LIGO VACUUM EQUIPMENT
FINAL DESIGN REPORT
VOLUME I
PROJECT MANAGEMENT

LIGO - C960962-02-V

CONTRACT NO:	**PC 175730**
PSI DOCUMENT NO:	**V049-1-002**
PROGRAM I.D.	**LIGO VACUUM EQUIPMENT**
CDRL NO:	**03**
APPROVAL STATUS:	**A**

Process Systems International, Inc.
20 Walkup Drive
Westborough, MA 01581

CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LIGO PROJECT

FINAL DESIGN REPORT

VOLUME I

PROJECT MANAGEMENT PLAN

CONTRACT NO:	**PC 175730**
PSI DOCUMENT NO:	**V049-1-002 Rev. 2**
PROGRAM I.D.	**LIGO VACUUM EQUIPMENT**
ISSUE DATE:	**NOVEMBER 16, 1996**
CDRL NO:	**03**
APPROVAL STATUS:	**A**

SUBMITTED TO:

California Institute Of Technology
391 South Holliston Avenue
Pasadena, CA 91125

SUBMITTED BY:

Process Systems International, Inc.
20 Walkup Drive
Westborough, MA 01581

Technical Director: D. A. McWilliams
David McWilliams

Project Manager: Richard Bagley
Richard Bagley, P.E.

LIGO VACUUM EQUIPMENT
FINAL DESIGN REPORT
CDRL 03
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REVISION 2
11/16/96

LIGO VACUUM EQUIPMENT

FINAL DESIGN REPORT

VOLUME I

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1.0 PURPOSE

The purpose of the Project Management Plan (PMP) is to document the detailed plans, procedures, systems and responsibilities required to successfully execute a PSI project. It also formally documents contractual requirements.

The requirements and nomenclature of this PMP are based on an ISO-9001 approach to project execution.

The requirements of the PMP are intended to ensure that design output meets criteria established by the design input requirements, has been developed against known acceptance criteria and conforms to appropriate regulatory and contractual requirements. In this respect, the word design covers all process, project and specialist engineering, design, procurement, fabrication, construction, contracts, etc.

2.0 GENERAL

The LIGO Vacuum Equipment Project will be executed and controlled via requirements, plans, procedures and systems detailed in this Final Design Report, (FDR). The Vacuum Equipment FDR consists of five sections as follows:

Volume I Project Management

Volume II Design

Volume III Fabrication

Volume IV Installation

Volume V Drawings

The FDR has developed during the LIGO Phase B - Final Design and will be updated (by section) throughout the project life. It provides detailed instructions for executing all phases of the project including administrative, contractual and technical aspects.

After LIGO's approval of the Vacuum Equipment FDR, any required changes will be analyzed for their level of impact. The following changes will be submitted to LIGO for approval prior to implementation (a 5 day approval cycle is required):

1. Changes which affect interfaces as defined in LIGO Spec. E940002-02-V Par. 4.7

2. Changes which significantly affect contractual requirements (i.e. vacuum performance, materials of construction, etc.)

All other changes made to FDR documents for manufacturibility, schedule, risk reduction, corrections, etc. will be implemented without prior approval and submitted for LIGO's information and review.

For all changes, PSI will submit updated drawings and other documents with revision marks indicating all changes from the last revision.

The FDR is available to all members of the project team and to PSI management. Weekly meetings are held by the project team to discuss job performance and to measure progress against schedule milestones. Problem areas which may arise are identified and a plan is immediately developed and implemented to remedy the problem. Status reports are distributed to PSI management personnel who monitor the status of all projects.

The FDR also mandates planning, design review, risk management, cost analysis and schedule monitoring procedures designed to ensure consistent cost effective project execution.

Some section of the FDR are independent documents (Eng. Plan, Q.A. Plan, Fab. Plan, etc.) to facilitate revision control during the project.

The revised detailed Vacuum Equipment Program Schedule is included in Attachment 2 of this volume.

Current status information on the various aspects of the Vacuum Equipment contract are detailed in the monthly vacuum equipment status report.

3.0 RESPONSIBILITIES

The LIGO project organization is structured to ensure responsiveness to the customer and schedule requirements of the contract.

To fulfill these objectives, the project will be staffed by a competent and versatile project team with the capability to effectively execute in the following program areas:

- Project Management
- Process Engineering
- Project Engineering
- Civil/Structural Engineering
- Electrical and Instrumentation Engineering
- Design/Drafting
- Procurement/Expediting
- Manufacturing
- Construction
- Contract Administration
- Scheduling
- Document Control
- Quality Assurance
- Safety

3.1 Project Management

The PSI Project manager directs all project efforts and is responsible and accountable for successful achievement of all project objectives. The PSI project manager is delegated the authority to execute the project according to the contract documents by the President of PSI. This includes all material expenditures and decisions and the negotiation of change orders, if required. It also includes the commitment of PSI labor resources to perform to the contract, and to resolve any situations that might arise during the course of a project.

The PSI Project Manager has overall responsibility for technical performance, quality, costs and schedule. This organizational structure provides a single point of contact on all matters relating to the project.

Specific responsibilities of the Project Manager include:

- Direction and control of the project team
- Definition, planning, budgeting and assignment of work elements.
- Allocation, scheduling and control of resources necessary to perform these work elements in a timely, cost-effective manner.
- Implementation of corrective action when potential problems arise.
- Interface with and commitment to the customer.

The project manager is assisted by an MIS function at PSI called Effective Management System (EMS). EMS provides material resource planning, material control and accounting information for both labor and materials.

Various departments at PSI input information directly into EMS, and access the reports necessary to control their operations. The project manager accesses EMS on a regular basis to provide information needed for status and planning reports. He prepares a formal project review monthly. This report contains information on all labor and material expenditures to date, and all expenditures and labor utilization planned for the duration of the project. It also contains schedule information.

PSI recognizes the need for frequent, clear communication between LIGO and PSI throughout the course of the project. All formal communication from the Institute will go through the PSI Project Manager. It is realized, however, that there is a need for direct lines of communication between the corresponding parties of both PSI & LIGO to avoid misunderstanding due to the involvement of third parties. This direct communications is encouraged. All matters will be documented by conversation minutes by PSI and forwarded to the customer.

All technical direction and change of scope items will be instituted by Cal-Tech and issued via "Technical Direction Memorandums" (TDM) or by "Technical Information Memorandums" (TIM).

3.2 Project Team

The Project Team is responsible for executing the project under the direction of the Project Manager.

The LIGO Project will be staffed with dedicated engineering/designers/ Q.A./Procurement/Manufacturing/Construction staff for all key positions (see 3.3 LIGO Project organization). Additional staff will be assigned from the Engineering/Administration/Manufacturing pool for peak and intermittent liaison needs.

The technical director and design coordinator are responsible for providing technical direction to the Project Team. The manufacturing coordinator is responsible for directing PSI manufacturing and facilities improvements and for coordinating outside fabricators.

The following LIGO Management Team report to the Project Manager and direct their area of responsibilities:

Technical Director

Design Coordinator

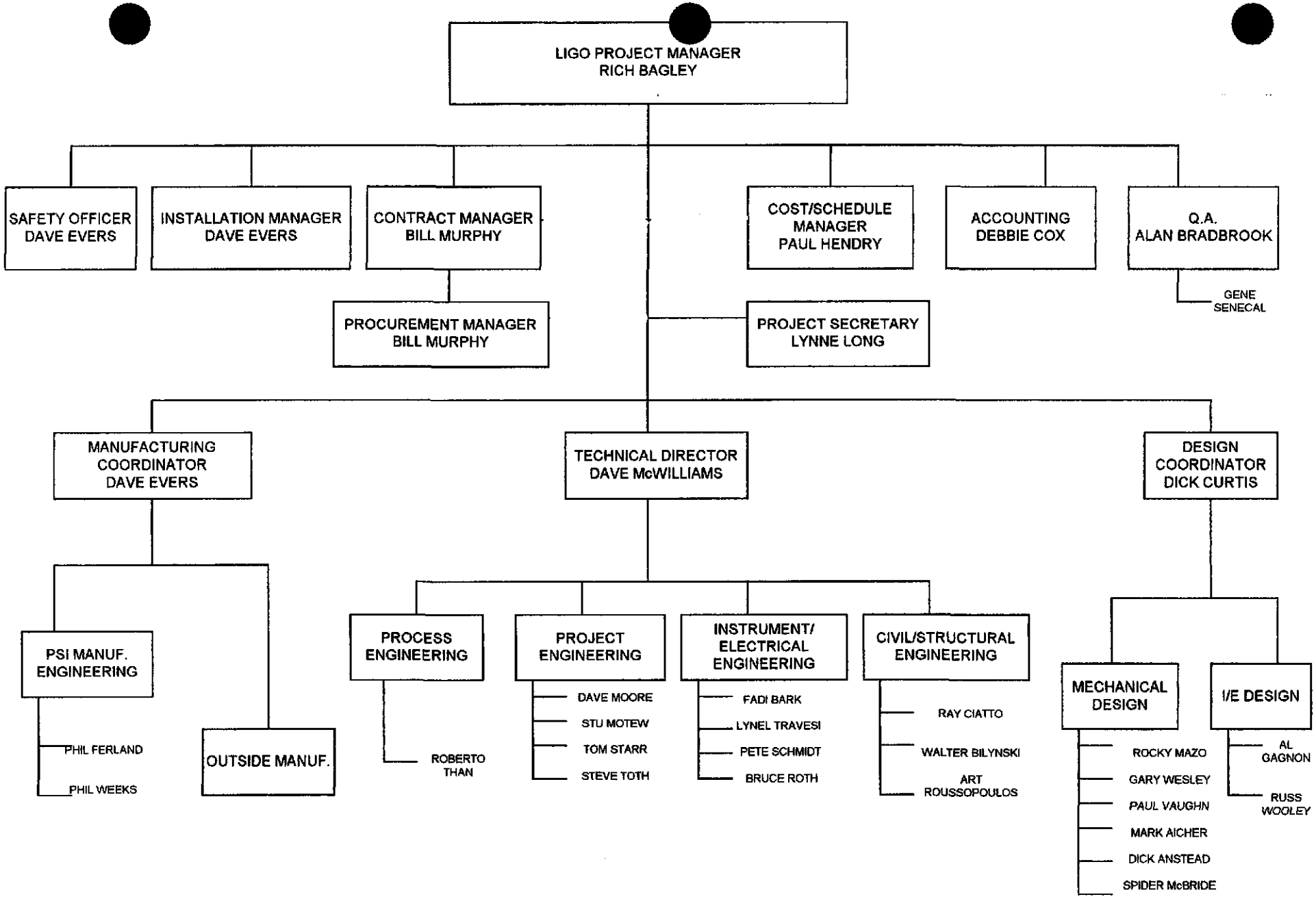
Procurement Manager

Cost/Schedule Manager

Manufacturing Coordinator

Installation Manager

Safety Officer



3.3 LIGO PROJECT ORGANIZATION

3.4 Safety Program

All members of the LIGO project team (and associated contractors) are responsible for executing the project in a manner that minimizes risk to personnel, facilities and equipment. The PSI project manager and LIGO safety officer are responsible for monitoring and enforcing project safety.

The Project Safety Plan V049-2-023 (Attachment 5) details the safety organization, objectives of the safety program and plans for project execution.

4.0 CONTRACTUAL BASIS

4.1 Project Proposal

This project is based on PSI's Phase "A" design (CDRL No. 1) developed under contract PP161533.

4.2 Original Contract

The LIGO Vacuum Equipment System project will be executed per Fix Price Contract PC175730 (enclosed). The contract has been updated as required by change orders during The Final Design - Phase B.

FIXED-PRICE CONTRACT

Between
California Institute of Technology
and
Process Systems International, Inc.
for
LIGO Vacuum Equipment Design,
Fabrication, Installation, and Test
(Phase B)

September 12, 1995

FIXED-PRICE CONTRACT
PC175730

BETWEEN

CALIFORNIA INSTITUTE OF TECHNOLOGY
1201 E. CALIFORNIA BLVD.
PASADENA, CALIFORNIA 91125

AND

PROCESS SYSTEMS INTERNATIONAL, INC.
20 WALKUP DRIVE
WESTBOROUGH, MA 01581-5003

THIS CONTRACT FOR

LIGO VACUUM EQUIPMENT
DESIGN, FABRICATION, INSTALLATION, AND TEST
(PHASE B)

IS A

SUBCONTRACT UNDER A NATIONAL SCIENCE FOUNDATION
COOPERATIVE AGREEMENT NO. PHY-9210038

CONTRACT PRICE: $39,100,000

LIGO-C950804-00-V

10 B

CONTENTS

PREAMBLE

This contract, entered into on
by and between the CALIFORNIA INSTITUTE OF TECHNOLOGY, (hereinafter called "Institute"), a corporation organized and existing under the laws of the State of California, and Process Systems International, Inc. (hereinafter called the "Contractor"), a corporation organized and existing under the laws of the State of Massachusetts and constituting a subcontract under the Cooperative Agreement No. PHY-9210038, between the National Science Foundation and the Institute;

WITNESSETH THAT:

The Contractor agrees to furnish and deliver the supplies and perform the services set forth in this contract for the consideration stated herein.

Article I. Statement of Work

A. The Contractor shall furnish all personnel, services, materials and facilities necessary for completion of this Statement of Work and the Delivery and Performance Schedule included below.

(1) **Preliminary Design** (updated): The Contractor shall revise (according to action items resulting from the PDR of Phase A) the preliminary design developed in Phase A and submit to LIGO for approval before proceeding with the final design. In addition the Contractor shall revise and submit the Project Management Plan to LIGO for approval.

(2) **Deliverables to the Beam Tube Contractor Final Design**: After approval of the preliminary design the contractor shall perform the final design of the deliverables to the Beam Tube Contractor. After approval by LIGO of the deliverables to the Beam Tube Contractor Final Design, the Contractor shall procure and deliver pump carts and gate valves to the two LIGO sites according to Exhibit III.

(3) **Final Design**: The Contractor shall perform a detailed final design in accordance with the approved design above (1) which meets the requirements of the Specification for the LIGO Vacuum Equipment (LIGO-E940002-02-V). The final design shall be submitted to LIGO for approval before procurement and fabrication is initiated. The contractor shall fabricate, procure any necessary support equipment, and run preliminary tests on a prototype chamber prior to the Final Design Review. Note that no documentation is required for the LA mid stations beyond the gate valve drawings (part of paragraph 2 above). The final design shall include, but not be limited to the following:

a. Final versions of the documentation developed in Phase A, paragraph 1, subject to the updates of paragraph A(1) above. Include all necessary details required for procurement, fabrication, installation and testing of the Vacuum Equipment.

b. All calculations and analyses required to confirm the structural integrity of the vacuum shell and mechanical supports.

c. All calculations and analyses required to confirm the performance of the pumping system. Include all assumptions such as material outgassing rates.

d. All calculations and analyses performed to specify the bakeout system. Provide details of necessary interlocks, power limits, temperature sensors/monitors, control of heating rates and gradients, and overall power requirements.

e. All documents required to control material quality, surface treatments and cleaning processes throughout the fabrication, assembly and installation phases.

f. All documents required to fully identify and control the interfaces between the Vacuum Equipment and the other facility and detector subsystems as listed in the Specification for the LIGO Vacuum Equipment.

g. Control Strategy. All documents required to fully define the hardware (VE hardware only) and software to be used for the control and interlocking of the Vacuum Equipment as required in the Specification for the LIGO Vacuum Equipment.

h. Failure Modes and Effects Analysis.

i. Shock, Vibration, and Acoustic noise. The contractor's proposal for mitigating vibration, shock and acoustic noise shall be performed as stated in proposal number LIGO-C950804-00-V (PSI-VE001AA1A01.) This analysis and the passive solutions proposed for mitigation shall be considered full compliance with paragraphs 4.6.1, 4.6.2, and 4.6.3 of the Specification for the LIGO Vacuum Equipment.

j. Hazard Analysis. The hazard analysis shall include a risk assessment of the conditions which may lead to a mishap. (A mishap is an unplanned event or series of events resulting in death, injury, occupational illness, or damage to or loss of equipment or property, or damage to the environment, i.e. accident). The analysis shall rate hazards according to hazard probability and hazard severity. MIL-STD-882C section 4.5.1 and 4.5.2 are suggested as guides to performing these analysis.

k. Vacuum Equipment Maintenance Requirements.

l. Site Installation and Assembly Plan including schedules, special equipment requirements, laydown areas and alignment tests.

m. Acceptance Test Plan.

(4) **Fabrication and Procurement**: After LIGO approval of the final design documentation the Contractor shall begin fabrication and procurement of the Vacuum Equipment in accordance with the approved Project Management Plan per paragraph A(1) above. The prototype vessel fabrication and procurement shall begin prior to FDR approval.

(5) **Installation**: After *joint occupancy for the Washington site has been accomplished the Contractor shall begin installation of the Vacuum Equipment. The Contractor shall begin installation of the Vacuum Equipment at Louisiana after joint occupancy for this site has been accomplished.

*Joint Occupancy is defined in Article 1. (m) of the General Provisions

(6) **Deliverable Hardware and Acceptance Testing**: The equipment to be delivered and tested is listed in Exhibit IV, "Hardware Deliverables." After installation has been completed the Contractor shall conduct the acceptance tests of the Vacuum Equipment according to the approved Acceptance Test Plan and the schedule in Article II. Delivery and Performance Schedule, of this contract.

(7) **Management**: The Contractor shall implement the approved Project Management Plan described in paragraph A(1) above. In addition the Contractor shall:

a. Provide technical and administrative management throughout the life of the contract.

b. Maintain informal technical liaison between the LIGO cognizant engineer(s) and the Contractor's equivalent(s).

c. Accept and implement in-scope technical direction as provided via Technical Direction Memorandum (TDM). Such direction shall be accepted only from the Contract Technical Manager by the contractor's project manager.

d. Notify the Contract Technical Manager at least 5 days prior to technical meetings where major decisions may be made.

e. Notify the Contract Technical Manager at least 5 days prior to the start of major fabrication, assembly, installation, or testing at any location.

f. Arrange non-escort privileges for Government and LIGO representatives to all areas of the Contractor's and subcontractor's facilities where the work is being performed under this contract. This shall include access to fabrication, assembly, cleaning, and test areas for the purpose of monitoring activities.

(8) **Reviews and Meeting**: The Contractor shall conduct the following reviews and meetings at the Contractor's facilities according to the schedule in Article II, Delivery and Performance Schedule and prepare and submit the documentation for these reviews according to Exhibit II, Deliverable Documentation, LIGO Vacuum Equipment.

a. Updated Preliminary Design Review.
b. Beam Tube Deliverables - Final Design Review
c. Final Design Review.
d. Prototype vessel data review.
e. Installation Readiness Review.
f. Acceptance Test Review.
g. Monthly Progress Meeting.

(9) **Deliverable Documentation:** The Contractor shall prepare and submit all plans and documentation in accordance with Exhibit II, "Deliverable Documentation, LIGO Vacuum Equipment." This Exhibit consists of the following:

a. Contract Data Requirements List (CDRL), listing and establishing delivery requirements *for* documentation to be generated under this contract.

b. Data Requirements Description (DRD), describing the basic requirements for each item of the CDRL.

(10) **Deliverable Hardware:** The Contractor shall deliver and test the Vacuum Equipment in accordance with Exhibit III, Beam Tube Deliverables and Exhibit IV, "Hardware Deliverables."

B. Provided by LIGO:

(1) Space for vacuum equipment to be installed in the mechanical equipment rooms.

(2) Concrete pads outside each station rollup door for the purpose of unloading equipment.

(3) Electrical distribution panels where the contractor may obtain 480/208/120 volt electrical power as required for the Vacuum Equipment task.

(4) Station floor concrete with a minimum 3000 psi strength rating throughout the LVEA and VEA areas. Floors will be flat to +/- 1/4 inch.

(5) Site layout and floor plans according to the following preliminary interface drawings:
Corner Station: WA-SK-101; dated 7/7/95 100% concept submittal.
Mid and End Stations: WA-SK-300; dated 7/7/95 100% concept submittal.
The Louisiana site design will be similar and will allow use of common Vacuum Equipment Designs.

