18 AWG and larger shall be type TFFN with insulation of PVC and nylon jacket, with a minimum temperature rating of 90C. Wire shall have an operating voltage rating of 600V-AC root mean square (rms). Conductor size No. 18 AWG shall be used for Class 1 control circuit wiring contained and completely within control cabinets and consoles.

Single conductor wire shall be color coded as described in NFPA 79 Chapter 16 and shall conform to NFPA 70 requirements for Type TFFN wire, where run in conduit or wireway.

#### 2.1.2 Multi-Conductor Flexible Cables (Unshielded)

Unless indicated otherwise on contract drawings multi-conductor cables shall be comprised of flexible stranded, twisted, tinned copper, No. 18 AWG

conductors with 60C minimum, color coded, PVC insulated and PVC outer jacket. Cable shall have a minimum operating voltage rating of 300V-AC root mean square (rms).

Multi-conductor cables shall conform to the following design requirements:

Cable shall conform to UL 62, UL 758, UL 1581, NEMA WC-5, CSA AWM, and ASTM B 33.

Cable shall be listed as being resistant to the spread of fire and shall meet the requirements of UL 13, Vertical Tray Flame Test.

Cable shall be flexible with minimum bending radius of 15 times diameter of cable.

#### 2.1.3 Twisted Pair No. 20 AWG Cables (Shielded)

Unless indicated otherwise on contract drawings twisted cables shall be comprised of color coded, twisted pair, stranded, tinned copper, No. 20 AWG conductors with 60C minimum rated polyethylene insulation, overall foil shield, and chrome PVC jacket. Cable shall have a minimum operating voltage rating of 300V-AC root mean square (rms). This cable type shall be used for instrumentation cable applications routed in conduit, above and below grade, wireway, and cable trays.

Cables shall conform to the following design requirements:

Cable shall conform to UL 13 and NFPA 70 requirements.

Outer jacket shall be sunlight and moisture resistant polyvinyl chloride (PVC) and shall be at least 0.71 millimeters thick.

Cable shall be listed as being resistant to the spread of fire and shall meet the requirements of UL 1581 Vertical Tray Flame Test.

Overall foil shield shall be aluminum-polyester with stranded tinned copper drain wire to provide 100 percent shield coverage.

#### 2.1.4 ControlNet Cables (RG-6)

ControlNet cable, termination connector, splices, tees and fittings shall be per PLC manufacturer requirements and as indicated on the contract drawings.

#### 2.1.5 Cable Tray Wire

Control wire installed in cable trays shall be Type TC cable 600 volts, with current-carrying capacity as determined by NFPA 70. Control wire installed in cable trays for Class 1 control circuits shall be a minimum size of No. 16 AWG. Cable shall also comply with UL 83.

#### 2.1.6 Twinaxial Communication Cable-Blue Hose (Shielded)

Cable for Data Highway Plus communication use shall be multi-conductor, 1

twinax (2 conductors), No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene insulation, polyester tape-aluminum foil shield with 20 AWG 7x28 stranded tinned copper drain wire and 100% shield coverage plus tinned copper braid shield with 55% shield coverage, with blue overall polyvinyl chloride jacket, UL type CL2. Cable shall also comply with UL 1581.

Cable installed in cable trays for Data Highway Plus communication use shall be multi-conductor, 1 twinax (2 conductors), No. 20 AWG, 7x28 stranded tinned copper conductors, polyethylene insulation, polyester tape-aluminum foil shield with 20 AWG 7x28 stranded tinned copper drain wire and 100% shield coverage plus tinned copper braid shield with 55% shield coverage, polyvinyl chloride jacket, armored with overall polyvinyl chloride jacket, UL type CL2, PLTC. Cable shall also comply with UL 1581 and NFPA 70.

## 2.2 FACTORY TESTING

Factory tests on wires and cables shall be made in accordance with the applicable provisions of the referenced standards.

Tests on wires and cables shall include dimensionals, physicals and electricals, (i.e., insulation resistance test) as applicable.

## PART 3 EXECUTION

This project involves procurement of indicated functioning equipment only, but will come complete with necessary materials. Equipment will be accepted for storage, and installation will be done on a separate Work Order. Statements for installation is indicated herein for guidance and reference purposes.

