# PROCESS SYSTEMS INTERNATIONAL, INC.

**FEDERAL EXPRESS**

**TO :** LIGO PROJECT M/S 51-33
CAL. INSTITUTE OF TECH.
391 S. HOLLISTON AVENUE
PASADENA, CA 91125

**DATE :** 11/17/95
**TRANS. NO. :** CT008
**PROJECT NO.:** V59049

**ATTN :** MS. LINDA TURNER

**SENT BY :** RICH BAGLEY

THE FOLLOWING [ ] DRAWINGS
[ ] DOCUMENTS
[ **X** ] SPECIFICATIONS

[ **X** ] ARE ATTACHED
[ ] SENT SEPARATELY

| Document No. | Rev. | Title | Dwg.Size | Sheets |
|---|---|---|---|---|
| V049-2-004 | 0 | ION PUMPS LIGO-E960034-00-V | | |

**CC :**

**ISSUED FOR:** [ **X** ] APPROVAL [ ] PRELIMINARY
[ ] REVIEW [ ] CONSTRUCTION
[ ] INFORMATION [ ] DISTRIBUTION

ENCL: [ **4** ] PRINTS [ **1** ] REPRODUCIBLES



20 Walkup Drive • Westborough, Massachusetts 01581-5003 • 508/366-9111 • FAX 508/870-5930

# SPECIFICATION FOR

# ION PUMPS

FOR

## LIGO VACUUM EQUIPMENT

Hanford, Washington
and
Livingston, Louisiana

**PREPARED BY:** D Moore

**QUALITY ASSURANCE:** Allan L Bradbrook

**TECHNICAL DIRECTOR:** D. C. McWilliams

**PROJECT MANAGER:** Rudolf Bagley

NOV 17 1995



| REV LTR. | BY-DATE | APPD. DATE | DESCRIPTION OF CHANGE |
|---|---|---|---|
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| P1 | 10-19-95 | RED | Released per DEO 0005 |
| P1 | TMS 9-26-95 | | REVISED FOR UPDATED PRELIMINARY DESIGN |

| PROCESS SYSTEMS INTERNATIONAL, INC. | | | | | SPECIFICATION | | |
|---|---|---|---|---|---|---|---|
| INITIAL APPROVALS | PREPARED | DATE | APPROVED | DATE | Number | V049-2-004 | Rev. 0 |
| | D Moore | 6/14/95 | BEB | 9/26/95 | | | |

## SPECIFICATION TABLE OF CONTENTS

## 1.0 SCOPE

This specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipping, shipment and delivery of the ion pumps for the LIGO vacuum system. The ion pumps will be used to perform the following functions:

a) Maintain an ultra high vacuum in the equipment at the corner, mid and end stations of the LIGO interferometer (main ion pumps).

b) Maintain an ultra high vacuum in the annular spaces between dual-sealed flanges on the chambers (chamber annulus ion pumps).

c) Maintain an ultra high vacuum in the annular spaces between the double gate seals and dual seal flanges of the large gate valves which isolate sections of the interferometer from each other (valve annulus ion pumps).

All attachments are incorporated herein by reference and made a part of this specification.

The specified equipment is intended for use as part of the Vacuum Equipment supplied for the Laser Interferometer Gravitational-Wave Observatory (LIGO). LIGO, which is operated by Caltech and MIT under an NSF grant, includes two sites (Hanford Reservation, near Richland, WA and Livingston, LA). Each site contains laser interferometers in an L shape with 4 km arms, a vacuum system for the sensitive interferometer components and optical beams, and other support facilities.

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.