Article II. Delivery and Performance Schedule

	Description	On or Before
(1)	Updated Preliminary Design (Phase B)	One (1) month ARO
(2)	Submit and Implement the Updated Project Management Plan	One (1) month ARO
(3)	Deliverables to the Beam Tube Contractor, Washington	As indicated in Exhibit III. Deliverables to the Beam Tube Contractor
(4)	Deliverables to the Beam Tube Contractor, Louisiana	As indicated in Exhibit III. Deliverables to the Beam Tube Contractor

(5)	Final Design	Seven (7) months ARO
(6)	Begin Fabrication and Procurement	After approval of final design
(7)	Begin Installation, Washington	At *Joint Occupancy Date for WA. Early Date 8/01/97, Late Date 9/01/97
(8)	Begin Installation. Louisiana	At Joint Occupancy Date for LA. Early Date 3/01/98, Late Date 4/01/98
(9)	Complete Acceptance Testing, WA	Eight (8) months after Joint Occupancy Date for WA
(10)	Complete Acceptance Testing, LA	Eight (8) months after Joint Occupancy Date for LA
(11)	Deliverable Documentation	As indicated in Exhibit IV, Deliverable Documentation
(12)	Project Reviews	Monthly except for special reviews below
(13)	Special Reviews:	
	• Updated Preliminary Design Review	October 3, 1995
	• Deliverables to the Beam Tube Final Design Review	Two (2) months ARO
	• Final Design Review	Eight (8) months ARO
	• Final Prototype Vessel Data Review	Ten (10) months ARO
	• Installation Readiness Review WA	One month prior to Joint Occupancy WA
	• Installation Readiness Review LA	One month prior to Joint Occupancy LA
	• Acceptance Test Review WA	One month after completion of acceptance testing WA
	• Acceptance Test Review LA	One month after completion of acceptance testing LA
(14)	Deliverable Hardware	As indicated in Exhibit IV. Hardware Deliverables

*Joint Occupancy is defined in Article 1. (m) of the General Provisions

ARTICLE III

Price And Payment

(Omitted)

IN WITNESS WHEREOF, the parties hereto have executed this Contract as of the day and year first above written.

CALIFORNIA INSTITUTE OF TECHNOLOGY

By _____

COLIN J. SILVIO

PROCESS SYSTEMS INTERNATIONAL

By _____

W. Kent Higgins
(Typed Name)

President
(Typed Name)

Instructions to Contractor:
Do not insert date on Preamble page.

ARTICLE IV. SPECIAL PROVISIONS

A. The Contractor warrants that it has been duly authorized to operate and do business in the states of California, Washington and Louisiana, that it will obtain at no cost to the Institute all necessary licenses and permits required in connection with the contract; and that it will fully comply with all laws, decree, labor standards and regulations of such states during the performance of this contract.

B. The Contractor agrees that all information released by the Contractor for publicity or promotional purposes which is directly related to the contract work will be submitted to the Institute for review of technical accuracy prior to issuance.

C. The Contractor shall provide the Institute copies, for information purposes, of any notification of invention and/or request for intangible property rights resulting from this contract. The same information will be provided for all subcontractors.

D. It is agreed that as a condition of the award of this contract, the Government and the Institute shall have the right to use, duplicate and disclose, and have others do so, the technical data contained in the proposal upon which this contract is based, subject to the restriction set forth in the PSI proposal dated June 19, 1995.

ARTICLE V. ESCALATION

A. The following items under this Contract shall be subject to economic escalation:

1. On-site craft labor rates
2. 9% nickel content steel, and 304L stainless steel.

B. On-site craft labor rates shall be for the following crafts:

1. Sheet metal worker
2. Millwright
3. Electrician
4. Laborer.

Baseline labor rates shall be those in effect in June 1995 for those crafts under the LIGO Project Labor Agreement for Hanford, WA, and the Davis-Bacon-Act Wage Determination for Livingston, LA.

The Contractor shall present a proposal for escalation of the above items to Caltech at the time such escalation is incurred. The proposal shall include the baseline costs proposed in the PSI proposal dated June 19, 1995, evidence of the escalated costs to be incurred (invoices, negotiated labor rates, etc.), and the delta to the contract. Upon conclusion of fact-finding and negotiations, the Contract amount will be adjusted accordingly by the issuance of a Supplemental Agreement to the Contract. Profit will not be applied to the escalated amounts.

C. 9% nickel content steel, and 304L stainless steel shall be escalated as follows:

<u>9% Nickel</u>
Escalation will be based on 25% of Milestone #17/Dewars, WA and Milestone #17/Dewars, LA as set forth in Article III, Price and Payment.
Escalation basis: Increases in Bureau of Labor Statistics Producer Price Indices Table 5 #3356-1.
Base: Average price Apr/May/Jun 1995
Escalate to: Average price three months prior to vessels being available for shipment.

<u>304L Stainless Steel</u>
Escalation will be based on 100% of Milestone #12 Receipt as set forth in Article III, Price and Payment.
Escalation basis: Increases in Bureau of Labor Statistics Producer Price Indices Table 5 #3312-45314.
Base: Average price Apr/May/Jun 1995
Escalate to: Average price two months prior to achieving the milestone.

4.3 Change Orders

(Change orders as they are received are added to this section of the Project Manual.)

4.3.1 PSI CHANGE ORDERS

The following PSI changeorders have been accepted by LIGO via T.I.M. notices and are included in the Final Design Report:

No.	03	Corner Station Pipe Bridge
	04	Failsafe Roughing Pump Gate Valve
	07	304L Machined Gate Valve Weld Stubs
	11	WA Corner Station Spool Change
	12	Freon Cooling Systems - BTD
	13	Revise BSC Floor
	15	8 in. Ion Pump Port
	16	1 Piece To 2 Piece Spools
	17	Pump Cart Modification
	18	Annulus Pump Pumping Speed
	19	30 in. Mode Cleaner Tube Changes

CHANGE ORDER No. 1

to

Contract No. PC175730 (LIGO-C950804-01-V)
Ligo Vacuum Equipment Design, Fabrication, Installation, And Test
(Phase B)
November 1, 1995

Pursuant to Article 4 of the General Provisions, Changes, the subject contract is hereby modified as follows:

1. Delete Article III, Payment, in its entirety, and replace with attached new Article III, Payment.

2. Delete Article IV, Special Provisions, in its entirety, and replace with attached new Article IV, Special Provisions.

3. Delete Article V, Escalation, in its entirety, and replace with attached new Article V, Escalation.

4. Delete the following General Provision articles, and replace with attached new articles:

   a. Article 1 - Definitions
   b. Article 2 - Order of Precedence
   c. Article 10 - Metric System
   d. Article 12 - Liability and Indemnification/ Land Holders
   e. Article 32(d)- Indemnification
   f. Article 37 - Acceptance
   g. Article 40(f) and (j) - Warranty
   h. Article 42(b)2- Suspension of Work
   i. Article 43(c)- Termination for Convenience
   j. Article 44(d)- Default

5. Delete Page 2 of 2 of Exhibit IV, Hardware Deliverables, in its entirety and replace with new Page 2 of 2.

These modifications shall be accomplished at no change in contract price or schedule. All other terms and conditions of this contract remain unchanged.

BY: _____

Edward J. Jasnow
Subcontracts Manager, LIGO Project

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MASSACHUSETTS			CHANGE ORDER REQUEST	NO.: 3
REV.	DATE	BY	TITLE:	PAGE 1 OF 1
REV. 0	12/05/95	P.F. Hendry	Design, fabricate, and install the pipe bridge at the WA and LA corner stations.	

PROJECT: LIGO VACUUM EQUIPMENT SYSTEM **PROJECT NO.:** V59049

CUSTOMER: CALIFORNIA INSTITUTE OF TECH. **CONTRACT NO:** PC175730

CUSTOMER REFERENCE: LIGO-C950732-00-V
T.I.M. No. 2 (PSI ref # V049-LP-5)

CHANGE ORDER SCOPE:

Design, fabricate, and install the pipe bridge at the WA and LA corner stations for use by PSI only. The structure is to be supported only from the LVEA floor, and clearance underneath will be a minimum of 9 feet.

Please refer to the preliminary sketch attached to this change order.

NOTES:

This change has no overall schedule impact site mechanical completion dates. This pipe bridge will need to be installed very early in the construction program for each site.

Proposed payment terms are net 30 days from the PSI invoice date, which will be transmitted upon installation of the bridge in the Washington corner station (50%) and installation of the bridge in the Louisiana corner station (50%).

TOTAL PRICE: **$49,950.00**
Pricing valid for 30 days from submittal date.

SUBMITTED BY: Brad Bagley **DATE:** 12/4/95

CUSTOMER APPROVAL: **DATE:**

CUSTOMER CHANGE ORDER NO:

COMMENTS:

12 B

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MASSACHUSETTS			CHANGE ORDER REQUEST	NO.: 4
REV.	DATE	BY	TITLE: Add fail safe gate valves to the main rough pump inlet (roots pumps - four locations)	PAGE 1 OF 1
REV. 0	12/11/95	P.F. Hendry		

PROJECT: LIGO VACUUM EQUIPMENT SYSTEM **PROJECT NO.:** V59049

CUSTOMER: CALIFORNIA INSTITUTE OF TECH. **CONTRACT NO:** PC175730

CUSTOMER REFERENCE: LIGO-C950732-00-V
T.I.M. No. 2 (PSI ref # V049-LP-5)

CHANGE ORDER SCOPE:

Add a 6 inch air operated, fail safe, high vacuum gate valves to the inlet (chamber side) main roughing pump inlet (roots pumps - four locations). The valve will be suitable for 170 degrees C at 10E-6 mbar of vacuum.

NOTES:

This change has no overall schedule impact on the required at site dates for the main roughing pumps. Minor rework will be required to the roughing pump specifications and P&ID's.

Proposed payment terms are net 30 days from the PSI invoice date, which will be transmitted upon shipment of the pump skids for the Washington Beam Tube contractor (50%) and Louisiana Beam Tube contractor (50%).

TOTAL PRICE: **$16,280.00**
Pricing valid for 30 days from submittal date.

SUBMITTED BY: William J. Murphy **DATE:** 12/11/95

CUSTOMER APPROVAL: **DATE:**

CUSTOMER CHANGE ORDER NO:

COMMENTS:

12C

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MASSACHUSETTS			CHANGE ORDER REQUEST	NO.: 7
REV.	DATE	BY	TITLE: Change buttweld end connections on large gate valves to 304L machined weld stubs	PAGE 1 OF 1
REV. 0	12/04/95	P.F. Hendry		

PROJECT: LIGO VACUUM EQUIPMENT SYSTEM **PROJECT NO.:** V59049

CUSTOMER: CALIFORNIA INSTITUTE OF TECH. **CONTRACT NO:** PC175730

CUSTOMER REFERENCE: **T.D.M. No. 5 , Dated 11/30/95, Item 4**
V049-TN-13 , Dated 11/29/95

CHANGE ORDER SCOPE:

Change the buttweld ends of the large gate valves to special 304L machined weld stubs (low sulphur .01 to .02%) and machined per LIGO fax V049-LP-011.

Revise valve specification and purchase order

Additional quality assurance scope of work

NOTES:

This change has no overall schedule impact on the required at site dates for the large gate valves providing the decision is made by December 15, 1995, because it impacts the design of the valve body by the vendor. Minor rework will be required to the valve specifications and purchase order.

Proposed payment terms are net 30 days from the PSI invoice date, which will be transmitted upon delivery of the gate valves at site.

TOTAL PRICE: **$17,953.00**
Pricing valid until 1/4/96

SUBMITTED BY: Rachel Bagley **DATE:** 12/4/95

CUSTOMER APPROVAL: **DATE:**

CUSTOMER CHANGE ORDER NO:

COMMENTS:

12 D

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MASSACHUSETTS			CHANGE ORDER REQUEST	NO.: 11
REV.	DATE	BY	TITLE: Washington Corner Station Beam Manifold Spool Changes	PAGE 1 OF 1
REV. 0	1/18/96	P.F. Hendry		

PROJECT: LIGO VACUUM EQUIPMENT SYSTEM **PROJECT NO.:** V59049

CUSTOMER: CALIFORNIA INSTITUTE OF TECH. **CONTRACT NO:** PC175730

CUSTOMER REFERENCE: T.I.M. No. 10, Dated 12/21/95
LIGO Doc. No. LIGO-C951471-00-V PSI No. V049-LP-23

CHANGE ORDER SCOPE:
In the Washington corner station only:
Delete: 2 A-8 spools, 6 B-1 spools, and 6 BE-1 spools
Add: 2 BE-5 spools in their place
Additional anchors, supports, and shipping costs
Engineering and design rework to existing drawings and designs

NOTES:
A decision is required by January 26, 1996 in order to avoid delays in the completion of the final design effort. No overall schedule impact is anticipated. Design of the equipment arrangements for the WA corner station is currently underway, and this section of the beam manifold is being held pending approval of this change order.

Proposed payment terms are net credit to LIGO by PSI on the invoice for Payment Milestone 17A, Major Vessel Delivery for the Washington Corner Station.

TOTAL PRICE: ($200,577.00) CREDIT TO LIGO
Pricing valid for 30 days from above issued date.

SUBMITTED BY: William J Murphy **DATE:** 1/10/96

CUSTOMER APPROVAL: **DATE:**

CUSTOMER CHANGE ORDER NO:

COMMENTS:

12E

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MASSACHUSETTS			CHANGE ORDER REQUEST	NO.: 12
REV.	DATE	BY	TITLE: Supply 4 freon cooling systems for the Beam Tube Deliverable Turbomolecular Pumps and 2 freon cooling systems for the BTD Main Roughing Pumps	PAGE 1 OF 1
REV. 0	2/28/96	P.F. Hendry		

PROJECT: LIGO VACUUM EQUIPMENT SYSTEM **PROJECT NO.:** V59049

CUSTOMER: CALIFORNIA INSTITUTE OF TECH. **CONTRACT NO:** PC175730

CUSTOMER REFERENCE: **T.I.M. No. 13, Dated 2/2/96**
LIGO Doc. No. LIGO-C960203-00-V

CHANGE ORDER SCOPE:

Supply six (6) freon cooling systems for the Beam Tube Deliverables in Washington, as follows:

- **Four (4) units for the Turbomolecular Pump Carts**
- **Two (2) units for the Main Roughing Pump Carts**
- **Supply a 40 foot hose and fittings for each cooling system to connect to the respective cart**

Engineering and quality assurance required to specify, bid, evaluate, purchase, review vendor drawings, and inspect the six cooling systems.

NOTES:

A decision is required within 30 days of the date of this change order in order to deliver the equipment when required by the Beam Tube Contractor.

Assumptions:

1. **No vibration analysis will be required by Cambridge Acoustical Associates.**
2. **PSI scope of work is equipment supply only, with installation by the Beam Tube Contractor.**
3. **This new scope is excluded from the final design scope of work.**

Proposed payment terms are the 50% of the value of the change order be added to the invoice for Payment Milestone 15A, Main Roughing Pumps Sets At Site, WA; and 50% added to Payment Milestone 15C, Turbo Molecular Pump Sets At Site, WA.

TOTAL PRICE: $61,036.00
Pricing valid for 30 days from above issued date.

SUBMITTED BY: William J. Murphy **DATE:** 2/28/96

CUSTOMER APPROVAL: **DATE:**

CUSTOMER CHANGE ORDER NO:

COMMENTS:

12 F

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MASSACHUSETTS			CHANGE ORDER REQUEST	NO.: 13
REV.	DATE	BY	TITLE: Revise the internal floor of the BSC to support a 500 kilogram load	PAGE 1 OF 1
REV. 0	2/14/96	P.F. Hendry		

PROJECT: LIGO VACUUM EQUIPMENT SYSTEM **PROJECT NO.:** V59049

CUSTOMER: CALIFORNIA INSTITUTE OF TECH. **CONTRACT NO:** PC175730

CUSTOMER REFERENCE: T.I.M. No. 1, Dated October 19, 1995

CHANGE ORDER SCOPE:

Revise the internal BSC removable maintenance floor design from the standard engineering practice of support for a 300 pound person, to support of a 500 kilogram load. In order to minimize cost, the following modified scope of supply was requested by LIGO:

- Supply of 7 BSC removable floors made out of 5/8" thick aluminum (4 to WA & 3 to LA)
- Provide removable support beams for each BSC capable of supporting the 500 Kg load
- Engineering and design costs for the revised floor design

This change order represents only the net additional cost for the revised floor costs as LIGO is receiving full credit for the original scope of supply.

NOTES:

A decision is required by March 6, 1996 in order to avoid delays in the completion of the final design effort. No overall schedule impact is anticipated.

Proposed payment terms are the total value of this change order added to Payment Milestone 17A, Major Vessel Delivery, Corner Station, WA.

TOTAL PRICE: $11,748.00
Pricing valid for 30 days from above issued date.

SUBMITTED BY: William F Murphy **DATE:** 2/14/96

CUSTOMER APPROVAL: **DATE:**

CUSTOMER CHANGE ORDER NO:

COMMENTS:

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MASSACHUSETTS			CHANGE ORDER REQUEST	NO.: 15
REV.	DATE	BY	TITLE: Add an 8-inch port to the Main Ion Pumps	PAGE 1 OF 1
REV. 0	1/24/96	P.F. Hendry		

PROJECT: LIGO VACUUM EQUIPMENT SYSTEM **PROJECT NO.:** V59049

CUSTOMER: CALIFORNIA INSTITUTE OF TECH. **CONTRACT NO:** PC175730

CUSTOMER REFERENCE: Verbal request for future laser detector requirements

CHANGE ORDER SCOPE:

Add an 8-inch port to each of 18 Main Ion Pumps and blind it off with a conflat flange.
Related engineering and design impact.
Leak check new ports in the field.

NOTES:

A decision is required by February 1, 1996 in order to avoid delays in the receipt of vendor information required for the completion of the final design effort, and delays in receiving a main ion pump need for the prototype testing program. No overall schedule impact is anticipated.

Proposed payment terms are 2/3 of total value added to Payment Milestone 20, Begin Installation, Washington, and 1/3 added to Payment Milestone 21, Begin Installation, Louisiana.

TOTAL PRICE: $9,854.00
Pricing valid for 30 days from above issued date.

SUBMITTED BY: William J Murphy **DATE:** 1/25/96

CUSTOMER APPROVAL: **DATE:**

CUSTOMER CHANGE ORDER NO:

COMMENTS:

12 H

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MASSACHUSETTS			CHANGE ORDER REQUEST	NO.: 16
REV.	DATE	BY	TITLE:	PAGE 1 OF 1
REV. 0	2/28/96	P.F. Hendry	Changes to the configuration of a quantity of 3 BE-3 spools from 1 piece to 2 piece spool	
REV. 1	3/14/96	P.F. Hendry	Rev. 1 generated due to TIM 19, dated 3/12/96, which reduced the scope of work for PSI from Rev. 0	

PROJECT: LIGO VACUUM EQUIPMENT SYSTEM **PROJECT NO.:** V59049

CUSTOMER: CALIFORNIA INSTITUTE OF TECH. **CONTRACT NO:** PC175730

CUSTOMER REFERENCE: **Minutes of meeting *V049-MM-8*, Item 20, Dated 2/14/96**
Transmitted on V049-PL-097, Dated 2/23/96

CHANGE ORDER SCOPE:

Revise a limited number removable BE-3 spools as detailed below:

Spool BE-3:

Change a quantity of 3 (2 WA, 1 LA) 60 in. spools from a 1 piece spool with 1 set of flanges and 1 expansion joint to a 2 piece 60 in. spool with 2 sets of flanges and 1 expansion joint. The new spools will be installed in WA at WBSC2 and WBSC4, and in LA at LBSC2. New spool designation is BE-3A.

Other Impacts: Engineering/design rework, bakeout blanket mods, installation & testing.

Assumptions:

1. **Spools will be assembled in PSI's shop and shipped as one piece.**
2. **No additional costs for shipping/test covers are included.**
3. **Spools will be installed as one piece and will not be disassembled prior to installation.**

NOTES:

A decision is required by March 21, 1996 in order to avoid delays in the completion of the final design effort. No overall schedule impact is anticipated.

PLEASE NOTE THIS CHANGE ORDER ONLY REPRESENTS ADDITIONAL COSTS ONLY.

