

Title: SPECIFICATION FOR ELECTRICAL & INSTRUMENT CONSTRUCTION WORK

SPECIFICATION
FOR
ELECTRICAL & INSTRUMENT CONSTRUCTION WORK
LIGO VACUUM EQUIPMENT
Hanford, Washington



EXPIRES July 1998

Fadi Bark

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Information contained in this specification and its attachments is proprietary in nature and shall be kept confidential. It shall be used only as required to respond to the specification requirements and shall not be disclosed to any other party.

REV LTR	BY—DATE	APPD—DATE	DESCRIPTION OF ACTION
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PROCESS SYSTEMS INTERNATIONAL, INC				SPECIFICATION	
INITIAL APPROVALS	PREPARED BY D. Parenti	DATE 4/29/96	APPROVED BY REB	DATE 4/29/96	Number LIGO-EG970138-02-V A V049-2-022
					Rev 2

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GENERAL REQUIREMENTS

1 CONSTRUCTION DOCUMENTS

- 1.1 Specification for Installation/Commissioning V049-2-021
- 1.2 Attachments to the Specification (see Table of Contents).

2 SCOPE OF WORK

- 2.1 Provide labor, tools, materials, and equipment necessary for a complete installation of the Work as specified and as indicated on Drawings.
- 2.2 Receive, store, and handle equipment furnished by others and required to be installed under this Contract.
- 2.3 Through PSI's representative, coordinate Work activities provided under this Contract with work provided by others.

2.4 SUMMARY OF ELECTRICAL WORK

- 2.4.1 Work as indicated on the Drawings takes place at two sites. The Washington site consists of one corner station, two mid stations, and two end stations.
- 2.4.2 Provide power, instrument, and control wiring installed in conduit or cable tray; receptacles and equipment connections as indicated. Panelboards and below grade conduits are provided by others unless otherwise indicated.
- 2.4.3 Install gages, switches, electronic transmitters, and other instruments; control cabinets; and other equipment furnished by others (see — ATTACHMENT B: *FURNISHED ELECTRICAL EQUIPMENT LIST*).
- 2.4.4 Provide instrument air/gas tubing between pneumatically operated devices and supply lines and connections as indicated. Provide process tubing between electronic transmitters and process points and connections as indicated.
- 2.4.5 Field Tests
 - Test power wiring for grounds and shorts.
 - Test instrument and control wiring for point-to-point continuity, grounds, and shorts.
 - Check instrument gas and process tubing for leaks.
 - Field Calibrations

3 INTENT

- 3.1 Intent of the Drawings and Specification is to assist and guide the Contractor and to establish minimum requirements.
- 3.2 Drawings indicate arrangement and approximate location of equipment. When necessary to deviate from the arrangement indicated to meet structural conditions or to clear other work, inform PSI's representative of proposed deviation before proceeding.

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- 3.3 Comply with specific, detailed requirements indicated on drawings in lieu of generally stated requirements.
- 3.4 All conflicts shall be brought to the attention of PSI's representative.
- 3.5 Drawings and Specification do not undertake to indicate every item necessary to produce a complete installation of the Work indicated or specified.

4 DEFINITIONS (ALSO SEE THE GENERAL CONDITIONS & THE NEC)

<u>By Others</u>	Work not under this Contract.
<u>Contractor</u>	Company doing electrical and instrumentation work as defined in the Contract Documents.
<u>PSI</u>	Process Systems International, Inc.
<u>Indicated</u>	Shown or noted.
<u>Install</u>	Place, secure, and connect.
<u>Labeled</u>	Equipment marked with an identifying symbol authorized by a nationally recognized testing company such as UL, FM, ETL indicating sample of product has been tested and determined it complies with their safety standards.
<u>Owner</u>	California Institute of Technology and The US Government
<u>Owner's Representative</u>	Persons designated by Owner
<u>Permitted</u>	As by code, Contract Documents, or PSI.
<u>Provide</u>	Furnish and install.
<u>Required</u>	As by code, Contract Documents, or prevailing conditions.
<u>Submittal</u>	Information required to show that the proposed equipment complies with project requirements.
<u>Use</u>	Provide material or equipment referenced.
<u>Work</u>	Material and equipment and their installation and other requirements as established in the Contract Documents.
<u>Wire (Verb)</u>	Connect to equipment indicated and provide wiring required for connection.
<u>Wiring</u>	Conductors, raceways, and accessories as required for a complete installation.

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5 CODES, STANDARDS, AND PERMITS

5.1 Comply with authorities having legal jurisdiction and applicable parts of the latest (unless otherwise required) publications by the following jurisdictions and organizations:

- Applicable federal, state, and local codes.
- Federal Occupational Safety and Health Act (OSHA)
- American National Standards Institute, Inc. (ANSI)
- National Fire Protection Association (NFPA)
- Institute of Electrical and Electronics Engineers (IEEE)
- National Electrical Manufacturers Association (NEMA)
- Insulated Cable Engineers Association (ICEA)
- Underwriter's Laboratories (UL), Factory Mutual Engineering Corp (FM), Electrical Testing Laboratories, Inc. (ETL), or other nationally recognized testing companies' equipment and installation safety standards

5.2 The Drawings and Specification do not undertake to repeat requirements written in the above codes, ordinances, and standards.