### 3.1 INSTALLATION OF CONTROL WIRING

The Contractor shall exercise care when handling and installing control wiring, to prevent damage to the control wiring.

The Contractor shall provide adequate supports and fasteners to secure control wiring and equipment in position. Metallic supports and fasteners shall have a corrosion resistant finish.

The Contractor shall use due caution when bending cable, to avoid kinks or other damage to sheath. The bend radius shall be as large as possible with a minimum of not less than 10 times the outside diameter of the cable. Minimum radii shall be increased when necessary to meet cable manufacturer's recommendations.

To minimize electromagnetic interference, low level signal control wiring shall be routed separately from all other power and high level control wiring.

Separate raceway shall be used for low level signal control wiring and adequate separation shall be maintained between raceways with control wiring of different signal levels. When entering or leaving conduits or

trays care should be taken to assure that control wiring of unlike levels do not become intermixed. Low level control signals shall not be mixed with high level control signals.

Immediately after control wiring placement, tags shall be attached as indicated in paragraph entitled "Tagging and Marking Control Wiring and Equipment" of this section.

#### 3.1.1 Control Wiring Placement

Wiring for remote control, signal, and power-limited circuits may be permitted to be installed in the same cable tray or raceway with other circuits in accordance with NFPA 70.

Control wiring placed in cable trays or under raised floors shall be installed in a neat and orderly manner and shall not cross or interlace other wiring except at breakout points.

Control wiring in vertical runs shall be individually retained with Ty-Rap straps, or approved equal, a maximum of 6 feet on center.

#### 3.1.2 Boxes and Enclosures

Each conductor of the control wiring shall be terminated on terminal blocks or on connectors as indicated and scheduled, except where specifically noted that terminations are future or where the control wiring is indicated on the drawings to be coiled.

Termination procedure for any control wiring within a distributor or other wiring enclosure shall not be started until all control wiring has been pulled into the enclosure. The control wiring shall then be terminated as indicated and as described in the specifications.

Where control wiring is pulled into existing or previously installed cabinet/panels, the existing hardware shall be protected against damage. Any damage to the existing hardware shall be repaired in an approved manner at no additional cost to the Government.

Cables, conductors, and shields shall be terminated as indicated. Terminals, ferrules and connectors shall be installed using only tools specifically recommended by the hardware manufacturer and shall be of the type that requires a specific force to perform the crimp and release of the handles of the tool for the next crimp. The installation procedure shall follow the manufacturer's installation directions.

Tying and lacing control wiring in the terminal enclosures shall be performed by the Contractor in a neat and orderly manner. Groups of conductors shall be bound by means of plastic fasteners similar to Thomas and Betts Co. self-locking Ty-Rap ties, wiring duct, or equal. These fasteners shall be placed every inch, four inches along the main harness and cable, and adjacent to each conductor leaving the bundle at the breakout point.

Cables shall be supported as near to the termination point as possible to

prevent strain due to the weight of the cable from being transmitted to the individual conductors where they are connected to terminal blocks or to connector terminations. The cables and the cable-harness assemblies shall be supported horizontally to their respective terminal-block mounting channels. The supports shall be spaced a maximum of 6-12 inches on center, with a support located immediately adjacent to and on each side of the breakout of the conductors from the cable. The supports shall be similar to self-locking Ty-Rap straps, wiring duct, or approved equal, and shall be securely bolted to the horizontal mounting channel. Care shall be taken not to have any of the cable shields or the conductor shields grounded to the cabinet/panel frame, especially at the points of cable supports. Where cables with overall shields or with individually shielded, but not jacketed, conductors or pairs are terminated on terminal blocks, the terminal-block mounting channel shall be insulated with insulating tape to maintain the isolation of the shields from ground.

### 3.1.3 Bonding and Grounding

The overall shield of installed cables shall be grounded as indicated on contract drawings and in accordance with NFPA 70.

## 3.2 TERMINATIONS

### 3.2.1 Control Wiring

Unless otherwise specified in the specification, termination of all conductors on screw-type terminals shall be made with slotted tongue (spade) pre-insulated lugs (forked type, with insulated sleeve) of the proper size for the wire and binding screw used. Termination of all conductors on screw clamp connection terminals shall be made with ferrules of the proper size for the wire and terminal size used. Ring type terminals are to be used at terminals where vibration or potential loosening at the connection may be expected. Lugs or ferrules shall be securely crimped to the conductor using the tool and techniques recommended by the manufacturer of the lugs or ferrules. All wiring in terminal boxes or equipment cabinets shall be neatly arranged using cable ties. Furnish and install terminal blocks in all terminal boxes shown on the drawings. All control wiring shall be terminated only at terminal blocks or directly on an end device.