Proposed payment terms are 2/3 of total value added to Payment Milestone 20, Begin Installation, Washington, and 1/3 added to Payment Milestone 21, Begin Installation, Louisiana.

TOTAL PRICE: $107,250.00
Pricing valid for 30 days from above issued date.

SUBMITTED BY: William J. Magerby **DATE:** 3/14/96

CUSTOMER APPROVAL: **DATE:**

CUSTOMER CHANGE ORDER NO:

COMMENTS:

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MASSACHUSETTS			CHANGE ORDER REQUEST	NO.: 17
REV.	DATE	BY	TITLE: Vacuum Pump Cart Modifications	PAGE 1 OF 1
REV. 0	3/1/96	P.F. Hendry		

PROJECT: LIGO VACUUM EQUIPMENT SYSTEM **PROJECT NO.:** V59049

CUSTOMER: CALIFORNIA INSTITUTE OF TECH. **CONTRACT NO:** PC175730

CUSTOMER REFERENCE: Minutes of meeting V049-MM-8, Items 4 & 7, Dated 2/14/96
Transmitted on V049-PL-097, Dated 2/23/96

CHANGE ORDER SCOPE:

1. Lower the cart (qty of 10) for the Turbo Molecular Pumps by a minimum of 7/8 inch. ENGINEERING AND FABRICATION OF THIS CHANGE ARE BEING PROVIDED TO LIGO AT NO COST.
2. Change the Main Roughing Pump Carts (qty of 4) as follows:
   - Lower the blower portion of the roughing cart by approximately 3 feet
   - Design the cart to facilitate movement with a pallet jack
   - Provide 10 feet of interconnecting flex vacuum hose
   - Provide 15 feet of interconnecting power and control cabling
   - Provide 10 feet of interconnecting water hoses between the 2 carts
   - No interconnecting provisions are being made between the 2 carts for instrument air and purge gas
   - Provide an installation sketch (by PSI)
   - Installation for Beam Tube use is by the Beam Tube Contractor
3. Provide a pallet jack for use during construction, which is to be retained by LIGO.

NOTES:

A decision is required by March 8, 1996 in order to support the delivery schedule of the main roughing pumps to the Beam Tube Contractor.

Proposed payment terms are 50% of total value added to Payment Milestone 15A, BTD Main Roughing Pumps At WA Site; and 50% added to Payment Milestone 15B, BTD Main Roughing Pumps At LA Site.

TOTAL PRICE: $39,316.00
Pricing valid for 30 days from above issued date.

SUBMITTED BY: William J Murphy **DATE:** 3/1/96

CUSTOMER APPROVAL: **DATE:**

CUSTOMER CHANGE ORDER NO:

COMMENTS:

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MASSACHUSETTS			CHANGE ORDER REQUEST	NO.: 18
REV.	DATE	BY		PAGE 1 OF 1
REV. 0	3/1/96	P.F. Hendry	TITLE: Reduce the annulus pump speed requirement from 0.3 liters per second to 0.2 liters per second in order to minimize overall project cost.	

PROJECT: LIGO VACUUM EQUIPMENT SYSTEM **PROJECT NO.:** V59049

CUSTOMER: CALIFORNIA INSTITUTE OF TECH. **CONTRACT NO:** PC175730

CUSTOMER REFERENCE: **Minutes of meeting V049-MM-8, Item 21, Dated 2/14/96**
Transmitted on V049-PL-097, Dated 2/23/96

CHANGE ORDER SCOPE:

By reducing the annulus pump speed requirement from 0.3 liters per second to 0.2 liters per second, PSI is able to offer LIGO a credit for the savings in flange cost due to overall reductions in flange forging thickness'.

Additional engineering and design costs are offset by other savings in annulus piping material changes due to small diameter reductions.

NOTES:
A decision is required by March 8, 1996 in order to support the final design schedule.

Proposed payment terms are 50% of total value credited to Payment Milestone 17A, Major Vessel Delivery, Washington Corner Station, and 50% credited to Payment Milestone 17B, Major Vessel Delivery, Louisiana Corner Station.

TOTAL PRICE: ($40,687.00) **CREDIT TO LIGO**
Pricing valid for 30 days from above issued date.

SUBMITTED BY: William F Murphy **DATE:** 3/1/96

CUSTOMER APPROVAL: **DATE:**

CUSTOMER CHANGE ORDER NO:

COMMENTS:

12K

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MASSACHUSETTS			CHANGE ORDER REQUEST	NO.: 19
				PAGE 1 OF 1
REV.	DATE	BY	TITLE:	
REV. 0	3/21/96	P.F. Hendry	30-Inch Mode Cleaner Tube Changes	

PROJECT: LIGO VACUUM EQUIPMENT SYSTEM **PROJECT NO.:** V59049

CUSTOMER: CALIFORNIA INSTITUTE OF TECH. **CONTRACT NO:** PC175730

CUSTOMER REFERENCE: **Minutes of meeting V049-MM-9, Item 23, Dated 3/14/96**
Transmitted on V049-PL-123, Dated 3/18/96

CHANGE ORDER SCOPE:

Revise the Mode Cleaner Tube Spools (B-2/3/5 & A-5) as follows:

- **Delete 12 sets of 30 inch flanges and machining associated with these flanges**
- **Delete 12 o-rings**
- **Delete the annulus piping for the above flange sets**
- **Delete the conical section of the A-5 spool (12 places)**
- **Add 6 new 30 inch expansion joints**
- **Add 6 new supports for the Mode Cleaner Tubes**
- **Redesign the equipment arrangement drawings of the corner stations**
- **Revise the affected equipment detail drawings for the Mode Cleaner Tube spools**
- **Engineering and design of the new supports for the Mode Cleaner Tube**

This impacts 4 Mode Cleaner Tubes in WA (8 A-5 spools) and 2 in LA (4 A-5 spools)

Implementing this change yields the following benefits:

- **Further reduce vibration reaching the HAM by adding a bellows on the vertex end of the mode cleaner tube between the turbo pump nozzle and the HAM**
- **Reduce o-ring offgassing by eliminating 12 o-rings**

NOTES:

A decision is required by March 26, 1996 in order to support the final design schedule.
Proposed payment terms are 67% of total value credited to Payment Milestone 17A, Major Vessel Delivery, Washington Corner Station, and 33% credited to Payment Milestone 17B, Major Vessel Delivery, Louisiana Corner Station.

TOTAL PRICE: **($35,298.00)** **CREDIT TO LIGO**
Pricing valid for 30 days from above issued date.

SUBMITTED BY: William F. Murphy **DATE:** 3/21/96

CUSTOMER APPROVAL: **DATE:**

CUSTOMER CHANGE ORDER NO:

COMMENTS:

12L

5.0 DESIGN INPUT

5.1 Scope

Project Scope is detailed in Section 5.2.

5.2 Design Basis

This project is based on LIGO Vacuum Equipment Specification No. LIGO-E9400020-01-V Revision 2 and the contract documents (SOW, etc.) in Section 4.0. Specification E9400020-02-V is attached in Section 5.2.1.

The contract documents apply in the following order of precedence:

1. The Contract (Including S.O.W.)
2. Specification No. LIGO E9400020-02-V
3. General Provisions
4. PSI Proposal of June 19, 1995

5.2.1

Contract No PC175730
LIGO-E940002-02-V

EXHIBIT I

VACUUM EQUIPMENT SPECIFICATION
LIGO-E940002-02-V

Vacuum Equipment Specification

1.0 SCOPE

This specification defines the technical requirements for the design, procurement, delivery, qualification, installation, and acceptance testing of the LIGO (Laser Interferometer Gravitational-Wave Observatory) vacuum equipment. The LIGO includes two installations at widely separated sites, near Hanford, WA and Livingston, LA. Each installation includes laser interferometers in an L shape with 4-km long arms, a vacuum system for the sensitive interferometer components and optical beams, and other support facilities. The vacuum equipment consists of interconnected vacuum vessels, pumping systems, valves and a monitoring and control system for each site. The vacuum equipment will be located in structures called stations, located at the corners, mid points, and ends of the L-shaped pattern. See Figure 1.

The vacuum tube joining the vacuum equipment in the stations is provided under separate contract, and is described by LIGO 1100004, Beam Tubes Specification. Cleaning, alignment and leak checking are critical processes. Vacuum levels during operation may range from a nominal 10^{-6} torr at the chambers to 10^{-9} torr in the beamtube.

2.0 APPLICABLE DOCUMENTS

If more than one document applies to a technical requirement, the more stringent standard shall have precedence. Requirements set forth in this specification shall have final precedence.

2.1 Industry Documents

2.1.1 American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code
Pressure Vessels, Section VIII, Division I.
Welding and Brazing Qualifications, Section IX.

2.1.2 American Society for Testing and Materials
ASTM E498 Standard Test Methods for Leaks Using the Mass Spectrometer Leak Detector.

2.1.3 Handbook of Acoustical Measurements and Noise Control
Chapter 43, Noise Criteria for Heating, Ventilating, and Air Conditioning Systems.

2.1.4 International Standards Organization
ISO Standard 2861 Flange standards.

2.1.5 American Society of Civil Engineers
Minimum Design Loads for Buildings and Other Structures, ASCE 788.

2.1.6 Expansion Joint Manufacturer's Association (EJMA)
Standards of Expansion Joint Manufacturer's Association.

2.1.7 National Fire Protection Association (NFPA) Standards

No. 70-National Electrical Code.

2.2 Government Standards

Building and safety codes: local, state, and federal, including OSHA.

Federal Standard 209 for clean rooms.

2.3 LIGO Documents

2.3.1 LIGO Drawings

LIGO Drawing 1101100, Vacuum Equipment, Corner Station, Washington Site, Phase A, attached.

LIGO Drawing 1101101, Vacuum Equipment, Corner Station, Louisiana Site, Phase A, attached.

LIGO Drawing 1101102, Vacuum Equipment, End Stations, Phase A, attached.

LIGO Drawing 1101103, Vacuum Equipment, Mid Stations, Washington Site, Phase A, attached.

LIGO Drawing 1101009, Beam Splitter Chamber (BSC).

LIGO Drawing 1101010, Horizontal Access Module (HAM).

LIGO Drawing 1101051, Attachment Brackets.

2.3.2 LIGO Specifications

LIGO 1100004, Beam Tubes Specification.

2.4 Interface Control Documents

2.4.1 Provided by LIGO

LIGO document TBD, LIGO Interferometer to the Vacuum Equipment.

LIGO document TBD, Vacuum Equipment to the Beam Tube.

2.4.2 Provided by the Vacuum Equipment Contractor

Contractor document TBD, Vacuum Equipment to the Buildings and Utilities.

Contractor document TBD, Vacuum Equipment to the LIGO CDS.

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3.0 SYSTEM DESCRIPTION

The LIGO vacuum system is divided into two parts: the beam tube modules and the vacuum equipment. The beam tube modules are two kilometers long and are addressed in a separate contract. The vacuum equipment is housed in buildings located at the intersection (corner) and ends of the beam tube modules. These buildings are the corner station, mid stations, and end stations. The vacuum equipment consists of the following subsystems:

- Vacuum enclosure subsystem
- Pumping subsystem
- Valve subsystem
- Vent and purge subsystem
- Bakeout subsystem
- Monitor and control subsystem

Together these subsystems, along with the beam tube modules, make up the vacuum system. The Washington site schematic is shown in Figure 2 and the Louisiana site schematic is shown in Figure 3. A description of the vacuum equipment according to station is given below.

3.1 Corner Station Washington Site

The vacuum enclosure for the corner station of the Washington Site is shown in Figure 4 and is divided into four vacuum sections as shown in Figure 2. The Vertex Section includes three beam splitter chambers (BSC), six horizontal access modules (HAM), and the two 76 cm diameter mode cleaner tubes. Two 122 cm gate valves isolate this section from the Beam Manifold Sections. All gate valves at the 80K pump locations shall provide 112 cm of clear aperture. Each Beam Manifold Section includes one BSC, a section of 183 cm diameter beam manifold, and one 80K pump. The beam manifolds provide for the addition of more chambers in future expansions. The Diagonal Section includes one BSC chamber, six HAM chambers, and two 122 cm gate valves. All major optical components are housed in the two chamber types (BSC, HAM). Removal of access covers from the chambers will allow for servicing the optical components during normal operations; the seals on these covers shall be designed as double O-rings with a pumped annulus for economical reuse during operations. A clean air vent and purge system shall be provided to break vacuum and maintain cleanliness of the optical components whenever a chamber is open.

The corner station pumping system shall include two 80K pumps (liquid nitrogen, continuous flow, or refrigerated) near the beam tube interfaces, and main ion pumps as shown in Figure 2. Ion pumps shall also be used to pump the annuli of double O-ring seals except as noted herein. Rough pumping from atmosphere shall be done with portable and stationary pump stations.

3.2 Corner Station Louisiana Site

The vacuum equipment for the corner station at the Louisiana site is similar to that at the Washington site, except that only one of the BSC/HAM groupings shall be installed. See Figures 3 and 5 for details.

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3.3 End Stations Both Sites

The vacuum equipment for the end stations is shown in Figure 6. Vacuum enclosures shall include one BSC. The pumping system shall include one 80K pump with 112cm isolation valves, and ion pumps for both the enclosure and the annuli. Rough pumping from atmosphere shall be done with portable and stationary turbo molecular pump stations.

3.4 Mid Station Washington Site

The vacuum equipment for the mid stations is shown in Figure 7. The pumping system shall include two 80K pumps with 112 cm isolation valves, and ion pumps for both the enclosure and the annuli. Rough pumping from atmosphere shall be done with portable and stationary turbo molecular pump stations.

3.5 Midpoint Pumping Station Louisiana Site

No equipment or utilities are to be installed here. One electrically operated 122 cm diameter gate valve shall be supplied for others to install. Refer to Figure 7.

4.0 SYSTEM REQUIREMENTS

4.1 Leak Rate

All leaks greater than 1×10^{-9} torr liters/sec of helium shall be repaired according to LIGO approved procedures. Leak checking procedures shall conform to ASTM E498 Standard Test Methods for Leaks Using the Mass Spectrometer Leak Detector.

4.2 Pump Down Time

Each vacuum section (an isolatable volume) of each corner station, without interferometer components, shall pump down from atmosphere to 1×10^{-6} torr in less than 24 hours. Of this time, acoustic noise and vibration may exceed the limits described below in Section 4.6 for no more than the initial 4 hours. Turbo pumps are exempt from the acoustic noise criteria at all times. In the case of the vertex and offset vacuum sections, two pump stations may be connected at once. Otherwise, only a single pump station shall be connected at one time.

4.3 Ultimate Pressures

Each vacuum section shall attain a total pressure of 2×10^{-8} torr, measured with an RGA at an ion pump pumpout port. after 100 hours of pumping. If the hydrogen content of the steel prevents the attainment of this value, then the total pressure of all gases, other than H_2 and H_2O. shall not exceed 6×10^{-9} torr. The partial pressure goals below will be adjusted, as mutually agreed upon by LIGO and the contractor, so that they are consistent with the prototype chamber results and the design margins required for reliable implementation, but in any case not less than

Table 1: Partial Pressures Goals

Gas Species	Partial Pressure - torr
H_2O	5×10^{-9}
H_2	5×10^{-9}
N_2	5×10^{-10}
CO	5×10^{-10}
CO_2	2×10^{-10}
CH_4	2×10^{-10}
All Others	5×10^{-10}

shown in Table 1.

This ultimate pressure test shall be performed after a 48 hour, 150 C bakeout and subsequent cool-down period. The section under test shall be exposed to the operating 80K pumps. The only other pumps allowed are the installed main ion pumps, the annulus ion pumps and the pumps required for temporary pumping of the gate valve annuli.

4.4 System Control and Protection

Each vacuum section shall have sufficient instrumentation and hardware to allow safe and reliable operation of valves, pumps and gauges under all conditions. LIGO will supply process control functions (hardware and software programming) needed for safe acceptance testing as well as normal operations.

4.5 Bakeout/Degassing Capability

A means shall be provided to heat all vacuum surfaces in a given section to any desired temperature, ranging from ambient to 150 C, with a maximum variation of -20 C to + 20 C. No vacuum seals shall be damaged by non-uniform temperatures or by overheating. Ramping of temperatures shall be controllable. Power density shall be limited in order to provide fail safe protection. The rate of temperature rise during warmup shall not exceed 1.8C/hour. Particulate generation or shedding caused by placement or removal of the insulation shall be minimized. The surfaces may be blanketed or entire vacuum sections may be insulated by rigid or flexible partitions.

4.6 Special Environmental Requirements

The LIGO vacuum equipment and laser areas house instrumentation which is potentially highly sensitive to vibration and acoustic noise, shock-induced damage or misalignment, electromagnetic interference, and contamination.

4.6.1 Shock

Valve actuation or other intermittent device operation shall induce no more than 0.01 g peak-to-peak acceleration at any point within 1 meter of any HAM or BSC chamber.

4.6.2 Acoustic Noise

Acoustic noise from all simultaneously operating equipment in normal operation shall not exceed NC-20 (Noise Criterion 20) at any location within LIGO vacuum equipment and laser areas. Limited narrowband exemptions may be permitted subject to LIGO approval. Rough pumping equipment, used intermittently to initiate pumpdowns, may be exempted for limited periods as provided in Section 4.2.

4.6.3 Vibration

The Vacuum Equipment shall be designed in such a way that vibration from all simultaneously operating vacuum equipment, in the absence of vibration from other sources, shall not induce motion of the walls of any vacuum chamber or of the facility floor within 1 meter of any chamber which exceeds the following spectral density limits (Table 2). Limited narrowband exemptions may be permitted subject to LIGO approval. Rough pumping equipment, used intermittently to initiate pumpdowns, may be exempted for limited periods as provided in Section 4.2. Compliance with this specification may be demonstrated by any combination of measurements and analysis, subject to LIGO approval.

Table 2: Maximum allowable spectral density of chamber or floor vibration induced by operation of LIGO vacuum equipment.

Frequency Band (Hz)	Vibration Limit ($m/\sqrt{Hz}$)
0.1 - 10	3×10^{-11}
10 - 1000	$3 \times 10^{-9} \times (1\ Hz/f)^2$
1000 - 10000	3×10^{-15}

4.6.4 Electromagnetic Emissions

All electrical equipment shall meet commercial standards for EMI.

4.6.5 Particulates and other contaminants

No installed equipment shall emit or harbor particulates at a level inconsistent with maintenance of a clean environment conforming to Federal Standard 209 Class 50,000. Bake-

out insulation may be exempted from this if it can be shown that reasonable cleaning procedures and a reasonable time period will restore the environment.

4.7 Interfaces

The following interfaces shall be provided for and fully documented:

- LIGO Interferometers to the vacuum equipment.*
- Vacuum equipment to the beam tube.**
- Vacuum equipment to the buildings and utilities.***
- Vacuum equipment to process control system.***

* ICD to be provided by LIGO.

** ICD to be provided by Beam Tube Installer.

*** ICDs to be provided by the Vacuum Equipment Contractor.

4.8 Design Life

The contractor shall design the vacuum equipment for a minimum serviceable life of 20 years assuming equipment is maintained and operated in accordance with vendors' recommendations.

4.9 Environmental

Under normal operations, the vacuum equipment will be operated in a temperature and humidity controlled environment. In case of power or control failure, and during the construction phase, conditions will be dictated by diurnal and seasonal ranges. Exposure to these conditions shall not damage the vacuum equipment provided that equipment is maintained, stored and operated in accordance with vendors' recommendations.

5.0 SUBSYSTEMS

5.1 Vacuum Enclosure Subsystem

The vacuum enclosure includes all components such as chambers, tubes, flanges, elbows, tees, blank-offs, and other fittings, which form the barrier between atmosphere and vacuum. These components are required to be compatible with use at 1×10^{-9} torr. Specific requirements are below.

5.1.1 Materials

All fabricated components exposed to vacuum shall be made from type 304L or 316L stainless steel, using low carbon weld filler wire, or aluminum alloys where required. Standard catalogue items of 304 or 316 stainless steel are acceptable if not available in 304L or 316L. Copper, aluminum, and prebaked Viton may be used for seals. Vacuum feedthroughs may utilize UHV compatible glass or ceramic. All other materials are subject to LIGO approval. Copies of mill test reports of chamber, tube and flange materials shall be furnished. Internal surface finish is subject to LIGO approval.