5.3 Arrange and pay for necessary permits, licenses, inspections, and certificates applicable to the performance of the Work. At conclusion of the Project, deliver certificates of inspection to PSI's representative.

6 LABELED EQUIPMENT

Provide labeled equipment and assemblies where recognized national testing company safety standards exist.

7 INSTALLATION RESTRICTIONS

7.1 Do not cut structural members or walls without written acknowledgment from the Owner obtained via PSI's representative. All wall penetrations shall be through wall block-outs provided by others.

7.2 Do not weld supports and equipment to building steel without written acknowledgment from the Owner obtained via PSI's representative.

7.3 Arrange equipment to allow accessibility to installations likely to need inspection, calibration, repair, and maintenance.

8 SPECIFIED EQUIPMENT AND SUBSTITUTIONS

8.1 The manufacturer of the equipment specified is used as the basis of the design and to establish quality required for this project. Unless no substitutions is stated, other manufacturers of equivalent equipment may also be proposed by the Contractor.

8.2 The description following a catalog number is basically to identify the product, but the description may also call

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for accessories, options, and modifications which are beyond the cataloged product.

- 8.3 Submit proposed substitutions to PSI's representative for acceptance. With submittal, provide details of necessary changes to accommodate substitutions. Submit samples if requested.

9 PROPOSED EQUIPMENT SUBMITTALS

Before delivering equipment to the job site and installing it, complete the submittal process as follows:

- 9.1 Equipment List: As soon as practicable, submit for review a list of equipment proposed for installation with each item identified by Specification paragraph number or where applicable by Drawing number. Include manufacturer's name with catalog or model number for each item.

- 9.2 Product Data: Where required by specification of the product, submit catalog data sheets or other published materials showing appearances, electrical ratings, performance characteristics, dimensions, installation methods, and space requirements of proposed equipment.

- 9.3 Shop Drawings: Where required by specification of the product, submit shop drawings, drawn to scale, indicating physical size and arrangement, construction details, provisions for conduits, access requirements for installation and maintenance, finishes, and materials used in fabrication. Supplement shop drawings with wiring diagrams and information as previously described under product data.

- 9.4 Mark submittals to clearly identify proposed equipment including accessories, options, and features and to exclude parts not applicable to the Project.

- 9.5 If proposed equipment deviates from the Specification or Drawings, indicate those differences and provide sufficient data to justify acceptance.

- 9.6 Provide products of one manufacturer for each classification of equipment.

- 9.7 Stamp submittals indicating that they have been checked and that they comply with Project requirements including physical restrictions before submitting.

- 9.8 Submittals reviews by PSI does not relieve the contractor from the responsibility of complying with the Specification and Drawings.

- 9.9 Unless otherwise required, provide two copies of submittals and deliver to PSI's representative. Where practicable submit all product data and shop drawings at one time. Arrange submittal in three-ring binders with loose-leaf dividers separating categories of equipment.

- 9.10 At the job site, maintain the latest equipment submittals showing the action taken by PSI's representative. Make these submittals available to Owner's and PSI's representatives.

10 TEMPORARY POWER

- 10.1 The Owner will provide electrical power, without charge. Make connections to the Owner's system where permitted.

- 10.2 Provide distribution of power as project needs require.

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10.3 When temporary power is no longer required, remove that portion provided under this Contract.

11 RECORD DRAWINGS

11.1 At the site, maintain a set of prints marking them to accurately reflect the actual installation including changes in sizes, locations, dimensions, and circuiting as the work progresses.

11.2 On a daily basis, trace over the prints with a highlighter (transparent marker) to indicate work installed. Make these prints available to Owner's and PSI's representative.

11.3 At completion of project, deliver marked prints to PSI's representative.

EQUIPMENT AND INSTALLATION

12 CABLE TRAY SYSTEMS

Where indicated, provide cable trays as follows:

12.1 MANUFACTURERS: PW Industries, B-Line, or MP Husky.

12.2 TRAYS: NEMA VE1; channel and ladder type trays as indicated; ladder tray with rungs on 12 inch centers unless otherwise indicated.