No more than two wires shall be connected to any one control terminal board point.

## 3.3 TAGGING AND MARKING CONTROL WIRING AND EQUIPMENT

Identification tags and markings shall be placed on control wiring and termination equipment as indicated on contract drawings and as specified in the specification. Cables shall be identified by their cable number at cable termination points, including where cables leave cable trays, enter or leave raised floors, and before they enter into terminal enclosures. The identification marker tapes shall be as indicated.

Identification labels placed on cables and conductors shall be stick-on wrap-around self-laminating vinyl with printer generated markings,

installed as indicated.

A minimum of one label shall be attached to each cable and conductor in each junction box and the terminal point. Labels shall be placed on conductors and cables in a consistent manner with respect to orientation and have the markings facing outward. Labels shall indicate from-to point-to-point termination identification information indicated on or derived from contract wiring diagram drawings.

### 3.4 SHIELDING

All thermocouple, analog input, and analog output cables which feed into and out of the instrument racks shall have electrostatic (copper or aluminum) shields with at least 90 percent coverage. Cables carrying high-speed digital signals shall have electrostatic shields with 100 percent coverage. The shield shall be electrically continuous. All shields shall be treated as individual signal-carrying conductors, shall be insulated from each other, from the leads, and from ground, and shall be routed through connectors and terminal blocks on separate pins and terminals, unless specifically noted otherwise on the drawings, cable schedules or wiring details. There must be one and only one grounding point for each shield. As a general rule, unless otherwise specified, shields for digital input/output leads and shields for analog transducers (other than those whose shields are grounded at the measuring end) shall be grounded at the computer end. In the case of thermocouple leads which are grounded at or near the hot junction, the shields shall also be grounded as near the same ground point as practicable. The shield of all cables must be covered with an insulated sheath appropriate to the environment to which each cable is exposed. Interconnecting leads between circuit elements shall be kept as close together as practicable. All shields shall be terminated at designated instrument ground points in the control room racks.

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SECTION 16960

CONTROL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

1.1.1 Scope

The work of this section includes, but is not limited to the following:

- \* Documentation
- \* Preparation of Control Panel Wiring Diagrams
- \* Fabrication
- \* Assembly
- \* Final Wiring Connections
- \* Software Implementation and Programming
- \* Maintenance and Warranty
- \* Factory Testing
- \* Training

1.1.2 Description

See Sections 16905, "Control Wiring", and 16965, "Industrial Instrumentation," for detailed specifications of contractor furnished items listed below.

1.2 REFERENCES

The publications listed below form a part of this section to the extent referenced:

INSTRUMENT SOCIETY OF AMERICA (ISA)

ISA RP55.1 (1983) Hardware Testing of Digital Process Computers

UNDERWRITERS LABORATORIES (UL)

UL 478 (1984) UL Standard for Safety Information-Processing and Business equipment fifth Edition 9-1-86; Bulletin 9-13-88; Bulletin 3-29-91

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals,":

SD-01 Data

Manufacturer's Catalog Data shall be submitted for the following items:

PLC Hardware  
PLC Purchased Software  
Termination Strips and Panels

SD-04 Drawings

All drawings shall be submitted under Section 15230, Carbon Tetrafluoride (CF4) Reclamation System (Performance Specifications).

SD-06 Instructions

Submit installation procedures including sequences of installation, schedule, conduit layouts, job site storage requirements, inspection and checkout.

For all purchased equipment and instruments, the Contractor shall submit manufacturer's installation instructions indicating the manufacturer's recommended method and sequence of installation.

SD-08 Statements

All test requirements are included in Section 15230, Carbon Tetrafluoride (CF4) Reclamation System (Performance Specifications).

1.4 GENERAL REQUIREMENTS

Sections 16905, "Control Wiring" and 16965, "Industrial Instrumentation", apply to the work specified in this section.