## 2.0 SCHEDULE

2.1 Equipment delivery shall be as follows:

Main Ion Pumps

| | | Quantity | Date |
|---|---|---|---|
| Lot 1 | PSI (Westboro, MA) | 2 | 4/1/96 |
| Lot 2 | Washington Site: | 12 | 9/1/97 |
| Lot 3 | Louisiana Site: | 4 | 3/1/98 |
| | Total Required | 18 | |

Chamber and Beam Manifold Annulus Ion Pumps

| | | Quantity | Date |
|---|---|---|---|
| Lot 1 | PSI (Westborough) | 2 | 4/1/96 |
| Lot 2 | Washington Site: | 28 | 9/1/97 |
| Lot 3 | Louisiana Site: | 13 | 3/1/98 |
| | Total Required | 43 | |

Valve Annulus Ion Pumps

| | | Quantity | Date |
|---|---|---|---|
| Lot 2 | Washington Site: | 20 | 9/1/97 |
| Lot 3 | Louisiana Site: | 12 | 3/1/98 |
| | Total Required | 32 | |

2.2 Acceptances at the sites are expected to occur on a staggered basis, with final acceptance at Washington expected to occur about May 31, 1998, and about November 30, 1998 in Louisiana.

## 3.0 EQUIPMENT REQUIREMENTS

### 3.1 Main Ion Pumps

3.1.1 The main ion pumps shall have minimum nominal pumping speeds at the pump inlet of 2,500 liter/sec for nitrogen at $1 \times 10^{-6}$ torr and 4,700 liters/sec for hydrogen at $1 \times 10^{-9}$ torr. The minimum guaranteed pumping speeds for other gases at the partial pressures specified in Table 1 shall be stated. The pumping speed for nitrogen for total pressures ranging from $1 \times 10^{-6}$ torr to $1 \times 10^{-10}$ torr shall be stated.

Table 1

| Species | Partial Pressure (Torr) | Min. Required Pumping Speed |
|---|---|---|
| $H_2O$ | $5 \times 10^{-9}$ | 2940 l/s |
| $H_2$ | $5 \times 10^{-9}$ | 4700 l/s |
| $N_2$ | $5 \times 10^{-10}$ | 2500 l/s |
| CO | $5 \times 10^{-10}$ | 2350 l/s |
| $CO_2$ | $2 \times 10^{-10}$ | 2940 l/s |
| $CH_4$ | $2 \times 10^{-10}$ | 2150 l/s |
| He | $5 \times 10^{-10}$ | 295 l/s |
| Ar | $5 \times 10^{-10}$ | 590 l/s |

3.1.2 A single large pump shall be provided.

3.1.3 Noble gas diode-type ion pumps with a minimum life of 40,000 hours or more at an operating pressure of $10^{-6}$ torr shall be used.

3.1.4 Main Ion Pumps (cell design and feedthroughs) shall be designed to allow starting at pressures of at least $1x\ 10^{-5}$ torr (minimum of two feedthroughs).

For this requirement, the vendor shall provide a design that allows an additional power supply (supplied by others) to be connected to a feedthrough on the pump, thus the ability to start the pump at a pressure of at least $1x10^{-5}$ torr.

3.1.5 The vendor shall supply a controller for each main ion pump with sufficient current capability to start the pump at a pressure of at least $1x10^{-6}$ torr and run all cells of the pump under normal operation ($1x10^{-6}$ torr and lower).

The vendor shall supply some form of manual switching capability (dual cabling or use of a jumper cable) to provide for one or two power supply operation to permit a starting pressure of $1x10^{-5}$ torr.

3.2 Chamber Annulus Pumps

3.2.1 Noble gas diode ion pumps, each with a capacity of 75 l/s of air at $1 \times 10^{-6}$ torr, shall be provided for each chamber to maintain the annular vacuum for dual-sealed flanges.

3.2.2 The vendor shall supply a controller for each annulus ion pump with sufficient current capability to start the pump at a pressure of at least $5x10^{-6}$ torr.

3.3 Valve Annulus Ion Pumps

3.3.1 Noble gas diode ion pumps shall be provided for each large gate valve to maintain the annular vacuum at the valve flange dual seal annuli, as well as the dual gate seals when the valves are closed.

3.3.2 Each valve annulus ion pump shall have a capacity of 25 l/s of air at $1 \times 10^{-6}$ torr..

3.3.3 The vendor shall supply a controller for each annulus ion pump with sufficient current capability to start the pump at a pressure of at least $5x10^{-6}$ torr.