5.1.2 Cleaning

All surfaces exposed to vacuum or purge gas shall be cleaned in accordance with procedures approved by LIGO prior to fabrication and installation; surface recontamination shall be prevented during all subsequent processes.

All items shall be wrapped or sealed after cleaning to maintain cleanliness through handling, transportation, and storage. Care shall be taken to minimize exposure to corrosive environments, such as those containing chloride compounds. No visible contaminant (viewed with the naked eye, under both natural and ultraviolet light) of any form shall be left within the vacuum enclosures or purge system piping when installed (for example: water, dust, sand, hydrocarbon film, etc.).

5.1.3 Welding

All welding exposed to vacuum shall be done by the tungsten-arc inert-gas (TIG) process. Exceptions may be allowed subject to LIGO approval. Welding techniques shall deviate from the ASME Code in accordance with the best ultra high vacuum practice to eliminate any virtual leaks in the welds; i.e., all vacuum welds shall be, wherever possible, internal and continuous; all external welds added to these for structural purposes shall be intermittent to eliminate trapped volumes. Defective welds shall be repaired by removal to sound metal and rewelding. All vacuum weld procedures shall include steps to avoid contamination of the heat affected zone with air, hydrogen, or water. This requires that inert purge gas, such as argon, be used to flood the vacuum side of heated portions.

5.1.4 Alignment and Dimensions

All chambers shall be aligned to within 2mm of the design optical axis in both transverse directions and to within 25mm of the design position in the axial direction. Unless noted otherwise, dimensions of chambers (including interconnecting tubes) refer to nominal internal dimensions. All other dimensions shall be +/- 3mm, +/- 1 degree, and +/- 3mm per 3 meter section of tube.

5.1.5 Mechanical Loads

All vacuum components shall be anchored to the floor or to each other so as to restrict all motion to bellows units. The floor anchors shall be supplied and installed by the contractor. The design of the vacuum enclosure shall allow for strains and stresses due to the following: normal cycling of the station HVAC (heating, ventilating, and air conditioning) system (expected to maintain temperature within a range of +/- 2 C); variations in atmospheric pressure; vacuum cycling of other sections of the vacuum enclosure; bakeout of any vacuum section; failure or non-operation of the HVAC.

5.1.6 Design

Each vacuum element with a diameter greater than 12 inches shall be designed according to the latest edition of ASME Boiler and Pressure Vessel Code, Section VIII, Division 1

and its subsequent addenda (except as noted in 5.1.3), even though vacuum chambers lie outside of the scope of that document. Alternate design methods may be employed subject to LIGO approval. Code certification and stamping are not required. All separable parts shall be fully interchangeable between assemblies. Adequate clearance shall be provided for assembly of mating flanges, and for handles. External access shall be provided to all vacuum seams for leak checking. All vacuum elements heavier than 50 lbs shall have lift lugs installed and each chamber assembly shall have an electrical ground connection (removable for diagnostic purposes). Calculations shall be made to determine design features, including the need for and the size of any reinforcements due to openings. Chambers shall be designed to withstand the loadings exerted by all applicable loads in accordance with the provisions of all applicable codes and standards. All chambers shall be designed to be free standing to allow blanked-off leak checking. To determine the probability of earthquakes and seismic coefficients in various areas of the United States, Standard ANSI A58.1 (ASCE Minimum Design Loads for Buildings and Other Structures) shall be applied.

5.1.7 Chambers

All optics are housed in two types of chambers. These chambers contain the seismic isolators and alignment mechanisms which support the optical elements. The two chambers are designated BSC and HAM.

5.1.7.1 Beam Splitter Chamber (BSC)

The Beam Splitter Chamber (BSC) configuration is shown in Figure 8.

5.1.7.2 Horizontal Axis Module (HAM)

The Horizontal Axis Module (HAM) configuration is shown in Figure 9. One spare HAM is required at the Washington site.

5.1.8 Attachment Brackets

Both chamber types shall have internal attachment brackets as shown in Figure 10. These brackets will be used to support lightweight optical components.

5.1.9 Flanges and Ports

Dual O-ring flanges shall be designed for convenient, quick and easy disassembly and assembly, consistent with reliable sealing. O-rings shall be vacuum quality Viton, free of lubricant, and baked to remove contaminants. O-ring grooves shall retain the O-ring during assembly/disassembly. Flange centering pins shall be tapered, rounded, and replaceable; centering pins for flange sets in the vertical plane shall support the weight of the mating cover. Except for the case of chamber to chamber connections, flange centering pins shall be included in the chamber flange of flange sets in the vertical plane, and the lower flange of flange sets in the horizontal plane. Port designs shall provide for maximum aperture and minimum neck length. Where applicable designs shall conform to ISO Standard 2861.

5.1.10 Access Connectors

The 152 cm diameter short tube sections located at BSC 2 and BSC 4 are defined as access connectors, and shall be designed for convenient removal and installation. As a minimum the total axial space required at these locations is 90 cm. The bellows portion shall be as short as practical to allow addition of side access ports in the future. A similar access connector is required at BSCs 7and 8.

5.1.11 Optical Baffles

All connecting tubes shall be designed to allow for installation of optical baffles at a later date. This requirement can be met by allowing access to all internal surfaces.

5.1.12 Annular Spaces

The annuli of each chamber shall be connected to a single flange. Pumping speed between this flange and any point of the pumped annulus is to be greater than 0.3 liters/sec for air. in molecular flow. Interconnecting tubing shall be routed close to the chamber wall, with all connections to be welded or CF flanges.

5.1.13 Fasteners

Flange fasteners shall be of high quality, appropriate for efficient assembly and disassembly. All fasteners shall be plated or made of alloys which allow use without lubricants. Floor anchors need not be plated. Where possible plate nuts shall be used.

5.1.14 Component Leak Rate

The contractor shall ensure that all leaks greater than 1×10^{-9} torr liter/second of helium on each chamber or tube section are repaired at the site of manufacture according to LIGO approved procedures. Leak checking procedures shall conform to ASTM E498 Standard Test Methods for Leaks Using the Mass Spectrometer Leak Detector.

5.1.15 Workmanship, Finish, and Appearance

The finished product shall be free of weld spatter, cutoff spatter, free iron, weld oxidation and defects. There shall be no grinding or abrasion of completed welds or internal vacuum surfaces.

5.1.16 Marking

Each separable part (except fasteners, seals, and interchangeable, standard blank flanges) shall be permanently marked with a unique identification number in a location readily viewed.

5.2 Pumping Subsystem

Vacuum pumps include portable roughing pumps, stationary backing pumps, annulus pumps, main ion pumps, and 80K pumps. The roughing pumps are used to pump the systems down from atmosphere to 10^{-6} torr. The ion pumps, and 80K pumps are used for vibration-free pumping during normal operation.

13K

The main pumping phases include:

- Initial Pumpdown (from 760 torr to less than 1 torr): Roots roughing pump sets are to be used. Smaller volumes may only require roughing with the turbo backing pumps. The duration of this phase is limited to 4 hours per vacuum section for all sections in the corner stations. See Section 4.2.
- Intermediate Pumpdown (from 1 torr to less than 10^{-6} torr): Turbo molecular pump sets are to be used. The duration of this phase is expected to be of order 24 hours. Low noise and vibration are required.
- Final Pumpdown and normal operation (below 10^{-6} torr): No mechanical pumps may be used. Ion pumps and cryogenic pumps are to provide continuous pumping without vibration.

5.2.1 Roughing Pumps

The roughing pumps shall consist of two types of portable pump stations and stationary backing pumps, the main roughing pump set and the turbo molecular pump sets. The main roughing pump set shall be used for pumping from atmosphere to less than 1 torr while the turbo molecular pump set shall be used for pumping from 1 torr to less than 10^{-6} torr. The main roughing pump sets are exempt from the vibration and acoustic noise limits. The turbo molecular pump sets, however, shall be designed to operate for extended periods of time without contributing to vibration and noise levels beyond those described in Section 4.6. The design of the roughing pumps shall preclude contaminating the beam tubes and chambers during the life of the equipment, even with equipment failures and operator mistakes.

5.2.1.1 Main Roughing Pump Sets

Each main roughing pump set shall consist of a roots blower backed by one or more backing pumps. Four sets are required in total. The minimum pumping speed at 1 torr at the pump inlet shall be 500 CFM and at 0.1 torr, 1000 CFM. There shall be no oil in the pumping path. The pump set shall be self contained so that under power failure or pump failure, interlocks shall prevent the pumped chambers from being vented. The pump set shall be capable of roughing volumes as large as the 2 km beam tube module (volume 2000 m^3) without overheating. Provisions for connection to the control system shall be provided. Provision for sealed connection to a ducted facility exhaust system shall be provided. There shall be vacuum gauges located at each pump inlet (both the roots pump and the backing pump) and there shall be auxiliary valved (manual) ports to allow connection of a leak detector. All unused connections shall be fitted with blankoff flanges.

5.2.1.2 Turbo Molecular Pump Sets

Each turbo molecular pump set shall consist of a wide range magnetically levitated turbo molecular pump backed by an oil free pump (diaphragm, piston, or scroll pump). Ten sets are required in total. The minimum pumping speed at the roughing port shall be 1400 liters/sec for nitrogen at 10^{-3} torr. Throughput at a backing pressure of 1 torr shall be at least 5 torr liters/second. The pump set shall be capable of pumping large

13L

volumes (2000 m3) without overheating. The pump set shall be self contained so that under power failure or pump failure, interlocks shall prevent the pumped chambers from being vented or exposed to pump lubricants. Provisions for connection to the control system shall be provided. There shall be vacuum gauges located at each pump inlet (both the turbo pump and the backing pump) and there shall be auxiliary valved (manual) ports to allow connection of a leak detector or auxiliary backing turbo. All unused connections shall be fitted with blankoff flanges.

5.2.2 Main Ion Pumps

The main ion pumps, positioned as shown in Figures 2 and 3, have nominal pumping speeds of 2500 liter/sec minimum for nitrogen. Each *main ion pump* shall have a manual isolation valve as well as a manual pump out valve. The minimum life of the pumps shall be 40,000 hours or more at an operating pressure of 10^{-6} torr. Noble gas diode-type ion pumps shall be used. If required for starting purposes, or to avoid the use of custom power supplies, multiple power supplies and feedthroughs may be employed to operate each pump. The ion pump design shall allow starting at pressures of 1×10^{-5} torr. However, the power supplies need only be capable of providing starting current for 1×10^{-6} torr. Ion pump power supplies shall be mountable in standard 19 inch racks. All ion pump power supplies shall have remote control capability with both current and voltage signals remotely readable.

5.2.3 80K Pumps

There are two types of 80K pumps: long and short. The long 80K pumps shall have a cylindrical cold surface 3.7 m long and the short 80K pumps shall have a cold surface 1.2 m long. All other features of the 80K pumps shall be identical. The pumping surface shall be coaxial with the beam tube axis, and provide a clear aperture of at least 1.30 m, warm or cold. The aperture at the pump flanges and necks shall be that of the adjacent gate valves. The 80K pumps may be of the liquid nitrogen, continuous flow, or refrigerated design. In any case the vibration requirements of section 4.6 shall be met.

Certain parts of the 80K pumps may have large thermal gradients which may give rise to local, intermittent release of gas. The design shall preclude the sudden and direct release of this gas into the optical path. Each 80K pump shall have a removable beam tube section at one end to allow insertion of optics components. The minimum length required for this section is 60 cm.

5.2.4 Annulus Pumps

Auxiliary turbo molecular pump sets (auxiliary turbo carts) shall be provided for roughing of the annular spaces. Ten pump sets are required. The pump sets shall be self contained so that under power failure or pump failure, interlocks shall prevent the pumped volumes from being vented. Provisions for connection to the control system shall be provided. These pump sets shall use an oil free backing pump to minimize the risk of contamination of the annuli. Each chamber shall have a 200l/s (maximum) ion pump to maintain the annular vacuum. The ion pump shall be isolatable from the annuli with a hand valve. Noble gas diode pumps shall be used. The minimum annulus ion pump used anywhere

13 M

shall be at least 20l/s. All ion pump power supplies shall have remote control capability with a remotely readable current signal.

5.3 Valve Subsystem

5.3.1 Gate Valves

All gate valves shall be stainless steel with metal sealed flanges or weld fittings where appropriate, and metal bellows stem feedthroughs. O-ring seals are allowed on the beam line flanges. Only non-contaminating and non-migratory lubrication shall be used on the internal mechanisms. Valve body and flange leakage shall be measured to be less than 10^{-10} torr liter/sec of helium before installation. 112 cm and larger gate valves shall have double viton gate seals. Annular spaces between gate valve seals shall be isolatable. This space shall be provided with a blanked-off port. All gate seals shall be leak free to a level of 10^{-9} torr liter/sec of helium. Valves of the same size and type shall be identical to minimize the number of required spare parts. All valves shall be rated for 10000 cycles before service is required. All valves, regardless of operation (electric, pneumatic, or manual), shall be protected from accidental operation. Such protection may be provided by mechanical, electrical, or procedural means. In instances where accidental venting is possible, redundant means shall be employed.

5.3.2 Small Valves

Small valves (less than 15cm aperture), such as right angle manual valves, shall be all metal and bakeable to 150C. Exceptions are those valves which are used on the o-ring annuli and those which are mounted on the portable pump stations. These may be viton sealed. All metal sealed valves shall be rated for 10000 cycles before service is required.

5.4 Vent and Purge Subsystem

Components inside each of the chambers shall be protected against particulate and hydrocarbon contamination at all times: when chambers are open, while venting to air, during opening and closing, and when closed, including pumpdown. This protection against particulates shall be equivalent to exposure within a Fed. Std. 209 Class 100 clean room. The vacuum enclosure area of each station will be constructed with materials consistent with a Fed. Std. 209 Class 50,000 clean room. Vent and purge systems shall be provided with valved and pressure limited. Class 100 air with a water vapor dew point of less than -60 degrees Celsius. The vent and purge system shall not introduce hydrocarbons into the purge air stream. There shall be one 200 CFM system available in the corner stations and 50 CFM systems elsewhere. No systems are required at the LA mid stations.The air compressors shall be mounted in the designated mechanical room areas. The purge system shall allow for the connection of air shower manifolds in the chambers, used to distribute purge gas over the optical components inside the chambers. Additionally, portable soft-wall cleanrooms shall be provided to allow coverage of open chamber ports. The cleanrooms shall be designed per Federal std. 209 (Methods at rest approach). Air flow shall be designed to optimize particulate removal. Unidirectional air flow is not required. A total of 13 portable units are required (8 for the Washington site).

5.5 Bakeout Subsystem

Insulation and heating equipment shall be modular so as to allow efficient removal and placement. There need only be enough equipment to bake the largest contiguous vacuum section at one time; however, the equipment shall be capable of baking any of the vacuum sections. Bakeout controls shall be sufficient to ensure that the performance requirements are met.

5.6 Monitor and Control Subsystem

Vacuum monitoring and control equipment includes Pirani gauges, ion gauges (cold cathode), process controllers for the large valves, and process controllers for the 80K pumps. Gauge tubes shall be mounted on 2 3/4 inch metal seal CF flanges at the locations shown in Figures 2 and 3. There shall be two auxiliary ports (one 2 3/4 and one 4 1/2 inch CF) complete with all metal valves and blankoffs for each BSC chamber. The 4 1/2 inch CF port is reserved for RGA sensors (to be provided by LIGO). There shall be sufficient controls logic (including hardware and software) to safely operate and commission each vacuum section. Site wide functions such as data logging and control room operations will be provided by the LIGO control system. The interfaces to this system shall consist of discrete digital and analog signals. Signal types, cabling and connectors are subject to LIGO approval. The suggested signal levels are listed below:

- Analog Input 0 to 10 VDC, input impedance greater than 1 Kohm.
- Analog Input 4-20 mA, input impedance 600 ohms nominal.
- Analog Output 0 to 10 VDC, output current drive 10 mA minimum.
- Analog Output 4-20 mA, voltage compliance 15 VDC maximum.
- Discrete Input 24 VDC, input impedance greater than 1 Kohm, or contact closure with contacts rated at 24VDC, 500mA.
- Discrete Output 24 VDC, 100 mA maximum.
- Discrete Contact Output 24 VDC, 1 A maximum.
- RTD Temperature Measurement ISO 385 curve platinum RTDs, 100 or 1 Kohm.
- Thermocouple Measurement Types B, R, S, E, T, J, K.

Input is defined as an input to LIGO controls from the Vacuum Equipment. Output is defined as output from LIGO controls to the Vacuum Equipment. All Vacuum Equipment electronics shall be supplied complete with standard 19" racks, however, vacuum gages are allowed to be of the "smart gage" type and do not require rack mounting.

5.6.1 Vacuum Gauges

Vacuum instrumentation shall be provided for pressures from atmospheric down to 1×10^{-9} torr (N_2 equivalent). Each chamber and beam tube section which can be isolated shall have installed one Pirani gauge, and one cold cathode gauge. Vacuum gages may be self contained "smart gage" type. Connectors for all vacuum gauges shall have locking, positive contact to the mating vacuum feedthrough, properly shield the high voltage and signal connectors, and provide proper strain relief.

5.6.1.1 Pirani Gauges

Pirani gauges shall operate from atmosphere to 10^{-4}torr. The controller shall have at least one setable process control contact or setpoint if commercially available. The gauges shall be installed on CF flanges and be bakeable to 200 degrees Celsius.

5.6.1.2 Cold Cathode Gauges

Cold cathode gauges shall operate from 10^{-3} torr to 1x10-9 torr. The controller shall have at least one setable process control contact or setpoint if commercially available. The gauges shall be installed on CF flanges and be bakeable to 250 degrees Celsius.

6.0 QUALITY ASSURANCE

6.1 Test Plans

Detailed plans including descriptions of the test equipment and procedures for the qualification, screening, and acceptance tests shall be approved by LIGO prior to use. Of particular interest are the qualification requirements for large gate valves.

6.1.1 Control of Contamination

Detailed plans to ensure control of cleanliness shall be approved by LIGO.

6.1.2 Component Acceptance Tests

6.1.2.1 Chamber and Tube Leak Tests

The contractor shall document helium leak rates on each vacuum chamber or tube section as part of the fabrication process. No vacuum chamber or fabricated tube section shall be field installed without first demonstrating acceptable leakage.

6.1.2.2 Pumps

Each electrically powered vacuum pump shall be tested (or certified) for speed, ultimate pressure, leakage, noise and vibration, and operation of protective features, before shipment from the manufacturer.

6.1.2.3 Valve Tests

Each vacuum valve shall be tested for leakage prior to shipment from the manufacturer. For dual gate seals, each seal shall be individually tested. As well, each vacuum valve (including each individual gate seal) shall be tested for leakage after installation on the LIGO vacuum system. Operation of each valve shall also be demonstrated.

6.1.3 System Acceptance Tests

6.1.3.1 Leakage

All vacuum leaks greater than the limit set by the system requirements section shall be measured, repaired and documented.

13 P

6.1.3.2 Pumpdown

Pumpdown from atmosphere to ultimate pressure (100 hours pumping) shall be performed on all vacuum sections and documented.

6.1.3.3 Noise and Vibration

Acoustic noise shall be measured and documented at the vacuum chamber walls with vacuum equipment operating in each of the 3 modes described in Section 5.2. Additionally, background levels shall be measured and documented as well. Vibration levels at the floor near the chambers shall be measured and documented, both with and without simultaneous operation of all of the vacuum equipment. All tests shall be conducted per the statement of work.

6.1.3.4 Purge System

A test shall be developed to ensure the cleanliness of the purge air supply system.

6.1.3.5 Control and Monitoring

Operation of each vacuum gauge shall be demonstrated after installation. Operation of each vacuum pump and each valve shall be demonstrated after installation. Operation, temperature uniformity, and temperature stability of the bakeout system shall be demonstrated.