12.3 MATERIAL: 6063-T6 aluminum

12.4 LOAD AND SPAN: rated for 50 pounds per linear foot or more and span to suit tray supports.

12.5 ACCESSORIES:

12.5.1 expansion fittings in accordance with manufacturer's recommendations to accommodate building expansion joints and thermal expansion of tray in ambient temperature range of 0°C to 50°C

12.5.2 bonding jumpers

12.5.3 end plates where applicable

12.5.4 drop-out fittings where conduit is not required

12.5.5 divider strips (barriers) where indicated with curved fittings and hold-down clips

12.5.6 other fittings to best suit each application

12.6 SUBMITTALS

12.6.1 Submit product data of each cable tray component for review.

12.6.2 Submit shop drawings of support system for review.

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12.7 INSTALLATION

- 12.7.1 Support horizontal and vertical trays by each side rail using hold-down clamps to prevent lateral or vertical displacement. Provide support brackets, channels/struts, 3/8 inch or larger hanger rods, and fittings to best suit installation (see *SUPPORTS*, Article 22).
- 12.7.2 Ensure that trays are effectively bonded to electrical equipment served by wiring in cable tray.
 - Where applicable, bond tray to building steel with #2 AWG copper conductor at two locations.
 - Bonding jumpers at expansion and adjustable fittings.
- 12.7.3 At approximate 20-foot intervals, identify instrument, and control cable tray with vinyl, self-adhesive signs with one inch high lettering or, similarly, with stencil and paint. Lettering shall read *24VDC INSTRUMENT AND CONTROL*.
- 12.7.4 At approximate 10-foot intervals, identify channel tray with high voltage, ion pump wiring with vinyl, self-adhesive signs with one inch high lettering or, similarly, with stencil and paint. Lettering shall read *DANGER—HIGH VOLTAGE*.

13 CONDUIT SYSTEMS
(ELECTRICAL RACEWAY OF CIRCULAR CROSS SECTION)

- 13.1 INTERMEDIATE METAL CONDUIT (IMC): Galvanized IMC conforming to UL 1242 standard may be provided as indicated on drawings..
- 13.2 ELECTRICAL METALLIC TUBING (EMT): At indoor locations, EMT conforming to ANSI C80.3 and UL 797 standards may be provided as indicated on drawings.
- 13.3 FLEXIBLE METAL CONDUIT (FMC): At connections to motors, transformers, and other vibrating equipment and instruments, provide thermoplastic covered, liquidtight FMC conforming to UL 360 standard and fittings to best suit application.
- 13.4 ACCESSORIES:
 - 13.4.1 Provide fittings to best suit each application.
 - 13.4.2 Provide expansion fittings as required in accordance with manufacturer's recommendations to accommodate building expansion joints indoors and thermal expansion of conduit in ambient temperature range of 0°C to 50°C. Where conduit system is discontinuous, provide bonding jumper, #12 of larger conductor.
- 13.5 INSTALLATION:
 - 13.5.1 Restrictions: Where practicable, keep instrument wiring at least 12 inches away from other wiring and minimize paralleling instrument wiring with power or control wiring.
 - 13.5.2 Arrangement: Make raceway offsets and bends symmetrically and uniformly.
 - 13.5.3 Supports:
 - Fasten conduits to building with one-hole malleable iron conduit clamps with screw or bolt.

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- Where applicable and where two, three, or more conduits are routed together, provide trapeze hangers made of 3/8 inch minimum hanger rods and channels/struts with conduit clamps.
- Support 1-1/2 inch or larger suspended conduits with 3/8 inch minimum hanger rods with conduit clamp.
- Provide supports as specified under *SUPPORTS*, Article 22, p.14.

13.5.4 Pull boxes: Provide pull boxes required for proper conductor installation in addition to boxes indicated.

13.5.5 Terminating conduits:

- Attach IMC to equipment by threading into integral cast hub, compression fitting, or double locknuts with bushing.
- Attach EMT with either set-screw or compression type fittings and connectors with integral insulating liners.

13.5.6 Flexible conduit connections:

- Connect to motors, transformers, and other vibrating equipment with 18 to 30 inches of FMC.
- At equipment mounted on vibrating isolators, provide 90° bend in the FMC.
- Connect to instruments with 18 to 30 inches of FMC.

13.5.7 Grounding: Where grounding conductor or bonding is applicable at locknut installations, provide threaded bushings with insulating liner and grounding lug.

13.5.8 Close openings: Keep conduits closed when not accessing them to prevent rain, dirt, and debris from entering.

14 BOXES, CONDUIT BODIES, AND WIREWAYS

14.1 PULL AND SPLICE BOXES:

14.1.1 Where indicated and as required to install wiring without damaging insulation or stretching conductors, provide galvanized or finished with gray baked enamel boxes with screw-on covers unless otherwise required.

14.1.2 Where applicable, provide galvanized or finished with gray baked enamel box barriers to maintain separation of wiring systems.

14.2 OUTLET AND JUNCTION BOXES

14.2.1 Provide cast-metal boxes with threaded hubs unless otherwise specified.

14.2.2 At outdoor locations, provide gaskets.

14.2.3 At indoor locations, sheet-metal boxes may be provided in lieu of cast-metal boxes and conduit bodies unless otherwise required.

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14.3 CONDUIT BODIES:

14.3.1 Where applicable, cast-metal conduit bodies with threaded hubs may be used in lieu of boxes unless otherwise required.

14.3.2 At outdoor locations, provide gaskets.

14.4 WIREWAYS AND AUXILIARY GUTTERS:

14.4.1 Where required, provide galvanized or finished with gray baked enamel wireways and gutters with screw-on covers unless otherwise required.