PART 2 PRODUCTS

2.1 APPLICATION AND REQUIREMENTS

The PLC system shall provide the hardware and application software necessary to meet the control and monitoring requirements.

Communications software, cables and adapters, shall be provided to allow programming, checkout and monitoring of the control system. The Contractor shall provide the necessary software/equipment to program the PLC processor from an IBM compatible personal computer.

Data input and output update sample rates shall be 10 samples per second (minimum). The update rate is the time required to read a signal into an input module, convert the signal to engineering units (if necessary), send the signal to the PLC processor, process the signal, send a signal based on the input signal to an output module, and finally an output sending a

signal to a field device.

In case of failure, analog and discrete outputs shall default to a configurable fail-safe state.

## 2.2 PROGRAMMABLE LOGIC CONTROLLER (PLC) EQUIPMENT

The PLC devices listed below are based on the Allen-Bradley ControlLogix Series or equal with model, type and configurations as listed in the contract specifications and indicated on reference drawings. Reclaimer PLC processor, communications hardware and software shall be compatible with existing facility heater Allen-Bradley/Rockwell type PLC and not require additional hardware, drivers or supporting software changes to existing heater PLC software. Processor shall be capable of selection as master/slave control PLC with existing heater processor.

### 2.2.1 PLC Processor

The PLC processor shall be Allen-Bradley, ControlLogix type.

The processor shall be furnished with programmer cable for connection to a personal computer via RS-232 port.

### 2.2.2 ControlLogix Chassis

The ControlLogix Chassis shall be Allen-Bradley Type 1756.

The Processor/Module rack (chassis) shall provide mounting for the following:

- \* PLC Processor (1 Slot)
- \* Input/Output Modules (as required by manufacturer)
- \* Communication Modules (ControlNet)

The chassis shall have a backplane which provides a communication path between the I/O modules and the processor module.

The chassis shall meet the following environmental conditions:

- \* Operating temperature: 0 to 55 degrees Celsius
- \* Storage temperature: -40 to 85 degrees Celsius
- \* Relative humidity: 5 to 95% (without condensation)

### 2.2.3 PLC Power Supply

The ControlLogix power supply shall be Allen-Bradley, type 1756.

The power supply shall be used with ControlLogix Chassis specified above to provide 1.2, 3.3, 5V, and 24 V dc power directly to the chassis backplane. The power supply shall have the minimum capacity of 95 watts to power I/O modules and shall be powered from 120V ac 60 Hz input.

### 2.2.4 Operator Terminal

The operator terminal stations shall be an an Active Matrix Thin Film Transistor (TFT) touch screen design with flat-screen pixal graphic color display, 384 touch cells, ControlNet interface for communication with the PLC processor,RS-232 Port, and provided with full complement of operator devices to create screens using Panelbuilder 32 software. The operator terminal stations be Allen-Bradley, PanelVIEW 1000.

Specifications:

* Display Size:	Active Matrix(8.3"x6.2")
* Backlight:	Field replaceable
* Application Memory:	1 Meg Flash
* Communication Port:	ControlNet & RS-232 Printer Port
* AC Power Requirements:	120V ac, 60Hz @ 100 VA maximum
* Overall Dimensions:	11"H x 15"W x 5"D
* Environmental conditions:	
Operating temperature:	0 to 55 degrees Celsius
Storage temperature:	-25 to 70 degrees Celsius
Relative humidity:	5 to 95% (without condensation)

2.3 PLC SOFTWARE

2.3.1 System Software

The PLC shall be provided with licensed software for current verified releases of all standard system software products to support the requirements. These shall include products described in the following sections or their functional equivalents. All software delivered shall be of the same version and release. If a new release of the software is issued prior to final acceptance, the PLC shall be retrofitted with the new software version at no additional cost to the Government.

2.3.1.1 Operating System Software

The current verified release of the operating system software shall be provided. This software shall include provisions for system initialization, downloading, monitoring, resource management and password protection capability, as well as integration of ladder logic and continuous control algorithms.

2.3.1.2 Future Revision Compatibility

The systems software shall be compatible with future software revisions.

2.3.2 Applications Software

2.3.2.1 Requirement

The PLC system shall be equipped with fully functioning continuous and sequencing algorithms. The algorithms shall enable the system components to meet operational and performance requirements. The algorithms shall also provide all necessary interlock logic.