/3 Q

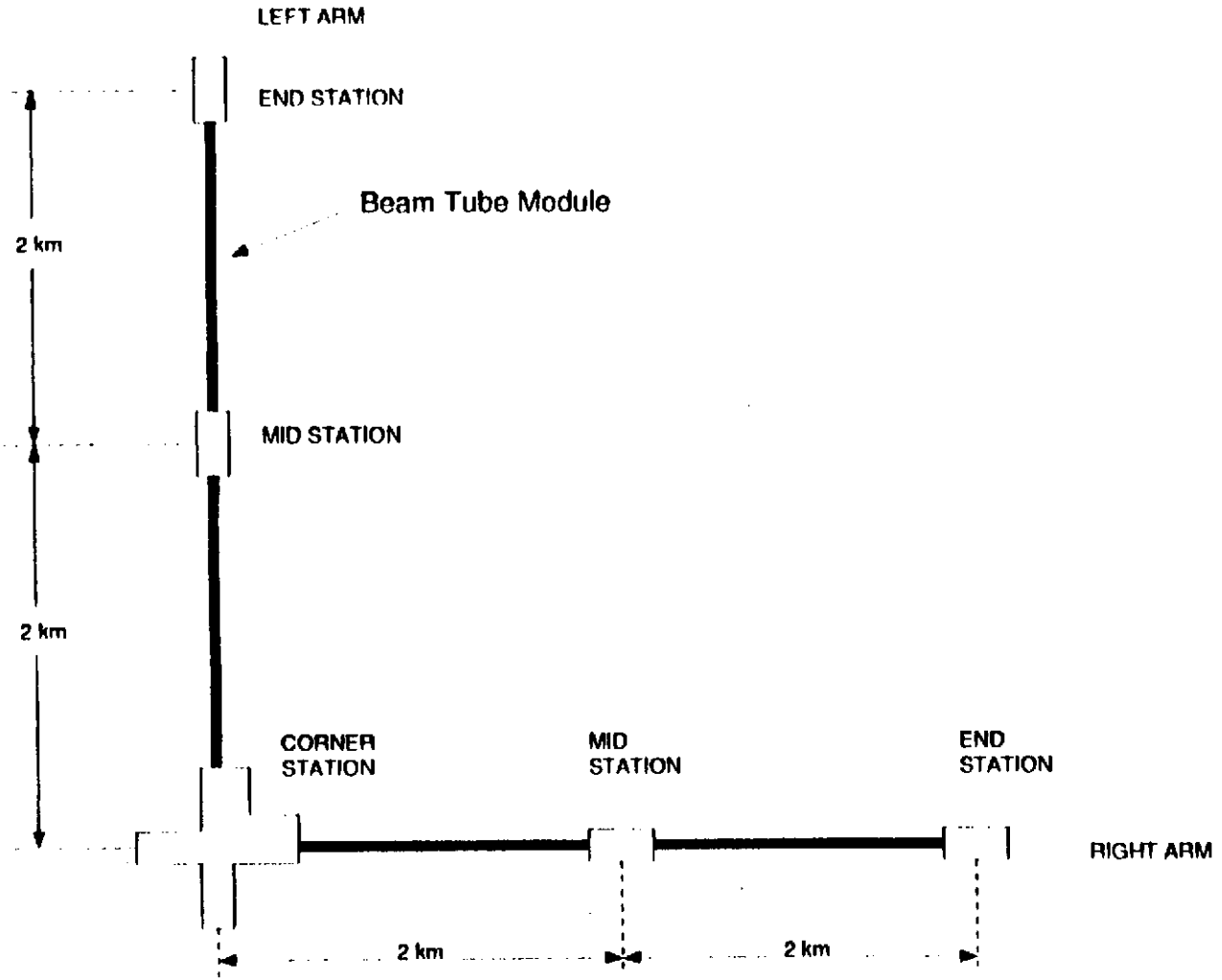

Figure 1. LIGO Geometry

/3R

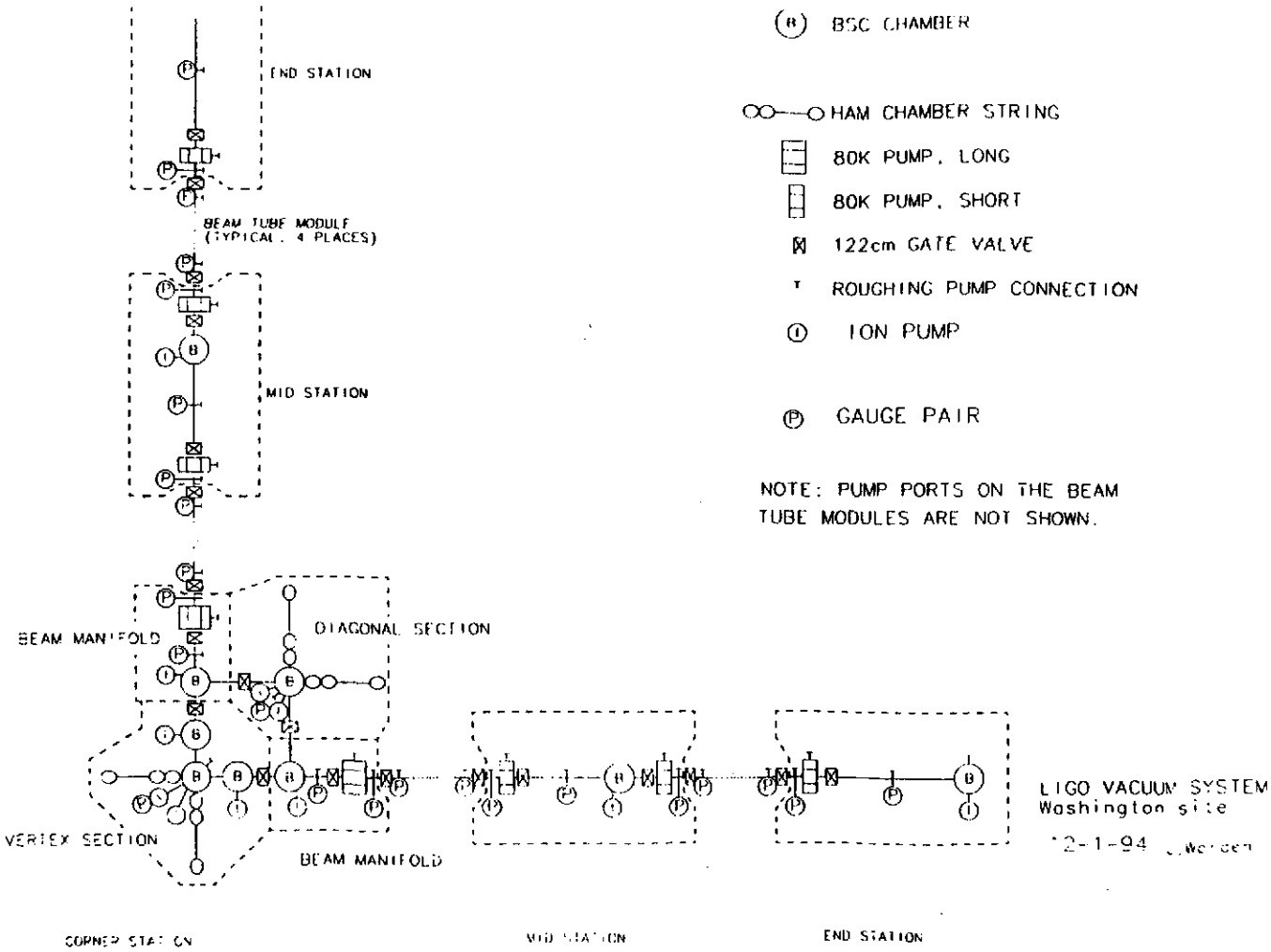

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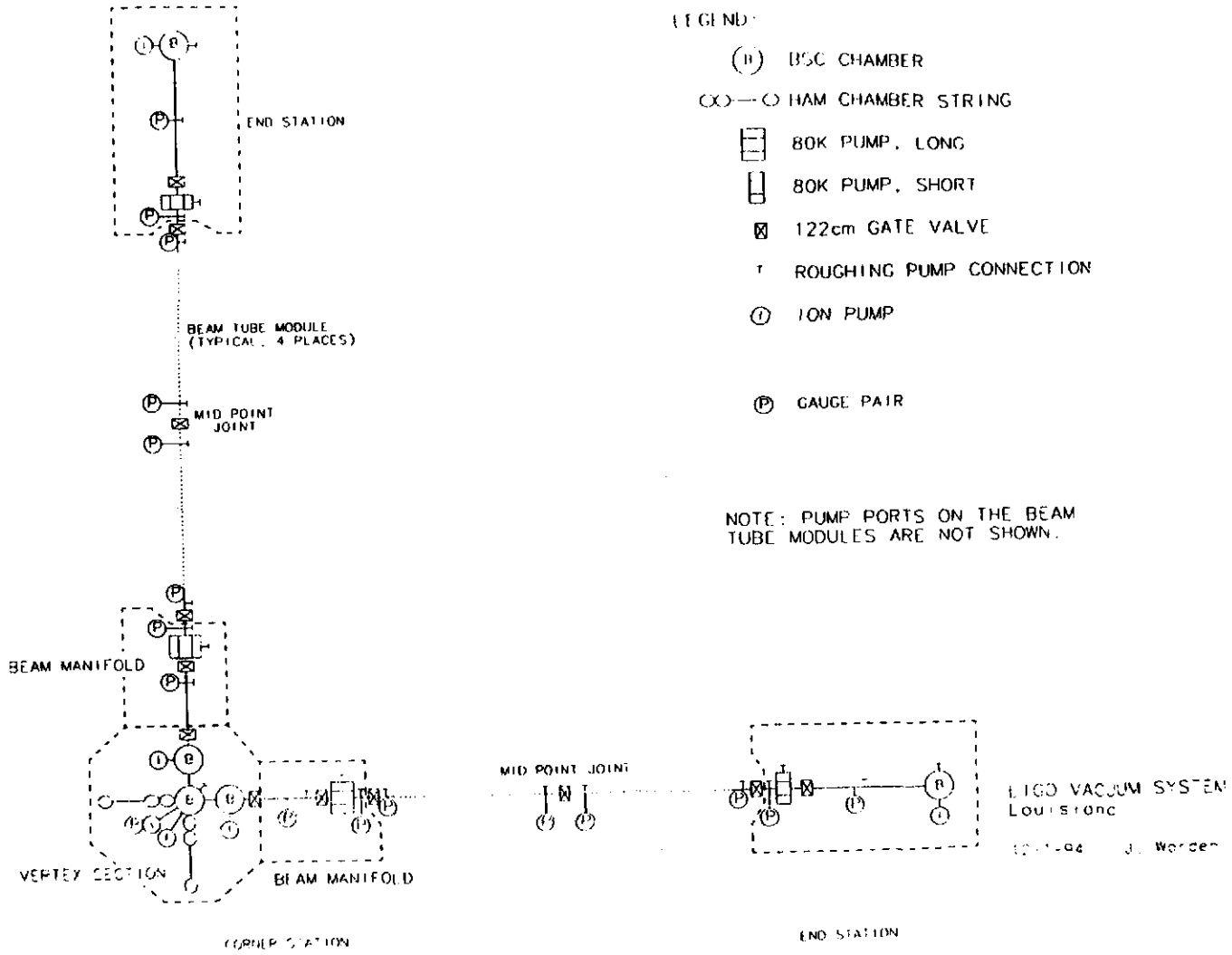
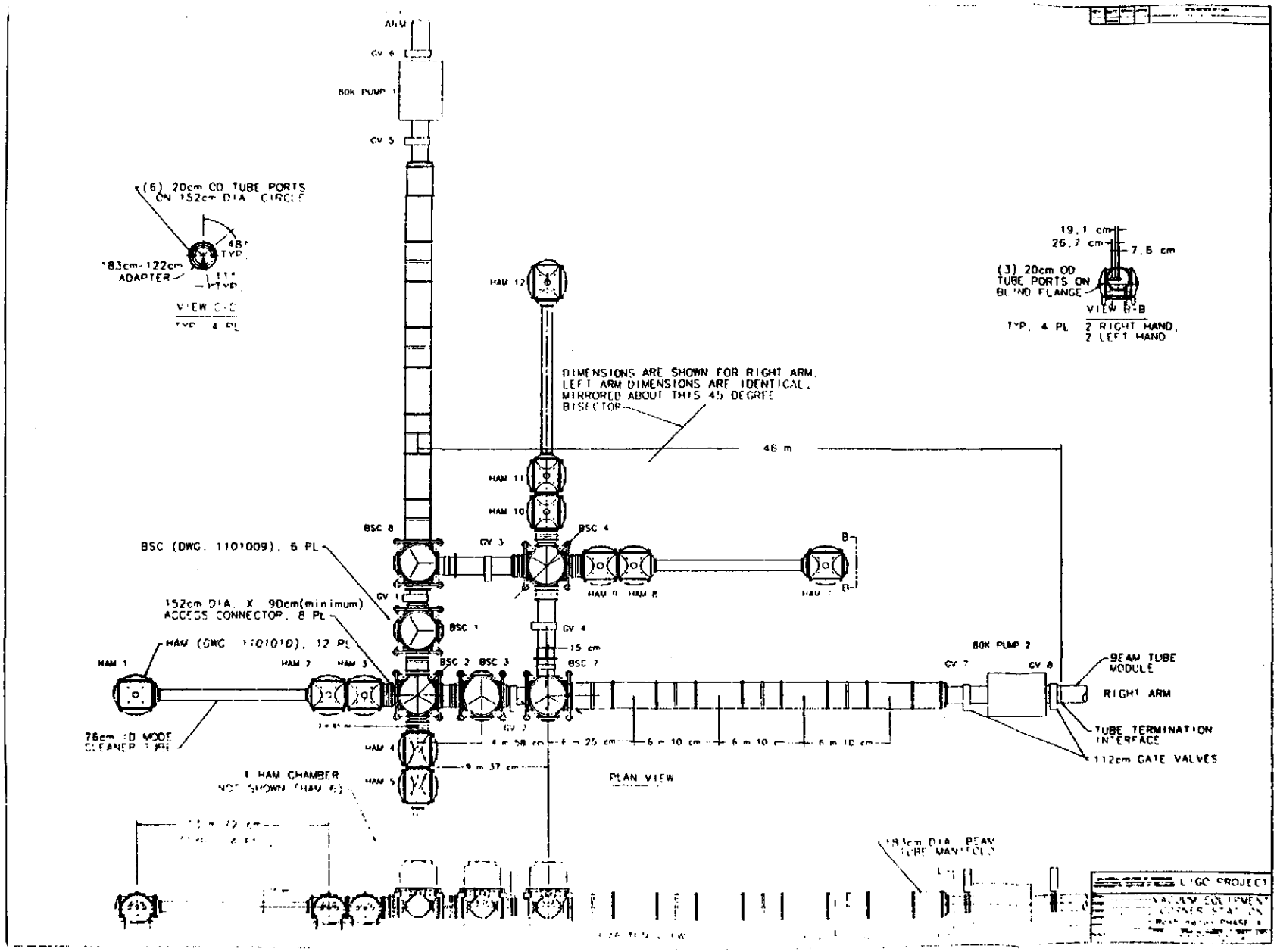
Figure 2.


END STATION
BEAM TUBE MODULE
(TYPICAL, 4 PLACES)
MID POINT
JOINT
BEAM MANIFOLD
VERTEX SECTION
BEAM MANIFOLD
CORNER STATION
MID POINT JOINT
END STATION
LEGEND:
BSC CHAMBER
HAM CHAMBER STRING
80K PUMP, LONG
80K PUMP, SHORT
122cm GATE VALVE
ROUGHING PUMP CONNECTION
ION PUMP
GAUGE PAIR
NOTE: PUMP PORTS ON THE BEAM
TUBE MODULES ARE NOT SHOWN.
LIGO VACUUM SYSTEM
Louisiana
J. Worden


(6) 20cm OD TUBE PORTS ON 152cm DIA CIRCLE
48° TYP.
183cm-122cm ADAPTER
11° TYP.
VIEW C-C
TYP. 4 PL
19.1 cm
26.7 cm
7.6 cm
(3) 20cm OD TUBE PORTS ON BLIND FLANGE
VIEW B-B
TYP. 4 PL
2 RIGHT HAND, 2 LEFT HAND
DIMENSIONS ARE SHOWN FOR RIGHT ARM. LEFT ARM DIMENSIONS ARE IDENTICAL, MIRRORED ABOUT THIS 45 DEGREE BISECTOR
46 m
BSC (DWG. 1101009), 6 PL
152cm DIA. X 90cm(minimum) ACCESS CONNECTOR, 8 PL
HAM (DWG. 1101010), 12 PL
76cm ID MODE CLEANER TUBE
1 HAM CHAMBER NOT SHOWN (HAM 6)
80K PUMP 1
80K PUMP 2
GV 1
GV 2
GV 3
GV 4
GV 5
GV 6
GV 7
GV 8
BSC 1
BSC 2
BSC 3
BSC 4
BSC 7
BSC 8
HAM 1
HAM 2
HAM 3
HAM 4
HAM 5
HAM 7
HAM 8
HAM 9
HAM 10
HAM 11
HAM 12
4 m 58 cm
6 m 25 cm
6 m 10 cm
6 m 10 cm
6 m 10 cm
9 m 37 cm
15 cm
BEAM TUBE MODULE
RIGHT ARM
TUBE TERMINATION INTERFACE
112cm GATE VALVES
PLAN VIEW
LIGO PROJECT
SEP 13 1995

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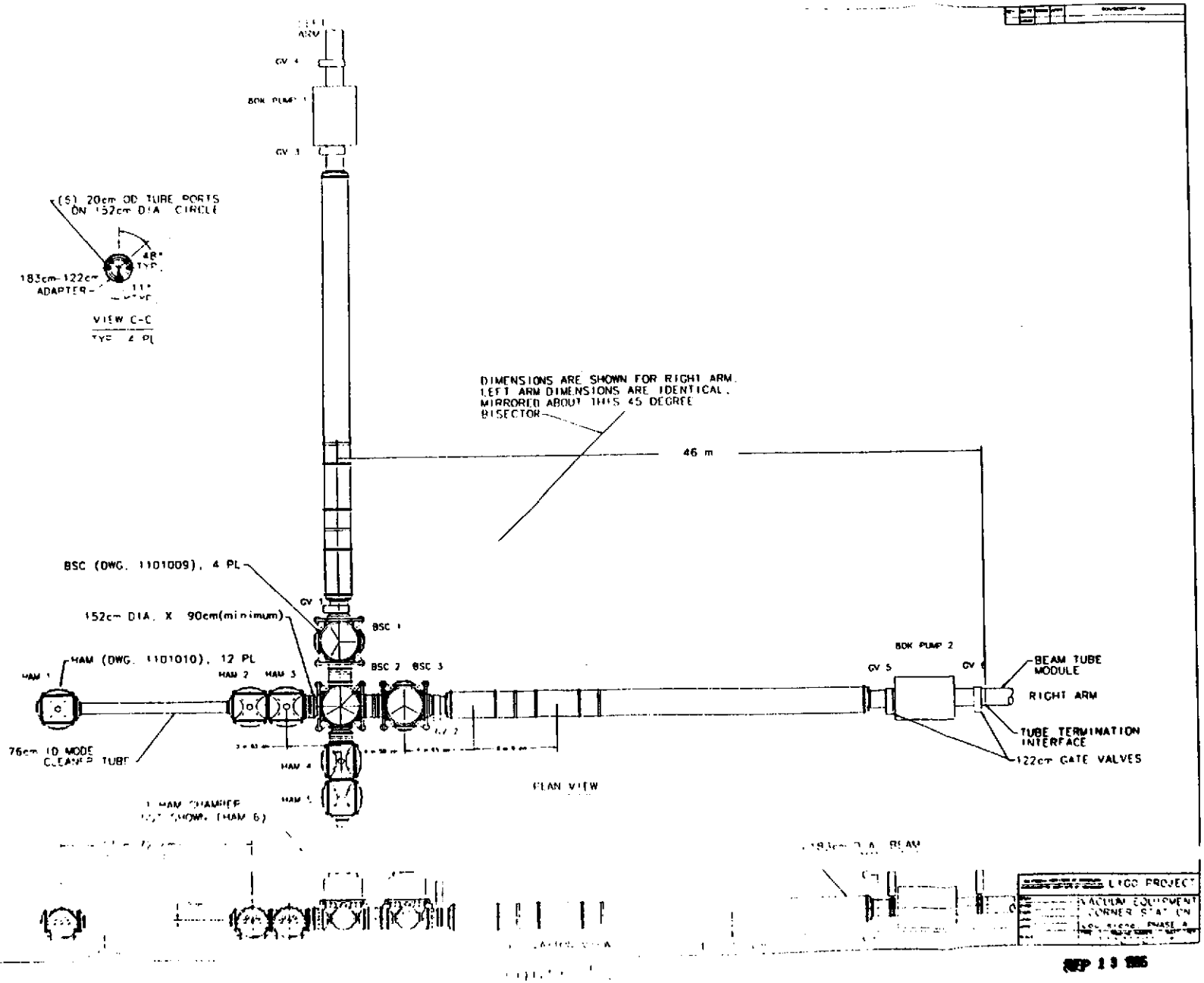
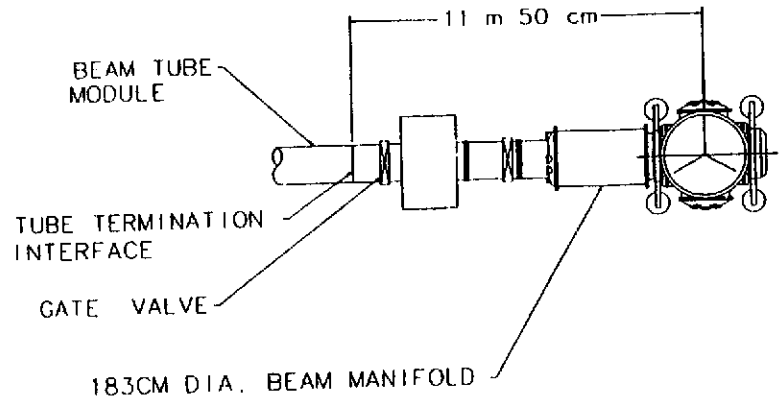