14.4.2 Where applicable, provide galvanized or finished with gray baked enamel box barriers to maintain separation of wiring systems.

14.5 ACCESSORIES: Provide fittings to best suit each application.

14.6 INSTALLATION:

14.6.1 General requirements:

- Arrange boxes neatly and symmetrically to adjacent components and architectural features.
- Identify wire and cables by tag numbers with indelible felt tipped marker pen or as specified under wiring systems.
- Provide supports as specified under *SUPPORTS*, Article 22.
- When not accessing, close equipment to prevent rain, dirt, and debris from entering.

14.6.2 Wireway and gutters: Where wireway or gutter is discontinuous, bond each section with #12 or larger conductor.

14.6.3 Pull and splice boxes: Provide supports to prevent conductors from resting on removable bottom covers.

14.6.4 Outlet and junction boxes: Rigidly fasten boxes directly to structure, to support channels/struts, or in framed constructions to bar hangers.

15 WIRE AND CABLE

15.1 POWER WIRE (up through 600 volts):

15.1.1 Provide #12 AWG or larger single; stranded copper; type THHN, THHN-THWN, THWN, or XHHW conductors rated 90°C, 600 volts unless otherwise specified.

Use colored coded insulation in sizes up to #8 AWG, except up to #6 AWG for grounding conductors, and black insulated conductors in larger sizes (see *WIRING IDENTIFICATION*, Article 16).

15.2 CONTROL WIRE (discrete signals):

15.2.1 120 VAC: Provide #14 AWG or larger, stranded copper, type THHN-THWN, multiconductor cable rated 90°C, 600 volts unless otherwise indicated.

15.2.2 24 VDC: Provide #18 AWG or larger, stranded copper,

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multiconductor cables rated 90°C and 300 volts unless otherwise indicated.

15.3 INSTRUMENT WIRE (analog signals):

15.3.1 4-20mA: Provide #18 AWG or larger, stranded copper, individually shielded twisted pairs, single or multipair cables rated 90°C, 300 volts unless otherwise indicated.

15.3.2 Thermocouple: Provide #18 AWG single pair and #20 AWG multipair ANSI type (as indicated), solid thermocouple extension cable shielded, rated 105°C, 300 volts unless otherwise indicated.

15.4 TRAY CABLE: In addition to above, provide cable tray installations with cable labeled for cable tray use.

15.5 SUBMITTALS: Provide product data of each wire and cable.

15.6 INSTALLATION:

15.6.1 Where practicable, keep instrument wiring at least 12 inches away from other wiring and minimize paralleling instrument wiring with power or control wiring

15.6.2 Install wiring without splices.

15.6.3 Simultaneously install conductors and multiconductor cables which occupy same conduit .

15.6.4 Only cable manufacturer approved pulling lubricant shall be used.

15.6.5 Use woven cable grips.

15.6.6 Do not to exceed manufacturer's recommended pulling tension and cable bending radius.

15.6.7 Seal cables exposed to weather or other harmful environments until cable is terminated.

15.6.8 Provide sufficient wire length at each end of pull to permit grouping and training the wires and cables. Where applicable, use self-locking nylon wire ties; cut off loose ends. Do not exceed manufacturer's wire bending radii. Do not allow wiring to bear against edges of enclosures. Replace wiring cut too short to meet installation requirements.

15.7 See *TESTING*, Article 23, p.14.

16 WIRING IDENTIFICATION

16.1 POWER WIRE:

16.1.1 Color code single conductors as follows:

<u>Line</u>	<u>208/120V</u>	<u>480/277V</u>
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
N	White	Gray
G	Green	Green

16.1.2 Where applicable, color code conductors using one-inch wide colored plastic adhesive tape wrapped with two full

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turns.

16.1.3 Identify each conductor end with panel designation and circuit number or with applicable identification to suit other type of circuits. Use printed, adhesive wire marker strips.

16.2 INSTRUMENT AND CONTROL WIRE:

16.2.1 Tag each end of single conductors and cable pairs with schematic wire number unless otherwise directed.

16.2.2 Tag each spare cable end with unique identification.

16.2.3 Use printed sleeve markers.

16.3 SUBMITTALS: Provide product data of printed sleeve markers.

17 WIRING TERMINATIONS

17.1 POWER WIRE:

17.1.1 Splices:

- #10 AWG and smaller conductors, provide insulated spring connectors.
- #8 AWG and larger conductors, provide either compression (crimp) connectors using matching installing tool or mechanical screw type connectors. Cover splices with insulating material made for connector where available; otherwise, cover with at least three layers of electrical, vinyl tape to attain insulation rating equivalent to that of the conductor.

17.1.2 Terminations:

- #10 AWG and smaller conductors to buses, enclosures, and similar applications, provide compression (crimp) terminals.
- #8 AWG and larger conductors, provide either compression (crimp) connectors using matching installing tool or mechanical screw type connectors.
- Where more than one conductor requires termination and terminals are not provided as part of the equipment, provide screw or pressure type insulated terminal blocks.