## 4.0 DESIGN REQUIREMENTS

### 4.1 Mechanical Requirements

4.1.1 The main ion pump shall be a single pump. The pump will be supplied with a 14" O.D. tube on which a 16.5" CF mounted. The pipe or manifold on which the ion pump mounts will be the responsibility of the Buyer.

4.1.2 The chamber annulus ion pumps will be supplied with a 4" O.D. tube on whch a 6" CF is mounted.

4.1.3 The valve annulus ion pumps will be supplied with a 2" O.D. tube on which a 3 3/8" CF is mounted.

4.1.4 Electrical feedthroughs shall be protected from mechanical damage.

41.5. All annulus pumps shall have a minimum life of 40,000 hours or more at an operating pressure of $10^{-6}$.

4.1.6 The vendor shall provide mounting or internal supports for the main pump (if necessary) to allow the pump to be mounted vertically from the CF. Lifting lugs shall be provided. See attached drawing.

### 4.2 Electrical Requirements

4.2.1 Instrumentation Requirements

4.2.1.1 The cables to interconnect the main ion pumps and controllers shall be provided. The cable length is approximately 150 feet for each pump. Exact lengths TBD.

4.1.1.2 The cables to interconnect the annulus ion pumps and controllers shall be provided. The cable length is approximately 10 feet for each pump.

4.2.1.3 Unused ports shall be fitted with blankoff flanges.

4.2.1.4 The vendor will submit full load power requirements for each controller.

4.2.2 Controls Requirements

4.2.2.1 The main ion pump controllers shall be rack mountable in standard 19 inch rack consoles (supplied by others). These consoles may be located up to 150 feet away from the pumps.

4.2.2.2 All main ion pump controllers shall have remote capabilities that include the following:

| | |
|---|---|
| Run Status | Dry Contact Output |
| Pump Fail | Dry Contact Output |
| Current Trip | Dry Contact Output |
| Standby Mode | Dry Contact Input |
| Start | Dry Contact Input |
| Stop | Dry Contact Input |

0-10VDC analog output proportional to ion pump current.

0-10VDC analog output proportional to ion pump voltage.

4.2.2.3 All annulus pump controllers will have a single 0-10VDC analog output proportional to the ion pump current.

4.2.2.4 All annulus pump controllers are not required to be rack mountable and will be located within 10 feet of the pumps.

4.2.2.5 Vendor shall provide max. starting pressures for all controller/pump combinations.

## 5.0 REQUIRED DOCUMENTATION

Documentation requirements listed in Attachment B shall be provided according to the Buyer's schedule (schedule later).

## 6.0 SHOP TESTING

In addition to the Vendor's standard tests, the first lot (Lot #1) of pumps shall be tested for speed, ultimate pressure, leakage and normal operation, referencing Table #1 located in Section 3.1.1 of this specification. All safety interlocks shall be tested.

## 7.0 INSPECTION

The inspections called for in Attachment A & B shall be performed by the Vendor. Each pump shall be inspected for dimensional ionformance to approved assy. drwings.

## 8.0 WARRANTY

Refer to RFQ for warranty requirements.