(5) 20cm OD TUBE PORTS ON 152cm DIA CIRCLE
48° TYP.
183cm-122cm ADAPTER
VIEW C-C
TYP 4 PL
DIMENSIONS ARE SHOWN FOR RIGHT ARM. LEFT ARM DIMENSIONS ARE IDENTICAL, MIRRORED ABOUT THIS 45 DEGREE BISECTOR
46 m
BSC (DWG. 1101009), 4 PL
152cm DIA. X 90cm(minimum)
HAM (DWG. 1101010), 12 PL
76cm ID MODE CLEANER TUBE
BSC 1
BSC 2
BSC 3
HAM 1
HAM 2
HAM 3
HAM 4
HAM 5
GV 5
80K PUMP 2
BEAM TUBE MODULE
RIGHT ARM
TUBE TERMINATION INTERFACE
122cm GATE VALVES
PLAN VIEW
LIGO PROJECT
VACUUM EQUIPMENT
CORNER STATION



END STATION

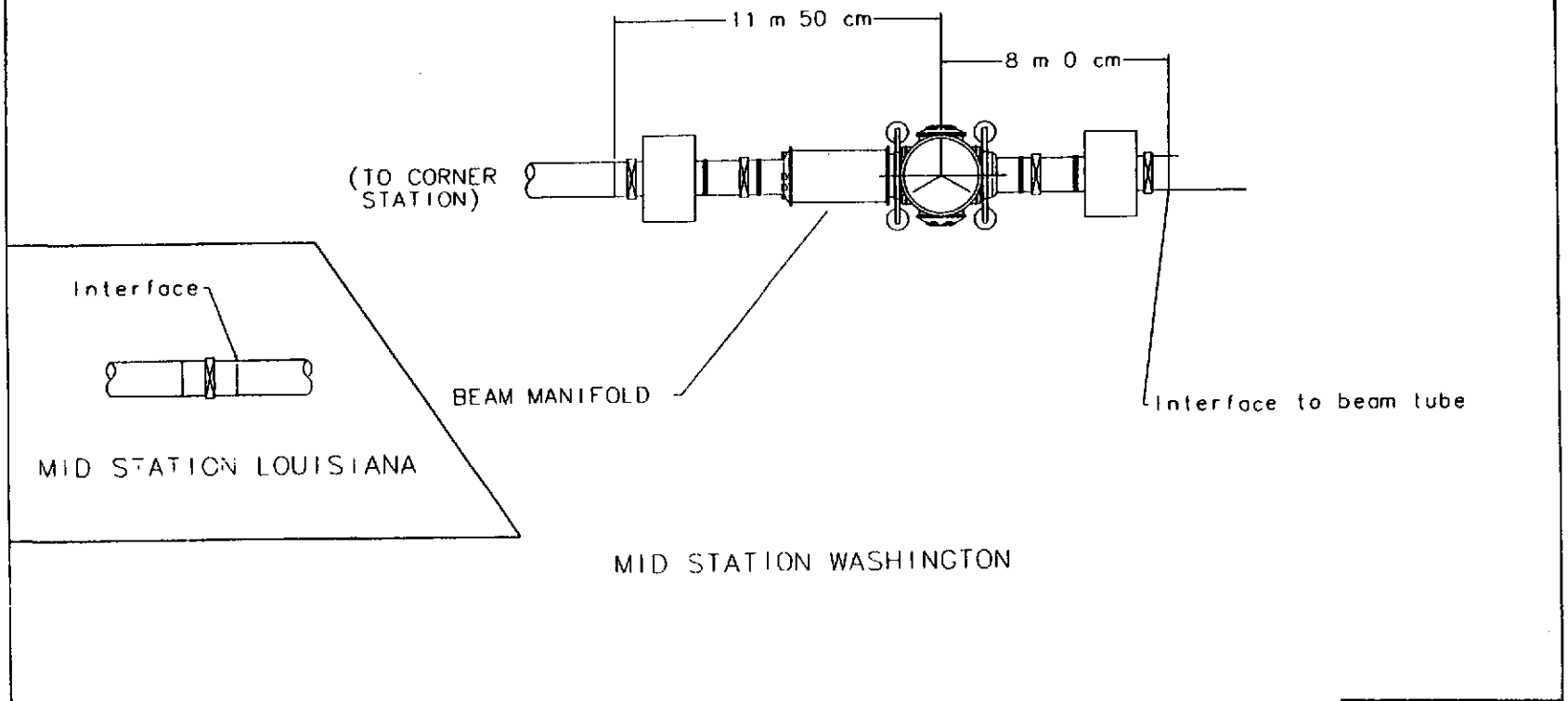
BOTH SITES WA and LA

LIGO PROJECT
VACUUM EQUIPMENT
END STATIONS

SEP 13 1995

Figure 6.

13W



LIGO PROJECT
VACUUM EQUIPMENT
MID STATIONS

Figure 7.

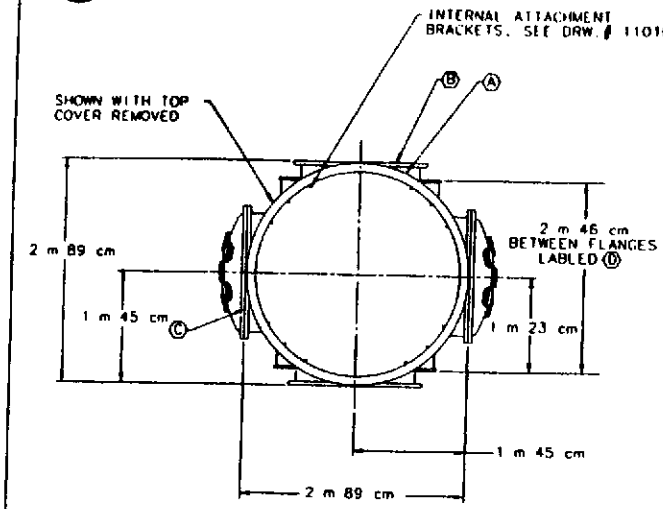
13X

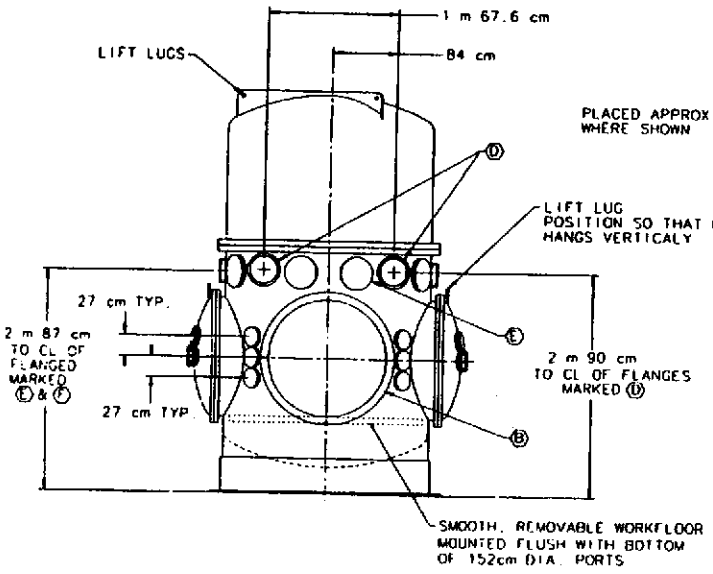
REV	DATE	DRWN	APPD	DCN/DESCRIPTION

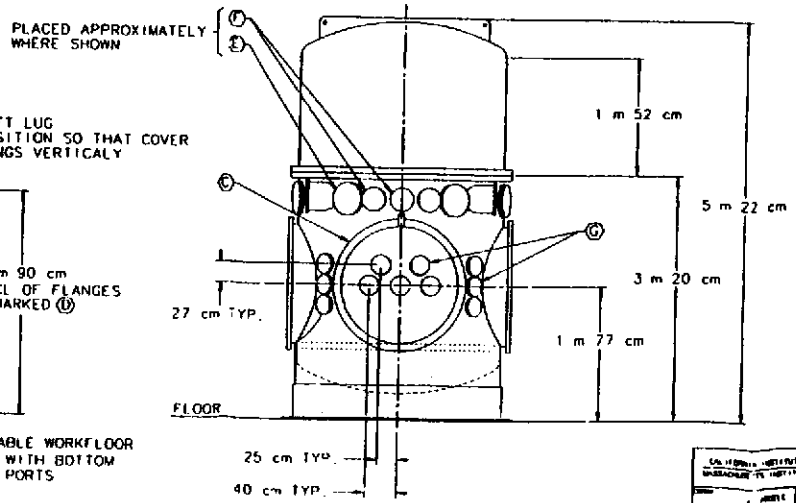
NOTES
1. HEADS ARE ASME F&D.
2. INCLUDE CENTERING PINS ON NOZZLE FLANGES WHERE APPROPRIATE.
3. VIEWPORT (ITEM Ⓒ) MEASUREMENTS REFER TO INTERSECTION OF VIEWPORT AXIS WITH OUTER SURFACE OF VACUUM WALL.
4. TOLERANCES, UNLESS OTHERWISE SPECIFIED: LINEAR, ±0.25 CM
   ANGULAR, ± 1 DEGREE
5. NOZZLE SCHEDULE PER TABLE BELOW:

ITEM	SIZE	QUANTITY	FLANGE TYPE	PURPOSE
Ⓐ	264cm ID TUBE	1	O/O-O/METAL*	MAJOR ACCESS
Ⓑ	152cm ID TUBE	2	O/O-O/METAL*	LASER BEAM, ACCESS (MINIMIZE NECK LENGTH)
Ⓒ	152cm ID TUBE	2	O/O-O/METAL*, WITH BLIND FLANGE	ACCESS (MINIMIZE NECK LENGTH)
Ⓓ	35cm OD TUBE	4	CONFLAT**	SUPPORT BEAMS REFERENCE ICD # TBD
Ⓔ	35cm OD TUBE***	8	CONFLAT**, WITH BLIND FLANGE	AIR SHWR, BACK-TO-AIR PURGE ROUGHING & ION PUMPS, UTILITY
Ⓕ	25cm OD TUBE***	6	CONFLAT**, WITH BLIND FLANGE	ELECTRICAL FEEDTHROUGHS
Ⓖ	20cm OD TUBE***	22	CONFLAT**, WITH BLIND FLANGE	OBSERVATION, BEAM PICK-OFFS
Ⓗ	3.8cm OD TUBE	1	CONFLAT**, WITH BLIND FLANGE	ANNULUS PUMPOUT (NOT SHOWN)

*DUAL O-RING DESIGN.
THESE FLANGES EACH INCLUDE AN ANNULAR CHANNEL BETWEEN O-RINGS, MANIFOLDED TO A SINGLE PUMPOUT PORT ON EACH CHAMBER, WITH CONFLAT** SEAL.
**REGISTERED TRADEMARK, VARIAN VACUUM PRODUCTS; COMPATIBLE ALTERNATES ARE ACCEPTABLE.
***THESE FLANGES ARE TANGENT TO LOCAL VACUUM WALL, WITH MINIMUM NECK LENGTH.







	LIGO PROJECT	
	BEAM SPLITTER CHAMBER (BSC)	
	SIZE D	1101009

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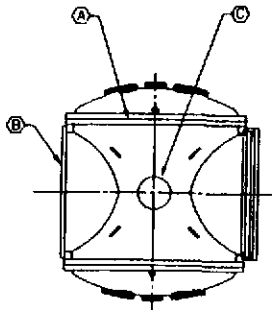
Figure 8.

REV	DATE	DRWN	APPD	DCN/DESCRIPTION

NOTES
1. HEADS ARE ASME I&D.
2. INCLUDE CENTERING PINS ON NOZZLE FLANGES WHERE APPROPRIATE.
3. VIEWPORT (ITEM Ⓕ) MEASUREMENTS REFER TO INTERSECTION OF VIEWPORT AXIS WITH OUTER SURFACE OF VACUUM WALL.

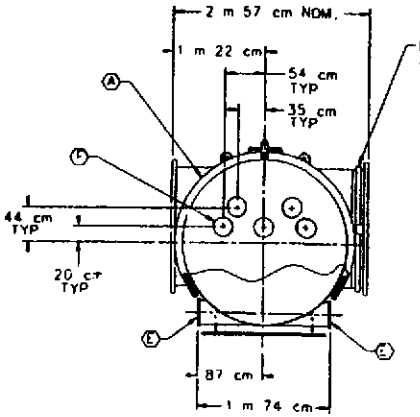
4. TOLERANCES, UNLESS OTHERWISE SPECIFIED LINEAR, ±0.25 CM
ANGULAR, ± 1 DEGREE

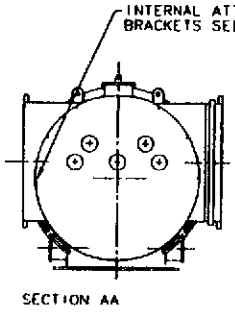
5. NOZZLE SCHEDULE PER TABLE BELOW:



ITEM	SIZE	QUANTITY	FLANGE TYPE	PURPOSE
Ⓐ	213cm ID TUBE	2	O/O-O/METAL*	MAJOR ACCESS
Ⓑ	152cm ID TUBE	2	O/O-O/METAL*	LASER BEAM
Ⓒ	35cm TUBE ***	1	CONFLAT**, WITH BLIND FLANGE	ION PUMP/AIR SHOWERS, BACK-TO-AIR PURGE
Ⓓ	25cm OD TUBE***	8	CONFLAT**, WITH BLIND FLANGE	ELECTRICAL FEEDTHROUGHS, UTILITY
Ⓔ	30cm OD TUBE	4	CONFLAT**	SUPPORT BEAMS REFERENCE ECD # TBD
Ⓕ	20cm OD TUBE***	10	CONFLAT**, WITH BLIND FLANGE	OBSERVATION, PICKOFFS
Ⓖ	3.8cm TUBE	1	CONFLAT**, WITH BLIND FLANGE	ANNULUS PUMPOUT (NOT SHOWN)

* DUAL O-RING DESIGN. THESE FLANGES EACH INCLUDE AN ANNULAR CHANNEL BETWEEN O-RINGS, MANIFOLDED TO A SINGLE PUMPOUT PORT ON EACH CHAMBER, WITH CONFLAT** SEAL.
** REGISTERED TRADEMARK, VARIAN VACUUM PRODUCTS; COMPATIBLE ALTERNATIVES ARE ACCEPTIBLE
*** THESE FLANGES ARE TANGENT TO LOCAL VACUUM WALL, WITH MINIMUM NECK LENGTH





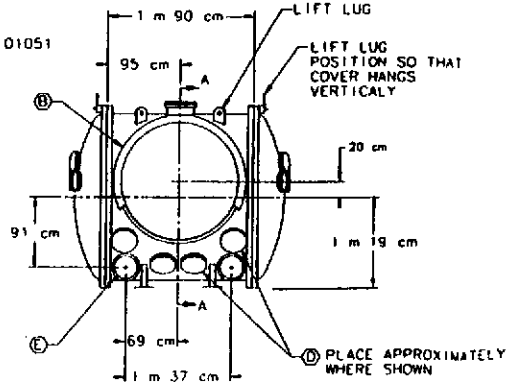


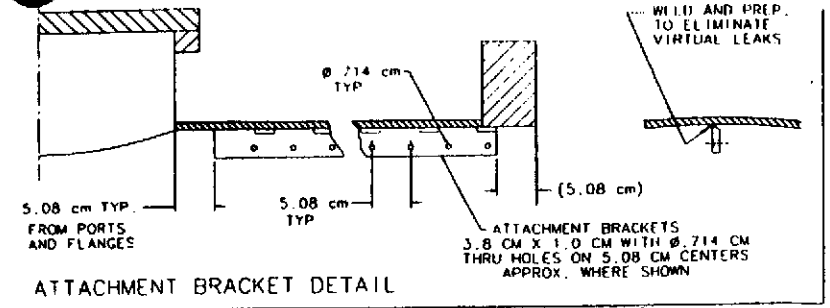
Figure 9.

CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LIGO PROJECT

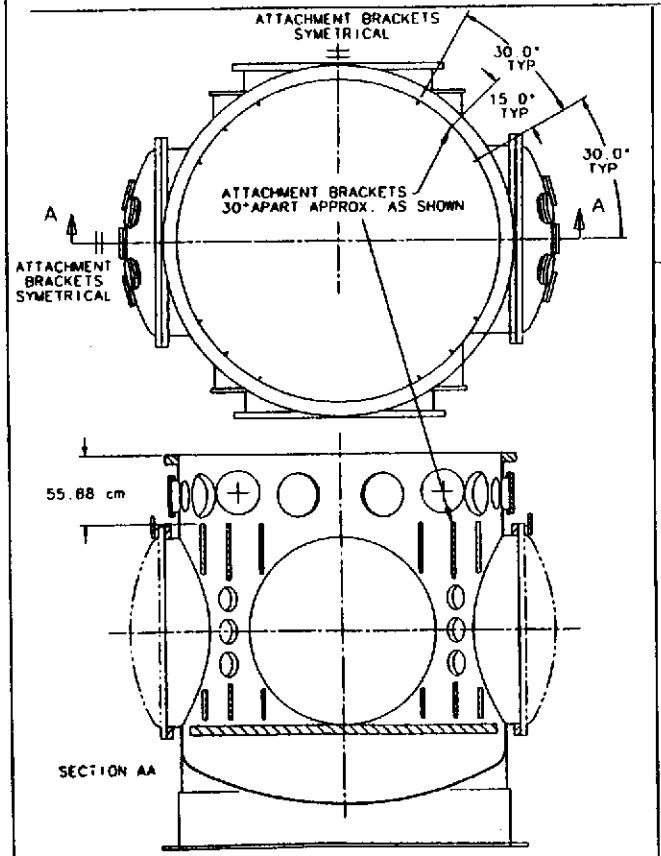
HORIZONTAL ACCESS MODULE (HAM)

SIZE D | DRAWING NUMBER 1101010 | SHEET 1 of 1 | REV

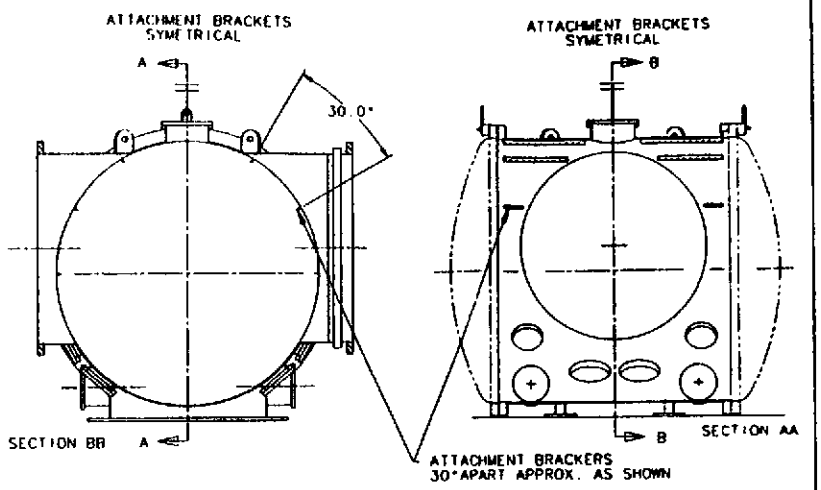
SEP 13 1995



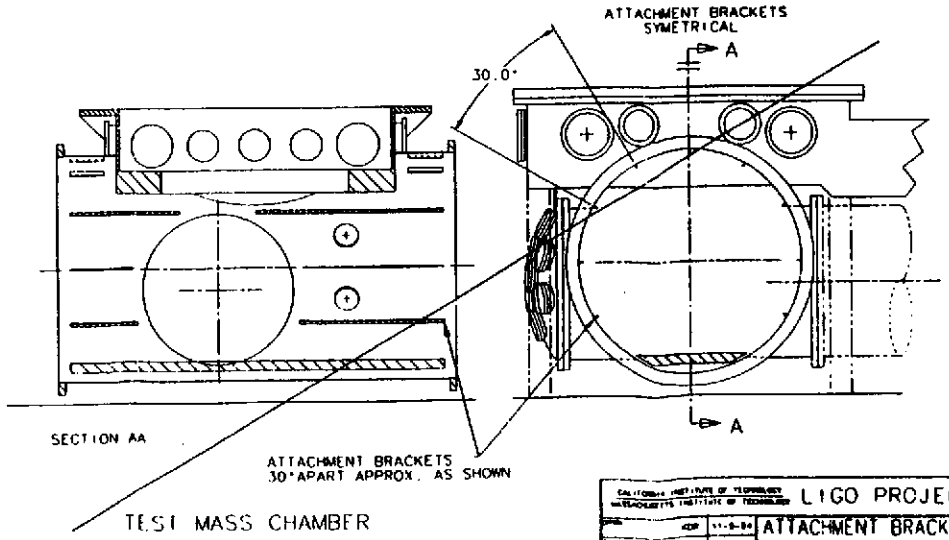
ATTACHMENT BRACKET DETAIL



BEAM SPLITTER CHAMBER



HORIZONTAL ACCESS CHAMBER



TEST MASS CHAMBER

Figure 10.

REV	DATE	DRWN	APPD	DCN/DESCRIPTION

LIGO PROJECT

ATTACHMENT BRACKETS HAM, BSC & TMC CHAMBERS

11C1CS1

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13 AA

EXHIBIT II

DELIVERABLE DOCUMENTATION
LIGO-C950804-00-V01

DELIVERABLE DOCUMENTATION

A. The deliverable documentation of this contract is summarized in the following Contract Data Requirements List (CDRL), which identifies the items to be delivered and when delivery is required, the quantity and type of each item, and frequency of issue. Documentation shall be delivered as early as available but no later than the date specified in the CDRL. The Data Requirement Description (DRD) forms referenced in the CDRL describe the specific requirements for the item(s) to be delivered.

B. The Contractor shall display on the cover or title page of all deliverable non-design documentation (i.e., all documents except drawings and specifications) the following minimum information:

- Document Title
- Contract Number
- Document Number (Institute and/or Contractor assigned)
- Program Identification
- Date of Issue
- CDRL Line Item Number
- Approval Status

C. The approval code on the CDRL is defined as follows:
A= Submitted for LIGO's approval.
X= LIGO approval not required.

D. The following applies to all data submitted for approval:

1. The Contractor shall submit the approval draft on or before the date indicated.

2. If the draft is approved, the Contractor will be notified in writing by the LIGO Contract Technical Manager. The Contractor shall then prepare and deliver final copies as indicated in the CDRL.

3. If the submitted approval draft requires significant Contractor modifications before approval will be granted, the following steps shall be taken:

- The required modifications will be transmitted or discussed between the cognizant parties.
- The Contractor shall submit an updated draft, containing the required modifications.
- If the updated draft is approved, the Contractor will be notified in writing by the LIGO

Contract Technical Manager. The Contractor shall then prepare and deliver final copies as indicated in the CDRL.

The approval requirements for revisions shall be the same as applied to the original data item submittal unless otherwise specified.

4. All documentation is to be delivered to the Document Control Center (DCC) in care of MS. Linda Turner, LIGO Project, Mail Stop 51-33, California Institute of Technology, 391 South Holliston Ave. Pasadena CA 91125. The Document Control Center will be the point of official receipt and distribution.

Table 1: CONTRACT DATA REQUIREMENTS LIST

CDRL #	Title or Description of Data	Approval Code	Frequency of issue	Date Due To User	# Copies	Remarks
1	Phase B Update of Preliminary Design					PDR - Preliminary Design Review ARC - After receipt of comments
	Draft	X	Once	3 days prior to PDR	4	
	Final	A	Once	30 days ARC	4	
2	Project Management Plan					
	Draft	X	Once	3 days prior to PDR	4	
	Final	A	Once	30 days ARC	4	
3	Final Design					
	Draft	X	Once	10 days prior to FDR	4	
	Final	A	Once	30 days ARC	4	
4	Preliminary Design Review Data Package	X	Once	3 days prior to PDR	4	Presentation material
5	Final Design Review Data Package	X	Once	10 days prior to FDR	4	Presentation material
6	Acceptance Test Report	A	Twice	TBD	4	One per site.
7	Acceptance Test Review Data Package	X	Once	10 days prior to ATR	4	Presentation material

NOTE: Each issue (submittal) shall contain one camera-ready copy.

Table 1: CONTRACT DATA REQUIREMENTS LIST

CDRL #	Title or Description of Data	Approval Code	Frequency of issue	Date Due To User	# Copies	Remarks
8	Minutes	X	Once for each meeting	7 days after meeting	4	
9	Status Report	X	Monthly	15 days after meeting	1	
10	Deliverables to the Beam Tube Final Design Review Data Package					
	Draft	X	Once	10 days prior to Deliverables to the Beam Tube FDR	4	
	Final	A	Once	30 days after FDR	4	
11	Prototype Vessel Data Review	A	Once	30 days after completion of prototype vessel tests	4	

NOTE: Each issue (submittal) shall contain one camera-ready copy.

Data Requirement Description (DRD)
for CDRL No. 1: Updated Preliminary Design

Purpose:
To document the design of the LIGO overall vacuum system and to substantiate that the design meets the requirements.

Preparation Instructions:
Assemble a package of plans, drawings, specifications procedures, calculations etc. which describe the overall vacuum system design. This data package shall include as a minimum the items described in Article I, Statement of Work, Delivery or Performance Schedule. Additional information which may be required to fully describe and assess, the adequacy of the system design shall also be included in this data package.

Data Requirement Description (DRD) for CDRL No. 2: Project Management Plan

Purpose:
To provide the basic operating plan for the project which allows for detailed scheduling, work progress reporting, and tracking of termination liability.

Preparation Instructions:
Update and revise the Project Management Plan generated for CDRL No. 02 of Phase A as described in Article I, Statement of Work.

Data Requirement Description (DRD) for CDRL No. 03: Final Design

Purpose:
To define and document the vacuum equipment design.

Preparation Instructions:
Prepare a stand alone document, consisting of drawings, specifications, plans, procedures, etc., as described in Article I, Statement of Work.

Data Requirement Description (DRD)
for CDRL No. 04: Preliminary Design Review Data Package

Purpose:
To present and substantiate the preliminary design for the vacuum equipment.

Preparation Instructions:
The Data Package to be provided in support of the Preliminary Design Review shall contain all presentation material as well as backup data and information on all topics to be discussed at the review.

Data Requirement Description (DRD)
for CDRL No. 05: Final Design Review Data Package

Purpose:
To present and substantiate the final design for the vacuum equipment.

Preparation Instructions:
The Data Package to be provided in support of the Final Design Review shall contain all data and information on all topics to be discussed and presented at the Review.

Data Requirement Description (DRD) for CDRL No. 06: Acceptance Test Report

Purpose:
To document the acceptance test process and results.

Preparation Instructions:
Substantiate that the vacuum equipment complies with the Design documented in CDRL No. 03 and the requirements in Article I, Statement of Work.

Data Requirement Description (DRD) for CDRL No. 07: Acceptance Test Review Data Package

Purpose:
To present all aspects of as built design and associated fabrication, installation and acceptance testing of the vacuum equipment, and to provide a permanent record of presented material and subsequent closeout of resultant action items.

Preparation Instructions:
The Data Package to be provided in support of the Acceptance Test Review shall contain all data and information on all topics to be discussed and presented at the Review and shall include, but not be limited to, the following for each LIGO site:

- Test report excerpts documenting the results of the acceptance tests, in accordance with CDRL No. 06, Acceptance Test Report.
- Performance verification.
- As-built drawings.
- Disposition of property procured under the contract or made available as Government furnished property.
- Remaining issues and open action items.

Data Requirement Description (DRD) for CDRL No. 08: Minutes

Purpose:
To document proceedings of all formal Institute/Contractor LIGO project meetings.

Preparation Instructions:
The Minutes shall document proceedings of all formal Institute/Contractor project meetings. The Minutes shall include:

- A summary of all business transactions between the Contractor and the Institute, including any alterations and/or clarifications to the Review Data Package generated during the Review.
- Contractor action items and planned completion dates.
- Institute action items and planned completion dates.

Data Requirement Description (DRD) for CDRL No. 09: Status Report

Purpose:

To assess project progress and status.

Preparation Instructions:

The Data Packages to be provided in support of the monthly progress meeting shall contain all data and information on all topics to be discussed and presented at a review, and shall include, but not be limited to, the following:

- All current technical contract activities, and percent complete at the WBS element level.
- Updated schedules including milestones and other events accomplished or missed, reasons for delay and corrective measures taken.
- Problem areas, including those concerns requiring action(s), decision(s) or assistance on the part of the Institute.
- Action items closed during the review period, progress of open action items, and identification of new action items.
- Response to technical direction received.

Data Requirement Description (DRD) for CDRL No. 10: Deliverables to the Beam Tube Final Design

Purpose:
To define and document the deliverables to the Beam Tube Contractor.

Preparation Instructions:
Prepare a stand alone document, consisting of drawings, specifications, plans, procedures, etc., as described in Article I, Statement of Work.

Data Requirement Description (DRD)
for CDRL No. 11: Prototype Vessel Data Review

Purpose:
To document the test results of the prototype vessel.

Preparation Instructions:
Prepare a stand alone document, consisting of test results as described in Article I, Statement of Work.

EXHIBIT III

DELIVERABLES FOR THE BEAM TUBE CONTRACTOR
LIGO-C950804-00-V02

EXHIBIT III
DELIVERABLES FOR THE BEAM TUBE CONTRACTOR

A. The Deliverables consist of pump carts and gate valves which are required for the beam tube pump down (a separate contract). These components are defined in Exhibit I Vacuum Equipment Specification. There are three types of pump carts and one type of gate valve. The required equipment is listed below:

WASHINGTON SITE - Required date: 6/19/96

LOUISIANA SITE - Required date: 8/10/97

Item	Quantity Hanford	Quantity Louisiana
1. Main Roughing Pump (per Exhibit I, paragraph 5.2.1.1)	2	2
2. Turbo Molecular Pump Set (per Exhibit I. paragraph 5.2.1.2)	4	4
3. Auxiliary Turbo Cart (per Exhibit I. paragraph 5.2.5)	2	2
4. 112 cm Gate Valve (per Exhibit I. paragraph 5.3.1)	8	4
5. 122 cm Gate Valve (per Exhibit I. paragraph 5.3.1)	0	2

NOTE: Quantities above are those required for the beam tube pump down only and may not be the same as the total quantity called for in Exhibit I Vacuum Equipment Specification.

EXHIBIT IV

HARDWARE DELIVERABLES
LIGO-C950804-00-V03

EXHIBIT IV
HARDWARE DELIVERABLES

A. The Hardware Deliverables consist of all the Vacuum Equipment to be installed and tested at the two LIGO sites. This equipment is defined in Exhibit I, Vacuum Equipment Specification. Each vacuum section shall be delivered, installed, and acceptance tested*, complete with all chambers, pumps, valves, supports, fittings and gauges. The equipment is listed below, and the acceptance dates are as stated in Article II.

*Acceptance dates will be determined jointly by LIGO, the A-E Contractor and the Vacuum Equipment Contractor.

WASHINGTON SITE - Exhibit I, Figures 4, 6, 7.

Item	Quantity
1. Corner Station Vertex Section	1
2. Corner Station Diagonal Section	1
3. Corner Station Beam Manifolds	2
4. Site Purge/Vent system	1
5. Site Bakeout system *(this system will also be used in Louisiana)*	1
6. Site Pump Carts	1 set
7. Left Arm Mid Station	1
8. Right Arm Mid Station	1
9. Left Arm End station	1
10. Right Arm End Station	1

LOUISIANA SITE - Exhibit I, Figures 5, 6, 7.

Item	Quantity
1. Corner Station Vertex Section	1
2. Corner Station Beam Manifolds	2
3. Site Purge/Vent system	1
4. Site Bakeout system *(the Washington bakeout system will be shipped to Louisiana)*	0
5. Site Pump Carts	1 set
6. Left Arm End station	1
7. Right Arm End Station	1

5.3 Design Input Review

Prior to contract acceptance, a detailed review is held internally at PSI to review the design input basis. The customers contract documents are reviewed against the PSI proposals and any subsequent letter addenda to ensure the project design basis is understood and contractually consistent between all documents. All discrepancies will be resolved before contract acceptance.

This meeting is attended by the Project Manager, the Director of Contracts and Senior Project Team Staff.

6.0 DESIGN OUTPUT

6.1 Project Execution Summary

The LIGO Project will be executed as shown on Chart 6.1 "Project Execution Summary".

Because of the technical challenges and fast track nature of the engineering phase of this project, some engineering, research and fabrication must be done in parallel to maintain the project schedule. This approach is also mandated to properly control risks associated with vessel fabrication, vibration/shock design and very large ultra high vacuum systems design.

6.1.1 VIBRATION STUDY

As part of the Phase B final design, PSI will conduct vibration/noise/shock testing of all the devices that have significant contribution to the vibration/noise spectrum. This source spectrum data (not available from most vendors) will enable PSI to calculate the resulting vibration/noise/shock at the beam tube system and recommend 2nd order remediation for approval by LIGO (NOTE: 1st order remediation is included in the lump sum price). See Volume I, Section 4 for more details of the vibration/noise/shock program.

6.1.2 FIRST ARTICLE FABRICATION

Also, as part of the Phase B Engineering Phase, PSI will fabricate a 1st article vessel (BSC or HAM) to validate proposed fabrication, sealing and cleaning techniques. This approach will provide significant risk management benefits and prevent fabrication false starts or large delays later in the program.

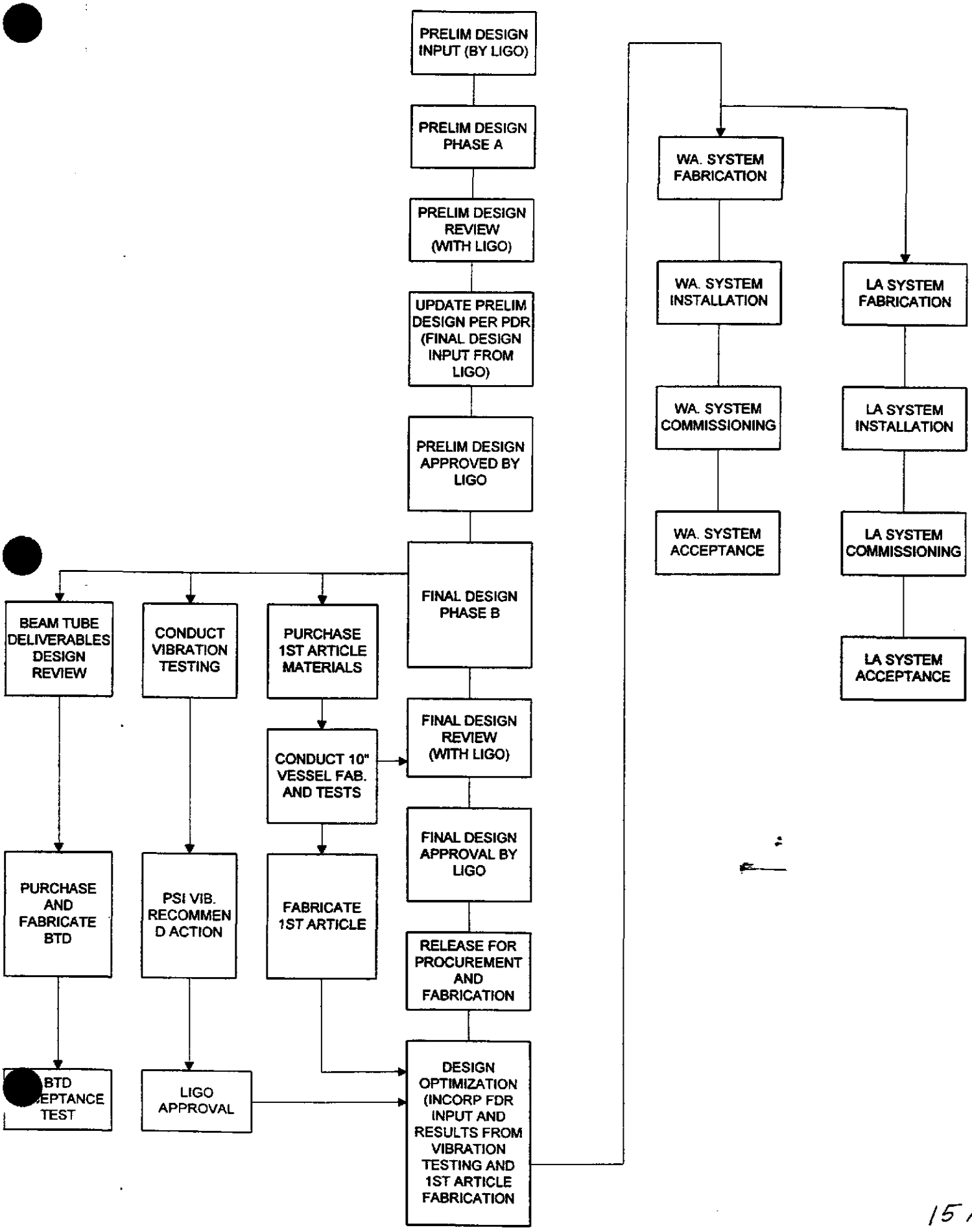
A first article large gate valve program is being executed by PSI. PSI has released one large gate for design and manufacture. This approach will reduce the risk associated with the large gate valves.

Prototype 10" vessels are also being fabricated and tested to validate fabrication and cleaning techniques prior to the Final Design Review.

6.1.3 PROCUREMENT

After final design approval by LIGO, PSI will purchase the remaining system equipment and material. PSI intends to purchase 304L S.S. (plate, flanges and heads) in mill runs to reduce project costs. Due to the future demand for S.S., this purchase will have to be made before the final design approval to maintain the schedule.

CHART 6-1
PROJECT EXECUTION SUMMARY



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6.1.4 FABRICATION

Fabrication of the vacuum system components will be conducted at various PSI and vendor facilities to optimize the utilization of space, equipment and staff expertise. (See Section 13). These complicated vessels will require sophisticated fabrication and stress relief techniques to successfully fabricate the units. PSI will draw on its history of cost effective innovation to design internal/external fabrication jigs and fixture to maintain vessel tolerances. See Volume III for additional fabrication information.