17.1.3 Motor Leads: To connect to motor leads, use split-bolt connectors. Cover splices with insulating material made for connector where available; otherwise, cover with at least three layers of electrical, vinyl tape to attain insulation rating equivalent to that of the conductor.

17.1.4 Where applicable, tighten screw type hardware in accordance with manufacturer's published torque values. If not available, comply with UL 486A standards.

17.2 INSTRUMENT AND CONTROL WIRE:

17.2.1 At instrument end of cable, strip and cutoff shielding back to edge of overall jacket. Then wrap two full turns of electrical plastic tape or placed heat shrinkable insulating sleeve half on conductors and half on overall jacket . At other end of cable, secure shielding to junction box terminal. (Shielding connects only to a single ground reference point at the electrical source.)

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17.2.2 Coil, insulate, and label ends of spare conductors.

17.2.3 Remove insulation from ends of conductors using mechanical or electric heat type stripper.

18 WIRING DEVICES

Provide devices as indicted on the Drawings.

19 GROUNDING

19.1 EQUIPMENT GROUNDING: Bond each end of equipment grounding conductors to the grounding bushing, the grounding bus, grounding lug, or the enclosure, respectively.

19.2 GROUNDING CONNECTIONS:

19.2.1 Use mechanical connectors to make grounding connections.

Completely remove paint, dirt, and corrosion down to bare metal at connection areas.

20 INSTRUMENT AIR/GAS AND PROCESS TUBING

Where indicated, provide the following:

20.1 INSTRUMENT AIR/GAS TUBING: Provide 1/4 inch, type L, or larger copper tubing, brass compression connectors, and copper clips (Design: 200PSI @ -20F - +150F).

20.2 PROCESS TUBING: Provide 3/8 inch, 0.035 WT, or larger 304 stainless steel, seamless tubing, stainless steel compression connectors, and stainless steel clips

20.3 INSTALLATIONS: Arrange tubing neatly and symmetrically to adjacent components. Use bending tools to make bends in tubing.

20.4 SUBMITTALS: Provide product data of tubing and accessories.

21 EQUIPMENT FURNISHED BY OTHERS

(SEE — ATTACHMENT B: FURNISHED ELECTRICAL EQUIPMENT LIST)

21.1 Receive, store (in clean, dry location), and handle equipment furnished by others and required to be installed under this Contract.

21.2 Set equipment in place and bolt free standing equipment to floor as specified under *SUPPORTS*, Article 22.

21.3 Make power, instrument, and control wiring and tubing connections as indicated.

21.4 Where practicable, keep instrumentation wiring 12 inches away from other wiring and minimize paralleling instrument wiring with power or control wiring.

21.5 Where necessary, cut holes in electrical boxes to accommodate conduit, cable, and tubing connections.

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22 SUPPORTS

- 22.1 Where applicable, provide steel channels/struts with galvanized or painted finish.
- 22.2 Fasten equipment and supports with corrosion resistant hardware.
- 22.3 Provide support systems of suitable strength to hold intended equipment in place.
- 22.4 Fabricate supports from structural steel or steel channels/struts rigidly welded or bolted. Paint cut ends of supports with rust inhibitor matching existing finish.
- 22.5 Secure free-standing equipment to concrete pad or floor with at least four 1/2 inch or larger bolts. Provide drilled concrete anchors where applicable.
- 22.6 Secure surface-mounted panels and cabinets weighing 75lbs. or less with at least four 1/2 inch or larger toggle bolts.

23 TESTING

- 23.1 No equipment shall be energized without consent of PSI's representative.
- 23.2 It is the Contractor's responsibility to conduct tests without damage to equipment.
- 23.3 POWER WIRE TESTING (up through 600 volts):
 - 23.3.1 Test each new conductor installed and existing conductor reconnected to ground using 1000-volt megger.
 - 23.3.2 Provide written test report listing resistance by feeder and branch circuit.
 - 23.3.3 Replace conductors measuring less than 25 megohm and retest.
- 23.4 CONTROL AND INSTRUMENT WIRE TESTING:
 - 23.4.1 Check point-to-point continuity of each conductor to ensure that wiring is intact and terminated at the proper place at both ends. After wiring has been terminated,
 - 1. lift one conductor at a time off of its terminal at both ends;
 - 2. establish an isolated return path (not ground, but may be one of the cable conductors);
 - 3. check conductor continuity;
 - 4. reconnect wire to terminals, or if defective, correct, recheck, and reconnect;
 - 5. with highlighter, mark wiring diagram or schedule to indicate that wire and connection has been verified; and
 - 6. proceed to next conductor.
 - 23.4.2 Using highlighter, indicate on terminal wiring diagrams or schedules that each wire and connection has been verified. Make these sheets available to Owner's and PSI's representatives.
 - 23.4.3 Replace defective wiring and retest.

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23.5 MOTORS TESTING:

23.5.1 Before connecting, measure motor winding resistance and ground resistance.

23.5.2 PSI will test each three-phase motor for proper rotary direction. Where necessary, correct circuit connections per PSI's representative.