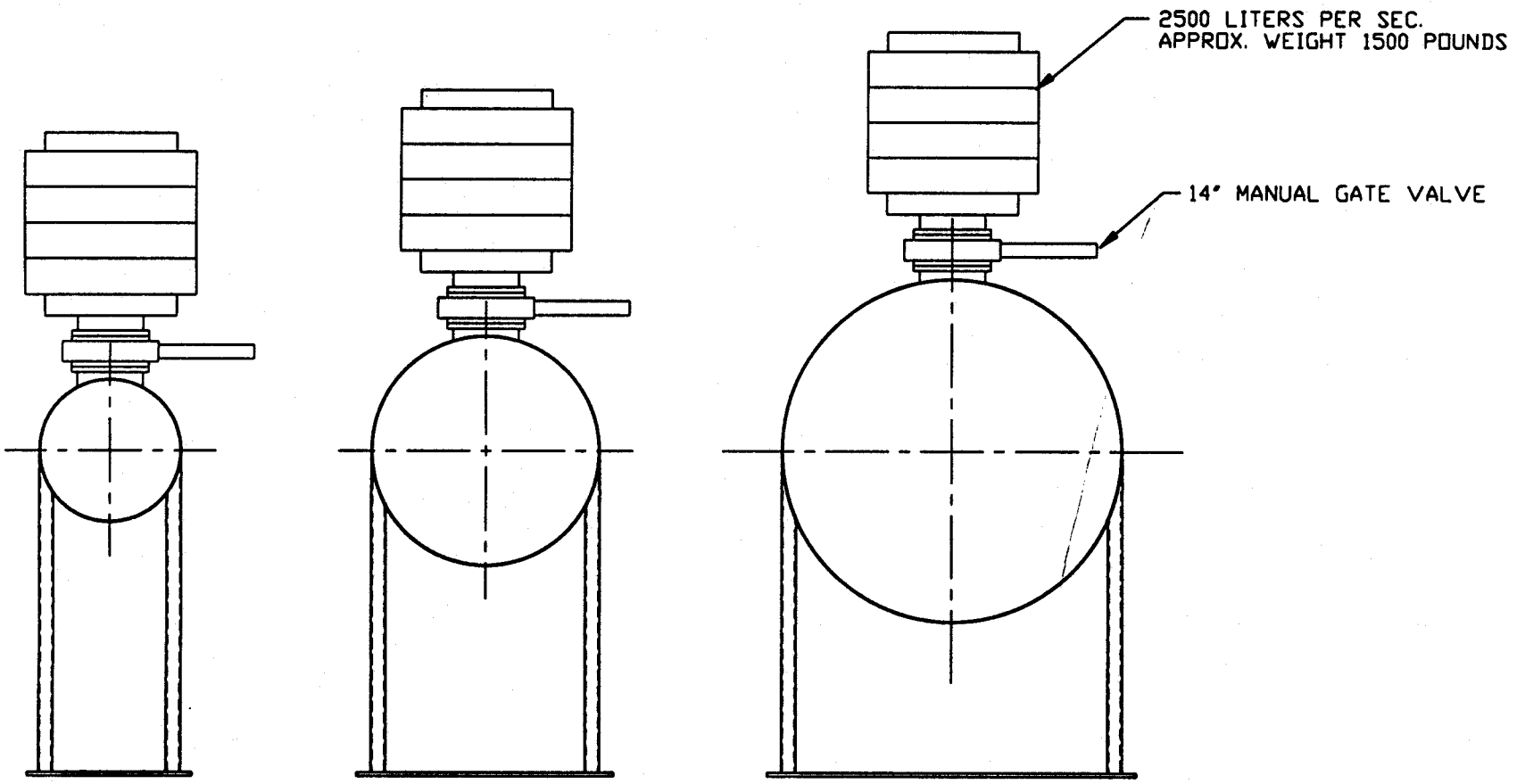
ATTACHMENT "A"

LIGO QUALITY ASSURANCE REQUIREMENTS SUMMARY



| LIGO VACUUM EQUIPMENT | VENDOR: | JOB NO.: V59049 |
|---|---|---|
| EQUIPMENT: ION PUMPS | VENDOR ENG. OFFICE: | DWG. NO.: |
| PSI P.O. NO: | VENDOR FACTORY: | SPEC NO.: V049-2-004 |

| TESTING INSPECTION AND DOCUMENTATION RECORD | Submittal After P.O. | Witnessed by PSI | Approval by PSI | Copies Req'd for PSI Files | Record in Mfr's File | Remarks: | Inspector: Date: |
|---|---|---|---|---|---|---|---|
| MILESTONE SCHEDULE | | | X | 2 | X | | |
| VENDOR Q.A. PLAN | | | X | 2 | X | | |
| CLEANING PROCEDURE | | | X | 2 | X | | |
| PREP FOR SHIPMENT PROCEDURE | | | X | 2 | X | | |
| ASSEMBLY DRAWINGS | | | X | 2 | X | | |
| DESIGN REVIEW | | X | | | X | | |
| IN-PROCESS INSPECTIONS | | X | | 2 | X | | |
| OPERATION & MAINTENANCE MANUALS | | | | 5 | X | | |
| SHOP TEST PLAN | | | X | 2 | X | | |
| SHOP TEST (WITH REPORT) | | X | | 2 | X | | |
| SHOP DIMENSIONAL INSPECTION | | X | | 2 | X | | |
| | | | | | | | |
| | | | | | | | |






UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES
FRACTIONAL ±
ANGULAR MACH ±0° DECIMAL ±0°
TWO PLACE DECIMAL ± .010
THREE PLACE DECIMAL ± .005
FINISHED SURFACE RMS
BREAK CORNERS .06 OUT.
REMOVE ALL BURRS

DO NOT SCALE THIS DWG.
USED ON
NEXT ASS'Y

| REV | DESCRIPTION | CHKD | DRWN | DATE | DCO# |
|---|---|---|---|---|---|
| | ISSUE DESCRIPTION | | | | |

PROCESS SYSTEMS INTERNATIONAL INC.
20 WALKUP DR. WESTBOROUGH, MASSACHUSETTS 01581 USA

ION PUMP SUPPORTS
LIGO VACUUM EQUIPMENT

| CAD FILE | SIZE | DWG. NO. | REV. |
|---|---|---|---|
| IONPUMP | B | | 0 |
| SCALE N.T.S. | SHEET 1 OF 1 | | |

Sept 27, 1995 - 1407-41

**DATE:**
**RFQ No.**
**DUE DATE:**

**TO:**

**SUBJECT:** **REQUEST FOR QUOTATION - THIS IS NOT AN ORDER - URGENT**

**DESCRIPTION:** **Ion Pumps**

1. The RFQ No. must be on all quotations and correspondence.
2. This inquiry implies no obligation on the part of the Buyer.
3. We welcome any suggestions regarding substitute products, materials, or designs that will reduce price and/or technical risk.
4. Any deviations must be identified in bidder's quotation.
5. Quotations must state place of manufacture, submittal and delivery dates.
6. Attachments:
   a. Instruction to Bidders
   b. Pricing Sheet(s)
   c. Certificate of Compliance
   d. Specification No. V049-2-004 (with attachments)
   e. Specification No. V049-2-034

Ronald B. Bento
Materials Manager

**DATE:**
**RFQ No.**

**Instruction To Bidders**

1. Quotations are due by the close of business on 11/21/95.

   Send quotations in triplicate to:

   Process Systems International, Inc.
   ATTN: Mr. R. Bento
   20 Walkup Drive
   Westborough, MA 01581
   (508) 898-0205, Fax: (508) 898-0351

2. Please submit all questions, both technical and commercial, in writing to:

   Process Systems International, Inc.
   ATTN:
   20 Walkup Drive
   Westborough, MA 01581
   (508) 898-0205; Fax (508) 898-0351

3. Quotations must be signed by a corporate officer and include a current financial statement.

4. Quotations must be for firm-fixed pricing for the specified period of performance and valid for acceptance by Buyer through 60 days.

5. All bidders are requested to identify major cost drivers with cost saving alternatives and technical risk areas with proposed alternatives to reduce such risk.

6. A bid bond in the amount of 25 percent of the quotation value is required with quotations or a statement of bonding capacity should time not permit bidder to obtain a bid bond and meet the required due date.

7. A supply bond in the amount of 100 percent of the purchase order price is required within 15 days of placement of purchase order with the successful bidder. The price of the supply bond is to be identified as a separate line item in bidder's quotation.

8. Payment Terms:

   90% upon delivery of the item to the specified destination.
   10% upon final acceptance of the item by Buyer's Customer.

   Alternate payment terms specifying the price reduction will be considered. Payment terms will be considered in the price evaluation.

9. Shipping Terms are FOB destination to specified location. Bidder's pricing is to include freight and insurance.

10. Sales tax is to be excluded. Buyer will provide a resale exemption number.

11. Bidder to include in its quotation applicable field service rates valid through final acceptance.

12. Bidder to specify and price recommended spares for each site for start-up and for the first year of operation separately.