PLC Software shall operate in Windows 2000/NT environment and RSLogix 5000

family of processors for ControlNet application.

#### 2.3.2.2 Parameter Naming Convention

The Contractor shall submit the parameter naming convention to be followed in the development of the applications software. This naming convention must be approved by the Contracting Officer prior to start of custom software development.

#### 2.3.2.3 Timing and Order of Execution

The Contractor shall carefully review the contract documents and specifications to gain a clear understanding of the process. The Contractor shall exercise special care to implement proper timing and order of execution in assembling the applications software.

#### 2.3.2.4 Bumpless Control Transfer

Applications software shall in all cases be designed to provide bumpless transfer and setpoint tracking when changing control modes.

#### 2.3.2.5 Bumpless Power-Up/Start-Up Operation

Upon power-up and initial start-up operations, the PLC system shall not allow inadvertent changes to the process components.

#### 2.3.2.6 Documentation

Application software shall be completely verified and documented with annotated source listings or other comparable documentation suitable for establishment of a software configuration baseline.

### PART 3 EXECUTION

#### 3.1 GENERAL

##### 3.1.1 Electronic Components and Assembly

Electronic components and circuit boards shall be factory tested.

##### 3.1.2 Equipment Safety Design

All component assemblies shall conform to applicable UL 478 requirements.

#### 3.2 INSPECTION AND TESTING

##### 3.2.1 Factory Acceptance Testing and Reviews

###### 3.2.1.1 General

The Contractor shall perform and document tests that demonstrate that the specified control system meets all performance, sequencing, and interlock requirements in the specification and contract documents. All tests shall

be documented in the test plan and procedure documentation. The Contractor shall perform, as a minimum, the tests described in this section. The Contracting Officer will witness all tests. A test is not considered complete until witnessed and approved by the Contracting Officer.

The objective of these tests is to verify the operation of all components and assembled systems after on-site installation.

The Contractor shall perform, as a minimum, the tests described. Any items that fail to perform in accordance with the manufacturer's written instructions, or fail to comply with contract specifications and drawings shall be repaired or replaced and retested by the Contractor, at no additional cost to the Government.

#### 3.2.1.2 Hardware Procurement Review

Prior to hardware procurement, the Contractor shall review with the Contracting Officer the proposed equipment to be purchased. The Contractor shall not purchase equipment until Contracting Officer has approved the proposed purchase. The Contracting Officer's approval of hardware purchase does not release the Contractor from responsibility to provide a complete system.

#### 3.2.1.3 Software Functional Review

Prior to software procurement and implementation, the Contractor shall review all logic and control algorithms with the Contracting Officer. The review shall include start-up, normal operations, non-normal operations, all procedures. The Contractor shall not procure or implement any software until the Contracting Officer has approved such actions. The Contracting Officer's approval of software purchase and implementation does not release the Contractor from responsibility to provide a complete system. All documents required for review shall be submitted to the Contracting Officer 14 calendar days prior to the review.

#### 3.2.1.4 Hardware Inspection

Prior to shipping any hardware on-site for storage, the Contracting Officer will inspect the hardware. After the inspection, the Contracting Officer will direct the Contractor when to ship hardware on-site.

#### 3.2.1.5 Operational Testing

Testing shall be in accordance with applicable sections of ISA RP55.1. The test procedures and the design of the Input/Output device shall be approved by the Contracting Officer prior to commencement of the tests. The Contractor shall arrange for shop tests to be observed by the Contracting Officer.

#### 3.2.1.6 Control Panel Testing

The following tests shall be performed on each control panel:

- \* Test and verify that all switches, pilot lights, and meters meet

functional requirements.

- \* Verify all wiring is connected properly.
- \* Simulate input and output signals from/to the control panel.
- \* Inspect control panels to insure that all specification requirements are met.