23.6 RECEPTACLES TESTING: PSI will test polarity and grounding of each receptacle device used with equipment furnished under this Work. Where necessary, correct circuit connections per PSI's representative.

23.7 INSTRUMENT GAS AND PROCESS TUBING TESTING:

23.7.1 Check tubing and connectors for leaks.

23.7.2 PSI will check gas operated valves for proper opening and closing or positioning of pneumatically operated device.

23.7.3 Make repairs as necessary and retest.

23.8 VALVES TESTING:

23.8.1 Valve cycling to verify proper operation of limit switches, pneumatic operators, and positioning operators is by PSI.

23.8.2 Make electrical and pneumatic repairs as necessary and retest.

23.9 CALIBRATION:

23.9.1 Calibrate instrumentation as required.

23.10 SCHEDULING, NOTIFYING, AND WITNESSING TESTING: Provide the PSI's representative with at least three days notification of scheduled testing. With the notification, include a list of proposed tests and the expected time to perform these tests.

— END —

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ATTACHMENT "A"
DRAWING LISTS

DRAWING	DESCRIPTION
V049-3-002	OVERALL SITE PLAN
V049-3-101	INSTRUMENT PLAN—VERTEX SECTION
V049-3-102	INSTRUMENT PLAN—LEFT BEAM MANIFOLD SECTION
V049-3-103	INSTRUMENT PLAN—RIGHT BEAM MANIFOLD SECTION
V049-3-104	INSTRUMENT PLAN—DIAGONAL SECTION
V049-3-106	CABLE TRAY PLAN—VERTEX SECTION
V049-3-107	CABLE TRAY PLAN—LEFT BEAM MANIFOLD SECTION
V049-3-108	CABLE TRAY PLAN—RIGHT BEAM MANIFOLD SECTION
V049-3-109	CABLE TRAY PLAN—DIAGONAL SECTION
V049-3-110	CABLE TRAY DETAILS-CORNER STATION
V049-3-111	INSTRUMENT/ELECTRICAL PLAN—VERTEX SECTION
V049-3-112	INSTRUMENT/ELECTRICAL PLAN—LEFT BEAM MANIFOLD SECTION
V049-3-113	INSTRUMENT/ELECTRICAL PLAN—RIGHT BEAM MANIFOLD SECTION
V049-3-114	INSTRUMENT/ELECTRICAL PLAN—DIAGONAL SECTION
V049-3-116	POWER PLAN—VERTEX SECTION
V049-3-117	POWER PLAN—LEFT BEAM MANIFOLD SECTION
V049-3-118	POWER PLAN—RIGHT BEAM MANIFOLD SECTION
V049-3-119	POWER PLAN—DIAGONAL SECTION
V049-3-120	DISTRIBUTION SYSTEM FEEDER SCHEDULE
V049-3-123	CDS INTERFACE DIAGRAM—CORNER STATION
V049-3-124	CONDUIT STUB-UP PLAN—CORNER STATION
V049-3-125	VACUUM CART INTERFACE PLAN—CORNER STATION
V049-3-127	DATA HIGHWAY PLAN— VERTEX STATION
V049-3-128	DATA HIGHWAY PLAN— LEFT BEAM MANIFOLD STATION

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Title: SPECIFICATION FOR ELECTRICAL & INSTRUMENT CONSTRUCTION WORK

<u>DRAWING</u>	<u>DESCRIPTION</u>
V049-3-129	DATA HIGHWAY PLAN— RIGHT BEAM MANIFOLD STATION
V049-3-130	DATA HIGHWAY PLAN— DIAGONAL STATION
V049-3-131	DATA HIGHWAY INTERCONNECT DIAGRAM— CORNER STATION
V049-3-133	GROUNDING PLAN - VERTEX SECTION
V049-3-134	GROUNDING PLAN - LEFT BEAM MANIFOLD
V049-3-135	GROUNDING PLAN - RIGHT BEAM MANIFOLD
V049-3-136	GROUNDING PLAN - DIAGONAL SECTION
V049-3-201	INSTRUMENT PLAN—LEFT MID STATION
V049-3-202	CABLE TRAY PLAN—LEFT MID STATION
V049-3-203	INSTRUMENT/ELECTRICAL PLAN—LEFT MID STATION
V049-3-204	POWER PLAN—LEFT MID STATION
V049-3-205	CONDUIT STUB-UP PLAN - LEFT MID STATION
V049-3-206	VACUUM CART INTERFACE PLAN—LEFT MID STATION
V049-3-208	CDS INTERFACE DIAGRAM—LEFT MID STATION
V049-3-209	GROUNDING PLAN—LEFT MID STATION
V049-3-301	INSTRUMENT PLAN—RIGHT MID STATION
V049-3-302	CABLE TRAY PLAN—RIGHT MID STATION
V049-3-303	INSTRUMENT/ELECTRICAL PLAN—RIGHT MID STATION
V049-3-304	POWER PLAN—RIGHT MID STATION
V049-3-305	CONDUIT STUB-UP PLAN—RIGHT MID STATION
V049-3-306	VACUUM CART INTERFACE PLAN—RIGHT MID STATION
V049-3-308	CDS INTERFACE DIAGRAM—RIGHT MID STATION
V049-3-309	GROUNDING PLAN—RIGHT MID STATION
V049-3-401	INSTRUMENT PLAN—LEFT END STATION
V049-3-402	CABLE TRAY PLAN—LEFT END STATION
V049-3-403	INSTRUMENT/ELECTRICAL PLAN—LEFT END STATION