13. Items will be delivered as specified in the attached Equipment Specification. The Bidder shall specify the required release date to meet that schedule. Buyer will not be responsible for cost incurred by Bidder on items not released in writing. The Bidder shall submit a completed copy of the attached pricing sheet. Bidder shall also confirm drawing(s) and specification(s) submittal date.

14. All quotations must be submitted in strict compliance with this request for quotation in order to be considered for award. Quotations containing bidder's standard terms and conditions will be considered nonresponsive and subject to rejection at Buyer's option.

15. Quotations will be evaluated based on technical compliance with the specification, pricing, delivery, schedule of drawings, specifications and equipment, acceptance of the commercial terms and conditions, past experience for similar goods, management and financial capability to execute the scope of work, and overall responsiveness and conformance to this request for quotation including proposed pricing reductions. Buyer reserves the right to purchase from other than the low price bidder.

16. Bidder will identify bidder's key project personnel, including the project manager, and include their qualifications/resume in the quotation.

17. All quotations must include a signed Certificate of Compliance, RFQ/CC-95.

**DATE:**
**RFQ No.**

# PRICING SHEET

(To Be Completed By Bidder)

**DESCRIPTION:** The base price must be in full compliance with the request for quotation. Option(s) are to be priced as requested by Buyer. Bidder is requested to submit additional options that offer price reductions and specify where the deviation is specifically addressed.

**BASE:** Attachments may be used to supplement and/or support the required information.

| Item No. | Description | Qty. | Destination | Release Date | Delivery Date | Unit Price | Total Price |
|---|---|---|---|---|---|---|---|
| 1. | **Main Ion Pumps & Controllers** | | | | | | |
| | Lot #1 | 2 | PSI (Westborough, MA) | | | | |
| | Lot #2 | 12 | Washington Site | | | | |
| | Lot #3 | 4 | Louisiana Site | | | | |
| 2. | **Chamber Annulus Ion Pumps & Controllers** | | | | | | |
| | Lot #1 | 2 | PSI (Westborough, MA) | | | | |
| | Lot #2 | 28 | Washington Site | | | | |
| | Lot #3 | 13 | Louisiana Site | | | | |
| 3. | **Valve Annulus Ion Pumps & Controllers** | | | | | | |
| | Lot #2 | 20 | Washington Site | | | | |
| | Lot #3 | 12 | Louisiana Site | | | | |
| 4. | Speed test | 1 | As noted in spec. | | | | |
| 5. | Buyer requested options | 1 | As noted in spec. | | | | |

**Buyer Requested Options:**

1. The vendor shall quote the heaters and isolation blanket necessary for bakeout of one main ion pump. Also, provide a quote for two type "J" thermocouples on this pump.

2. The vendor shall provide a quote for one main pump with dual pump ports. Provide a 8" blank conflat flange on one of these ports.

3. The vendor shall provide quotations for optional 2 3/4" Conflat flange roughing ports on all size pumps.

4. The vendor shall provide a quotation for providing a safety interlock that will automatically shut down the power supply whenever the HV cable is disconnected at the pump or the controller.

**Bidder Offered Options:**

**Spare Parts:** **(Attach List by Grouping)**

**Supply Bond:**

## CERTIFICATE OF COMPLIANCE

**PSI INQUIRY NO.** _____
**BIDDER NAME:** _____
**BIDDER'S PROPOSAL NO.** _____

**INSTRUCTIONS:** **This form must be completed by each bidder and must accompany the quotation. Any quotation not accompanied by a properly executed copy of this form will be considered nonresponsive.**

**CHECK ONE BOX ONLY:**

☐ **We certify that this proposal complies with the Request for Quotation, and all attachments thereto, as well as all referenced industry codes and standards.**

☐ **We certify that this quotation complies with the Request for Quotation, and all attachments thereto, as well as all referenced industry codes and standards, except for the comments/exceptions listed on the following page(s)**_____
_____.*

**BY:** _____
**(Signature of Company Officer)**

_____
**(Name Typed or Printed)**

**TITLE:** _____

**DATE:** _____

***NOTE:** **Each Request for Quotation document should be addressed separately. It will be assumed that Bidder is in complete compliance with any document not so addressed.**

**RFQ/CC-95**