#### 3.2.1.7 System Operational Demonstration

The PLC system shall be completely assembled prior to testing. For this demonstration, the system shall consist of the following:

- \* PLC Chassis and Input/Output Modules
- \* Control panels and Operator terminals
- \* Termination panels
- \* All interconnecting wiring
- \* Simulated input/output devices developed by the Contractor

The shop test shall include, but not be limited to, the following:

- \* PLC Input/Output modules shall be tested from the termination points
- \* The following control functions
  - Sequencing with control panels and Operator Terminal
  - Fault detection and annunciation
  - Debugging and monitoring tools
- \* PLC loop rates: suitable tests shall be performed to verify that each controller can cycle through its control loops at the specified frequencies

#### 3.3 OPERATOR TRAINING

The Contractor shall provide on-site classroom and field instruction in the operation and maintenance of the PLC system. These services shall be directed by the Contractor. This training shall be customized to the specific system configurations. Instructional materials shall be provided for 12 participating Government personnel, 10 calendar days in advance of the scheduled training.

-- End of Section --

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DIVISION 16 - ELECTRICAL

SECTION 16965

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SECTION 16965

INDUSTRIAL INSTRUMENTATION

PART 1 GENERAL

1.1 SUMMARY

The Contractor shall provide, install, and test instrumentation as required herein.

1.2 REFERENCES

The publications listed below form a part of this section to the extent referenced:

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (2002) National Electrical Code

NFPA 79 (2002) Electrical Standard for Industrial Machinery

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA ICS 1 (2001) General Standards for Industrial Control and Systems

NEMA ICS 2 (2000) Industrial Control Devices and Assemblies

UNDERWRITERS LABORATORIES (UL)

UL ECMD (1988) Electrical Construction Materials Directory Supplement

1.3 SUBMITTALS

The following shall be submitted in accordance with Section 01330, "Submittals," in sufficient detail to show full compliance with the specification:

SD-01 Data

Manufacturer's Catalog Data, including Equipment and Performance Data, shall be submitted indicating for the following items:

- Power Supplies
- Switches/Pushbuttons
- Signal Conditioners / Transmitters
- Watchdog Timer

Terminating Devices  
Relays  
Control Accessories  
Enclosures  
Spare Parts Data

A listing of tag numbers shall accompany the data sheets for the instruments. Manufacturer's catalog cuts shall be included to supplement the information. Data sheets shall contain the name of manufacturer, model number, and applicable information concerning the following:

Range, Accuracy, and Repeatability Units  
Pressure and Temperature Rating  
Materials of Construction  
Electrical Rating  
Power Supply  
Input and Output Signals  
Instrument Calibration Sheets

#### 1.4 GENERAL REQUIREMENTS

Section 16905, "Control Wiring", and Section 16960, "Control Systems" apply to the work specified in this section. Wiring methods and practices as described in NFPA 79, Chapter 16, shall apply to work specified in this section.

#### 1.5 HARDWARE CERTIFICATION TEST RESULTS

Hardware certification and calibration tests on industrial instrumentation shall be performed in accordance with the manufacturer's standard practice. The test results shall ensure conformance with the specification requirements. Calibrations shall be traceable to the National Institute of Standards and Technology, NIST.

### PART 2 PRODUCTS

#### 2.1 GENERAL

Manufacturer's standard materials and equipment shall be used. Provide system components as described in the following subparagraphs and associated tables. The data sheets specify the minimum requirements only. All tag numbers shown on the data sheets tables refer to tag numbers shown on the drawings. Furnish equipment and material listed by UL ECMD and bearing the UL label, wheresoever standards have been established and label service is regularly furnished.

#### 2.2 WATCHDOG TIMERS

Watchdog timers shall be designed to monitor control system integrity of the PLC systems. The timers shall monitor the integrity by an edge-triggered input. The timer shall be a package unit for direct plug-in to standard socket, DIN rail mounting type. The unit shall include adjustable timeout rated 0.1 to 60 seconds, optically isolated trigger

input, and input state LED indicator. The unit shall operate on 24 Vdc, 2-second time-out with Form C dry output rated for 5 Amperes at 250 Vac/30Vdc.

### 2.3 ENCLOSURES

Boxes, cabinets, and electrical enclosure for all electrical field wiring and devices shall provide, as a minimum, corrosion resistant, galvanized steel, enclosures with gray enamel finish of the type, size, and classification appropriate for use and location.

Field mounted instrument enclosures for indoor locations shall be NEMA 12 construction minimum, and for exterior wet locations, shall be NEMA 3R construction minimum, unless otherwise specified.