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DRAWING	DESCRIPTION
V049-3-404	POWER PLAN—LEFT END STATION
V049-3-405	CONDUIT STUB-UP PLAN - LEFT END STATION
V049-3-406	VACUUM CART INTERFACE PLAN—LEFT END STATION
V049-3-408	CDS INTERFACE DIAGRAM—LEFT END STATION
V049-3-409	GROUNDING PLAN—LEFT END STATION
V049-3-501	INSTRUMENT PLAN—RIGHT END STATION
V049-3-502	CABLE TRAY PLAN—RIGHT END STATION
V049-3-503	INSTRUMENT/ELECTRICAL PLAN—RIGHT END STATION
V049-3-504	POWER PLAN—RIGHT END STATION
V049-3-505	CONDUIT STUB-UP PLAN—RIGHT END STATION
V049-3-506	VACUUM CART INTERFACE PLAN—RIGHT END STATION (2 SHEETS)
V049-3-508	CDS INTERFACE DIAGRAM—RIGHT END STATION
V049-3-509	GROUNDING PLAN—RIGHT END STATION

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DRAWING	DESCRIPTION
V049-3-001	GENERAL NOTES & LEGEND
V049-3-006	ELECTRICAL INSTALLATION DETAILS
V049-3-007	INSTRUMENT ELECTRICAL INSTALLATION DETAILS
V049-3-008	INSTRUMENT INSTALLATION DETAILS
V049-3-009	GROUNDING DETAILS

REFERENCE DRAWING LIST

DRAWING	DESCRIPTION
V049-3-004	ION CONTROLLER CABINET (2 SHEETS)
V049-3-121	PNL-100A & 100B ASSEMBLY
V049-3-122	PNL-100A & 100B WIRING DIAGRAM
V049-3-207	PNL-200 WIRING DIAGRAM
V049-3-307	PNL-300 WIRING DIAGRAM
V049-3-407	PNL-400 WIRING DIAGRAM
V049-3-507	PNL-500 WIRING DIAGRAM

* Reference drawings, used by others to fabricate equipment, are furnished to supplement installation details and indicate wiring terminations.

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ATTACHMENT "B"

FURNISHED ELECTRICAL EQUIPMENT LIST

ITEM

INSTRUMENT TAG/EQUIPMENT DESIGNATION

V INDICATES VACUUM ENVIRONMENT LOCATION

DESCRIPTION (INDICATED ON DRAWING/SHEET)

1	FI-104	—	CRYOPUMP WCP1 FLOW INDICATOR (V049-3-102)
2	FI-154	—	CRYOPUMP WCP2 FLOW INDICATOR (V049-3-103)
3	FI-204	—	CRYOPUMP WCP3 FLOW INDICATOR (V049-3-201)
4	FI-254	—	CRYOPUMP WCP4 FLOW INDICATOR (V049-3-201)
5	FI-304	—	CRYOPUMP WCP5 FLOW INDICATOR (V049-3-301)
6	FI-354	—	CRYOPUMP WCP6 FLOW INDICATOR (V049-3-301)
7	FI-404	—	CRYOPUMP WCP7 FLOW INDICATOR (V049-3-401)
8	FI-504	—	CRYOPUMP WCP8 FLOW INDICATOR (V049-3-501)
9	LT-100	—	CRYOPUMP WCP1 LEVEL TRANSMITTER* (V049-3-102)
10	LT-105	—	CRYOPUMP WCP1 DEWAR LEVEL TRANSMITTER* (V049-3-102)
11	LT-150	—	CRYOPUMP WCP2 LEVEL TRANSMITTER* (V049-3-103)
12	LT-155	—	CRYOPUMP WCP2 DEWAR LEVEL TRANSMITTER* (V049-3-103)
13	LT-200	—	CRYOPUMP WCP3 LEVEL TRANSMITTER* (V049-3-201)
14	LT-205	—	CRYOPUMP WCP3 DEWAR LEVEL TRANSMITTER* (V049-3-201)
15	LT-250	—	CRYOPUMP WCP4 LEVEL TRANSMITTER* (V049-3-201)
16	LT-255	—	CRYOPUMP WCP4 DEWAR LEVEL TRANSMITTER* (V049-3-201)
17	LT-300	—	CRYOPUMP WCP5 LEVEL TRANSMITTER* (V049-3-301)
18	LT-305	—	CRYOPUMP WCP5 DEWAR LEVEL TRANSMITTER* (V049-3-301)
19	LT-350	—	CRYOPUMP WCP6 LEVEL TRANSMITTER* (V049-3-301)
20	LT-355	—	CRYOPUMP WCP6 DEWAR LEVEL TRANSMITTER* (V049-3-301)
21	LT-400	—	CRYOPUMP WCP7 LEVEL TRANSMITTER* (V049-3-401)
22	LT-405	—	CRYOPUMP WCP7 DEWAR LEVEL TRANSMITTER* (V049-3-401)

* Furnished with accessories.