### 2.4 SWITCHES

#### 2.4.1 Pushbutton/Selector Switches

Pushbuttons used in field mounted control panels and for emergency stop functions for low voltage (24VDC and 120V) control circuits shall be heavy-duty, oil tight, momentary contact devices rated 600 volts with threaded base, gasket, colored cap, and threaded chrome plated threaded collar for flush mounting.

Pushbuttons shall be equipped with normally open, circuit closing contacts, and normally closed, circuit opening contacts as indicated. Pushbutton contact rating shall be in accordance with NEMA ICS 1 and NEMA ICS 2 with contact designation A 600.

Selector switches used in field mounted control panels for low voltage (120V) control circuits shall be heavy-duty, oil tight maintained-contact devices with the number of positions as indicated on drawings. Contact ratings shall be in accordance with NEMA ICS 1 and NEMA ICS 2.

Switches/pushbuttons shall have a NEMA rating equal to or superior to the panel in which it is being mounted and as a minimum shall be NEMA Type 13.

Pushbuttons used in control room consoles not including pushbuttons for emergency stop functions, shall have a snap-in housing for flush mounting designed for individual or strip mounting, with side barriers, colored bezel cap, and interchangeable momentary action or alternate action contacts as required by control circuit. Switch contacts shall be rated for 5 amps at 125 VAC.

Legend shall be computer-generated label applied to control room mounted pushbutton lens as shown on contract drawings. A nameplate shall be provided with each field mounted switch or pushbutton.

### 2.5 RELAYS

Control relays shall be UL listed, electromagnetic type with encapsulated coils. Relays shall be provided with the number of contacts and shall be of the type, style, and current/voltage rating as indicated on the drawings

or required for the control application.

Unless indicated otherwise, general-purpose control relays for power limited control circuits shall be enclosed module units with 24 VDC and 120 VAC coils. Relay shall have a minimum mechanical life of 10 million operations. Relays shall be screw terminal din rail mounting type. Relays shall be compatible with PLC output modules.

## 2.6 INDICATOR LIGHTS

Indicator lights used in field mounted control panels shall be heavy duty, oil tight devices with threaded base, gasket, and collar for flush mounting, with convex translucent colored lens, full voltage candelabra screw-base lamp holder and 120 volt, 6 watt incandescent lamps. The indicator lights shall have a NEMA rating equal to or superior to the panel in which they are mounted and as a minimum shall be NEMA Type 13.

## 2.7 TRANSMITTERS

Temperature, pressure and flow transmitters shall have zero and span adjustments.

## PART 3 EXECUTION

### 3.1 INSTALLATION

The Contractor shall furnish all labor, tools, materials, interconnection, services, and adjustments required for a complete and operable system.

Instrumentation shall be carefully handled, shall not be subjected to shock, and shall be protected from weather, dust, and damage during construction.

Instrumentation shall be installed as indicated and in accordance with manufacturer's recommendations. Field mounted instruments shall be located approximately where shown on the drawings. The precise location shall be determined in the field. Devices shall be securely mounted on stand, plates, or brackets heavy enough not to vibrate excessively. Instruments shall be located in a manner and at an elevation that permits convenient access for calibration and maintenance. Care shall be exercised in mounting to prevent interference with equipment, equipment maintenance, building structure, passage, etc.

All control panel instruments shall be mounted by the panel fabricator in the shop and shipped mounted on the panel.

### 3.2 FIELD WIRING

All conduit and wiring between panels and field devices shall be furnished in accordance with the requirements of Section 16905, "Control Wiring", and NFPA 70.

### 3.3 IDENTIFICATION

Provide engraved instrument identifying nameplates mounted above/below panel mounted instruments. Provide stainless steel or brass identifying tags, for each field mounted instrument, firmly affixed to face of device. Fasten nameplates to equipment with stainless steel rivets or screws. Tags shall be securely attached, to valves and other instruments which cannot be drilled, with rust resistant ties or straps or attached to the device with epoxy adhesive.

3.4 CALIBRATION

Calibrate instrumentation in accordance with manufacturer's recommendations.

3.5 TESTING PROCEDURE

3.5.1 Acceptance Test Procedure

The Contractor shall submit 6 copies of an acceptance test procedure to the Contracting Officer. The test procedure shall, as a minimum, indicate how

the system is to be tested, what variables will be monitored during the test, and what criteria for acceptance should be used.

-- End of Section --