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Title: SPECIFICATION FOR ELECTRICAL & INSTRUMENT CONSTRUCTION WORK

ITEM	INSTRUMENT TAG/EQUIPMENT DESIGNATION	
		V INDICATES VACUUM ENVIRONMENT LOCATION
		DESCRIPTION (INDICATED ON DRAWING/SHEET)
23	LT-500	— CRYOPUMP WCP8 LEVEL TRANSMITTER* (V049-3-501)
24	LT-505	— CRYOPUMP WCP8 DEWAR LEVEL TRANSMITTER* (V049-3-501)
25	PNL-100A	— CORNER STATION ION CONTROLLER PANEL (V049-3-116)
26	PNL-100B	— CORNER STATION ION CONTROLLER PANEL (V049-3-116)
27	PNL-200	— LEFT MID STATION ION CONTROLLER PANEL (V049-3-204)
28	PNL-300	— RIGHT MID STATION ION CONTROLLER PANEL (V049-3-304)
29	PNL-400	— LEFT END STATION ION CONTROLLER PANEL (V049-3-404)
30	PNL-500	— RIGHT END STATION ION CONTROLLER PANEL (V049-3-504)
31	PT-101	— CRYOPUMP WCP1 PRESSURE TRANSMITTER* (V049-3-102)
32	PT-151	— CRYOPUMP WCP2 PRESSURE TRANSMITTER* (V049-3-103)
33	PT-201	— CRYOPUMP WCP3 PRESSURE TRANSMITTER* (V049-3-201)
34	PT-251	— CRYOPUMP WCP4 PRESSURE TRANSMITTER* (V049-3-201)
35	PT-301	— CRYOPUMP WCP5 PRESSURE TRANSMITTER* (V049-3-301)
36	PT-351	— CRYOPUMP WCP6 PRESSURE TRANSMITTER* (V049-3-301)
37	PT-401	— CRYOPUMP WCP7 PRESSURE TRANSMITTER* (V049-3-401)
38	PT-501	— CRYOPUMP WCP8 PRESSURE TRANSMITTER* (V049-3-501)
39	TE-103A, 102A, 102B	— CRYOPUMP WCP1 THERMOCOUPLE (V049-3-102)
40	TE-153A, 152A, 152B	— CRYOPUMP WCP2 THERMOCOUPLE (V049-3-103)
41	TE-203A, 202A, 202B	— CRYOPUMP WCP3 THERMOCOUPLE (V049-3-201)
42	TE-253A, 252A, 252B	— CRYOPUMP WCP4 THERMOCOUPLE (V049-3-201)
43	TE-303A, 302A, 302B	— CRYOPUMP WCP5 THERMOCOUPLE (V049-3-301)

* Furnished with accessories

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Title: SPECIFICATION FOR ELECTRICAL & INSTRUMENT CONSTRUCTION WORK

ITEM			INSTRUMENT TAG/EQUIPMENT DESIGNATION
			✓ INDICATES VACUUM ENVIRONMENT LOCATION
			✓ DESCRIPTION (INDICATED ON DRAWING/SHEET)
44	TE-353A, 352A, 352B	—	CRYOPUMP WCP6 THERMOCOUPLE (V049-3-301)
45	TE-403A, 402A, 402B	—	CRYOPUMP WCP7 THERMOCOUPLE (V049-3-401)
46	TE-503A, 502A, 502B	—	CRYOPUMP WCP8 THERMOCOUPLE (V049-3-501)

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ATTACHMENT "C"
S U B M I T T A L L I S T

Submit for review the proposed equipment submittals and reports as required under the Specification and listed below:

1. Equipment substitutions (Article 8.3, page 6)

Submit proposed substitutions PSI's representative for acceptance. With submittal, provide details of necessary changes to accommodate substitutions. Submit samples if requested.

2. List of proposed equipment (Article 9.1, page 6)

As soon as practicable, submit for review a list of equipment proposed for installation with each item identified by Specification paragraph number or where applicable by Drawing number. Include manufacturer's name with catalog or model number for each item.

3. Cable tray (Article 12.6, page 7)

Product data of each cable tray component.
Shop drawings of support systems.

4. Wire and cable (Article 15.5, page 11)

Product data of each wire and cable.

5. Wiring identification (Article 16.3, page 12)

Product data of printed sleeve markers.

6. Instrument air/gas and process tubing (Article 20.4, page 13)

Product data of tubing and accessories.

7. Testing (Article 23.3.2, page 14)

Written test report listing resistance by feeder and branch circuit.

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