6.1.5 INSTALLATION/COMMISSIONING

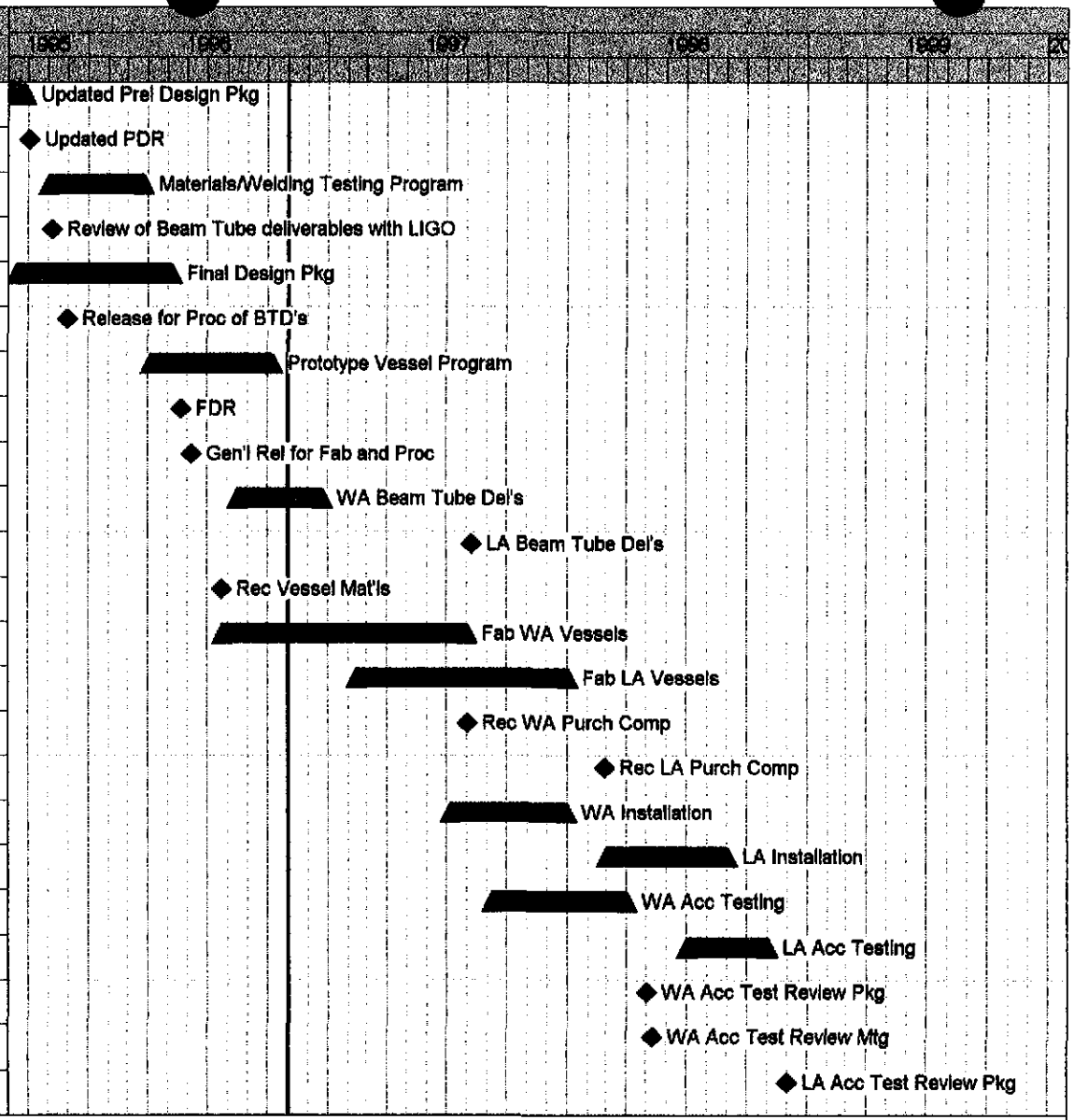
PSI will use local contractors to install the LIGO systems. These contractors will be selected based on precision alignment and clean service experience. A PSI representatives will be present at the site to coordinate activities and interface with LIGO representatives.

The vacuum systems will be tested and commissioned using the control system provided by LIGO. The system components will be commissioned and turned over to LIGO in phases.

See Volume IV for additional installation/commissioning information.

6.2 LIGO SCHEDULE SUMMARY

Act ID	Description	Early Start	Early Finish
1000	Updated Prel Design Pkg	01SEP95 A	27SEP95 A
1010	Updated PDR	03OCT95 A	
1500	Materials/Welding Testing Program	01NOV95 A	25MAR96 A
1600	Review of Beam Tube deliverables with LIGO	07NOV95 A	
2000	Final Design Pkg	12SEP95 A	07MAY96 A
2010	Release for Proc of BTD's	30NOV95 A	
2015	Prototype Vessel Program	05APR96 A	08OCT96 A
2020	FDR	22MAY96 A	
2030	Gen'l Rel for Fab and Proc	07JUN96 A	
3000	WA Beam Tube Del's	16AUG96 A	23DEC96
3010	LA Beam Tube Del's	08AUG97 *	
4000	Rec Vessel Mat'ls	23JUL96 A	
4010	Fab WA Vessels	24JUL96 A	01AUG97
4020	Fab LA Vessels	13FEB97 *	02JAN98
5000	Rec WA Purch Comp	01AUG97 *	
5010	Rec LA Purch Comp	27FEB98 *	
6000	WA Installation	07JUL97	31DEC97 *
6010	LA Installation	02MAR98	01SEP98 *
7000	WA Acc Testing	08SEP97	01APR98 *
7010	LA Acc Testing	02JUL98	02NOV98 *
7020	WA Acc Test Review Pkg	01MAY98 *	
7030	WA Acc Test Review Mtg	11MAY98 *	
7040	LA Acc Test Review Pkg	01DEC98 *	



Process Systems International, Inc.

VACUUM EQUIPMENT SUMMARY SCHEDULE

01NOV96

6.3 Documentation Deliveries

Vacuum equipment deliverables are detailed in Volumes I thru V of this Final Design Report.

6.4 Documentation Format

All documents will be supplied in PSI standard drawing format. LIGO title block information (Customer Document No., etc.) will be added to the PSI title block.

All PSI documents will be numbered per PSI Standard SOP-006-003 "Procedure For Assigning Engineering Documents Numbers".

6.5 Required Approvals

The final design has been submitted and approved by LIGO.

Installation readiness reviews will be conducted prior to the start of installation at each LIGO site.

7.0 PROJECT ADMINISTRATION/TECHNICAL COORDINATION

7.1 Progress Report

PSI will prepare monthly reports documenting the status and action items from the monthly LIGO/PSI progress meetings.

7.2 Project Filing System

Project/Customer correspondence, internal memorandum, vendor correspondence etc., shall be filed by the project secretary in the project file.

All PSI/Customer correspondence will be assigned a sequential number by category and recorded in the project log. Document numbers shall be assigned as follows:

Correspondence (Letter or Fax): from PSI to LIGO — V049-PL-_____

Correspondence (Letter of Fax): from LIGO to PSI — V049-LP-_____

Any correspondence received out of sequence number shall be investigated and resolved.

All PSI/LIGO correspondence shall be sent and received through the PSI project secretary.

7.3 Project Document Control

All project documents (specification, drawings, procedures, etc.) are reviewed, signed-off, issued and archived per PSI SOP-006-012 "Procedure for Release of Controlled Documents" (See Exhibit I).

All project documents, (hard copy and electronic), are issued and archived through the PSI Document Control Department (DCD).

All PSI and customer submittals are also handled through the DCD. PSI submittals to LIGO shall be documented by PSI transmittal notices and logged by the DCD.

All engineering document submittals from LIGO will be logged in by the project secretary and copies internally distributed. The original will be filed in the LIGO project file.

7.4 Document Numbering System

All PSI documents will be numbered per PSI procedure SOP-006-003 "Assigning Engineering Document Numbers".

7.5 Project Chart Of Accounts

Project labor and costs will be monitored and recorded by means of a Project Chart of Accounts. The breakdown will be based on the Project Work Breakdown Structure (WBS) and tracked via PSI's M.I.S. System (EMS).

7.6 Project Needs List

Requests for information between LIGO and PSI shall be monitored and controlled through a project needs list. This system of consolidated information requests ensures timely closure of technical and commercial requests for information. Two separate lists are kept for each organization request.

The items on the needs list are numbered sequentially (LIGO to PSI V049-NL-LP-1, -2, etc., PSI to LIGO V049-NL-PL-1, -2, etc.) and roll-off the list when completed. The needs list is transmitted between LIGO and PSI as required and is part of the monthly progress report.

See enclosed samples.

7.7 Project Reviews

Internal project reviews are held monthly to review project status with PSI upper management.

During the project review, each phase of the project is scrutinized in an effort to understand project status, identify area of risk requiring further action, and to discuss issues critical to successful project execution. Project Q.A. status (in-house audits, non-conforming vendor performance/audits) is also discussed.

The project review meeting is attended by the PSI President, Vice president of Operations, Controller, Manager of Contracts, Project Manager, Engineering Manager, Manufacturing Manger and others as appropriate.

7.8 Project Planning/Execution Review

In-depth project planning and reviews (PPER) are held for all major PSI projects at critical milestones of the project. These meetings are designed to review all aspects of the project with an emphasis on "Looking Forward" strategies and planning on a company wide basis.

The first meeting is held within 30 days of project kickoff and is designed to set the project plans and strategies to achieve project goals and schedules. Other PPER meetings are held at key milestones (prior to release for fabrication, construction, etc.).

The PPER meeting is attended by key project team members, PSI senior management, engineering managers and non-project team PSI staff as required who have applicable experience or expertise to contribute.

Typical PPER meeting topics include:

Contract Review

Top Level Program

Engineering Plan

Procurement Plan

QA/QC

Manufacturing Plan

Construction Plan

Commissioning/Startup

Customer Issues

Risk Management

8.0 CLIENT RESPONSIBILITY

8.1 Project Codes and Standards

Project codes and standards are detailed in the LIGO Vacuum Equipment Specification and subsequent technical direction memorandums as detailed in Section 5.2 of this manual.

8.2 Building Drawings/Facilities

LIGO is responsible for providing building drawings for all site facilities for the Hanford, WA and Livingston, LA site to PSI in a timely manner.

LIGO is also responsible for providing site buildings, utilities, control system and operator interface stations at each site building etc., as agreed to in the contract.

8.3 Laser System Design Input

LIGO is responsible for providing design requirements for the laser system relative to the Vacuum Equipment System design in a timely manner. Internal clearance, support, etc., must be established early in the Phase B schedule to avoid project delays and additional costs.

8.4 Drawing Review/Approval

LIGO document review requirements are detailed in Exhibit II, "Deliverable Documentation, LIGO C950804-00-V01". (See Section 5.2).

8.5 Scope Changes

Timely approval of scope changes are necessary to keep major projects on schedule.

Requirements for scope change approval are detailed in Section 4.0, "Contractual Basis".

9.0 ENGINEERING/DESIGN EXECUTION

9.1 General

The engineering phase of a PSI project is executed per the project CPM schedule under the direction of the Project Technical Director in conjunction with the project manager. The Technical Director is assisted by the Project Design Coordinator in coordinating the actives of the engineering and design departments.

PSI employs a system of control over engineering and design activities by implementing procedures which provide for review and approval of specification, drawings and other engineering documents, as well as revision to these documents prior to issuance for use. Such reviews are conducted to verify completeness and adequacy with respect to contract and design input requirements.

PSI will conduct system design reviews at strategic points during the engineering phase of the program. These reviews are attended by the Project Team and PSI's technical management to objectively review and discuss process design, including process flow diagrams, piping and instrumentation diagrams, equipment sizing, mechanical and structure design, electrical instrumentation and controls. Design review meetings ensure that client specifications and design input requirements are adhered to.

9.2 Engineering Plan

9.2.1 GENERAL

The LIGO Engineering Plan has been developed to ensure that the engineering/design output match the criteria established by the design input requirements, has been developed against known acceptance criteria and conforms to appropriate regulatory and contractual requirements.

The Phase B engineering/design effort of the LIGO project will be executed as shown on the attached SureTrack Critical Path Schedule (See Exhibit II).

The goals of the final design phase are as follows:

- Incorporate LIGO PDR comments and laser system requirements into the Vacuum Equipment Design.

- Update vacuum system component specification to incorporate vendor bid data and laser system requirements and suitable design margin to reduce overall project risk.

- Qualify and execute contracts with equipment suppliers. Vendor proposals are reviewed against the technical and commercial requirements of PSI equipment specifications.

- Develop equipment and installation documentation and procedures in sufficient detail to ensure vacuum system integrity, cleanliness, dimensional requirements and overall system performance are met or exceeded.

- Develop operating procedures & control logic to enable LIGO to develop the central control system software.

- Perform failure mode analysis.

Specifications have been generated by the engineering disciplines for unique major purchased parts or items (compressors, pumps, vessels, valves, heat exchangers, electrical, instruments, controls, etc.). These specifications reflect the requirements of the contract which are to be imposed on all subvendors. Each specification is a binding document and is so stated in the body of the PSI purchase order. Completed specifications are reviewed and signed-off by Engineering, Project Management, Quality Assurance and released via a Design Engineering Order (DEO).

Detailed fabrication drawings for manufacturing have been prepared by the design/drafting group under the direction of the project manager and engineering disciplines. Completed drawings are checked by the Design Department and then reviewed by Engineering, Project Management, Quality Assurance and then released on a DEO.

Procedures for welding, cleaning, painting, etc. (when applicable), have been developed, reviewed and released in the same manner as specifications and drawings.

Design changes after the Final Design Review will be executed using PSI's "Request for Change" procedure. Design changes are submitted to Project Management and Engineering for review and sign-off. When review and sign-offs are complete, the Document Control Department assigns a number to the form for control and filing. If fabrication has been released, a copy of the Request for Change is made and is routed to the Material Control Department. It is attached to the affected drawing or document in the manufacturing area. This constitutes authorization to proceed with the required change. Design changes after the Final Design Review will be submitted to LIGO for approval prior to release.

Critical design calculations prepared by the project team have been independently reviewed within the engineering department by a qualified individual other than the person who performed the original design. The design engineer and the reviewer sign the front cover page of each set of required calculations. These calculations are maintained in the engineering job files.

All documents are issued per PSI SOP-006-012 "Release of Controlled Documents".

The LIGO Engineering Plan has been designed to maximize system performance and minimize overall project risk. To this end, PSI has execute additional engineering/testing/fabrication activities designed to develop necessary engineering data and to validate proposed fabrication and testing techniques. These additional activities include cleaning analysis (XPS), plasma welding test, 10 in. vessel testing and Viton o-ring bakeout testing.

9.2.2 VIBRATION/NOISE/SHOCK PROGRAM

As part of the Phase B engineering effort, PSI has retained a world class vibration/noise/shock consultant (Cambridge Acoustical Consultants, Inc.) to study the source levels from vacuum system equipment. They will then make recommendations for remediation of Vacuum System/Vibration/Noise/Shock content beyond what is included in PSI's first order lump sum proposal. In addition, they will develop computer models to predict resultant vibration/noise/shock levels before and after second order remediation.

This approach is mandated since source levels (in the LIGO system configuration) are not available from the vendors. Without accurate source data, it is impossible to predict resultant vibration/noise/shock levels. The lack of current LIGO building/foundation information also contributes to the current uncertainty.

9.2.3 FIRST ARTICLE FABRICATION

As part of Phase B engineering period, PSI is fabricating a first article BSC to validate proposed material specification/preparation, fabrication and cleaning techniques and sealing system. This approach will provide valuable data and risk reduction for the LIGO Program. The information and techniques developed during this program will be incorporated in the Final Vacuum System Design.

9.2.4 VESSEL/SYSTEM ENGINEERING

During Phase B engineering, vessel design has been optimized to meet laser system and vacuum performance requirements. PSI currently employs state-of-the-art Finite Element Analysis (FEA) methodologies for the analysis and design of the structural components. Combined with the requirements of the governing codes, PSI can offer the most cost effective design which will meet all of the client operational and safety related requirements. Our engineering/design programs also have the ability to interface with the AUTOCAD drafting/detailing system. All of the computer software is maintained and updated annually to meet the changes of the relevant codes.

The overall anchorage and structural support systems has been finalized during Phase B of this project. System Vacuum/ATM loads/bakeout loads/failure mode loads, etc. have been investigated and documented. Results from the analysis have been used to finalize system fabrication and installation drawings. A comprehensive analysis/design package will be presented to LIGO at the FDR meeting.

The site anchor bolt systems were moved to PSI's scope of supply during final contract negotiations. The anchor bolts will be field installed by PSI after the concrete floor has been installed (by others).

9.2.5 SHOP CLEANING/TESTING

During the Phase B Engineering Program shop cleaning and testing procedures have been finalized. Information from the 10 in. vessel program and the first article program will be used to optimize the procedures.

PSI has continued with the surface analysis testing program to confirm the effectiveness of the proposed cleaning procedure.

9.2.6 INSTALLATION/COMMISSIONING

Installation and commissioning plans have been optimized and finalized during Phase B. See Volume IV for additional information.

9.3 Project Control Plan

9.3.1 PLANNING/SCHEDULING

Project plans and schedules are developed by the cost/schedule manager in conjunction with the project team and the project manager.

Plans and schedules of major PSI projects are reviewed on a company wide basis at the PPER meetings (See Section 7.8).

PSI Project scheduling is performed on a computer software package from Primavera Systems called SureTrack Project Scheduler. SureTrack is a comprehensive project control software. It produces critical path schedules and various reports used for resource planning. The schedule is periodically updated by the project manager to show status and current critical path tasks.

Schedule updates will be provided to LIGO the monthly progress meetings.

9.3.2 COST CONTROL

PSI project costs are monitored and controlled by the project manager via the project review financial report. This report is generated form data in the PSI MIS/MRP system 'EMS'.

Labor usage is updated weekly into EMS from timecard data. Project material and expense costs are updated monthly as part of the PSI accounting procedure.

9.3.4 PROJECT ESTIMATES

The original estimate is entered into the project review database after contract award. This base estimate form the benchmark data for measuring project financial status.

As project change orders occur, the change order is estimated and if approved, the project budgets are adjusted to reflect the new project scope.

By keeping the project budget current, project performance can be evaluated with the aid of the SureTrack scheduling % complete data.

9.3.5 TECHNICAL PERFORMANCE MEASUREMENTS

Technical performance shall be measured during the engineering/design portion of Phase 'B' by the following means:

- PSI internal design review
- PSI/LIGO design reviews
- First article fabrication and testing
- Vibration/Noise/Shock modeling of proposed remediation programs

Each of these measures will test or predict the results of the vacuum equipment system operating performance.

9.4 Engineering/Design Interface

The engineering and design department work very closely together during the detailed design phase. In addition to the one-on-one contact between engineers and designers, the technical director and design coordinator provide hands-on participation in the engineering/design process.

Weekly project team meetings are held to establish priorities and information needs and to promote project team communication.

9.5 Applicable PSI Standards, Guidelines, and Software Programs

Applicable PSI standards and guidelines to be used on the LIGO project are detailed in Attachment I.

9.6 Engineering QC Program

PSI engineering managers and Q.A. engineers audit PSI projects periodically to verify that company and project procedures are being followed, that engineering quality is high. Vendor Q.A. programs are also audited and approved.

Reports are filed in the project files of all audit results.

9.7 Engineering Document Review

All engineering/design documentation (spec, drawing, procedures, etc.) are reviewed and signed-off before issue.

9.8 Vendor Drawing Review

Drawings are submitted to PSI for approval by vendors for all major purchased equipment. Vendor drawings are logged in through the Document Control Department (DCD) and circulated to the project team for comments.

After the review cycles, they are returned to the vendor by the DCD with the appropriate approval status (approved, approved as noted, rejected) as determined by the project manager.

All documents not "approved" are revised by the vendor and resubmitted. (See SOP-006-011 "Document Control Department" Exhibit I).

9.9 Engineering/Design Status

The engineering and design effort for the Final Design Review has been completed essentially on schedule. The Washington site is presented in the FDR drawing package. The Louisiana site will be issued after the Final Design approval is received from LIGO and the LA building drawings are issued.

10.0 DESIGN VERIFICATION

10.1 Design Reviews

PSI will conduct system design reviews at strategic points during the engineering phase of the program. These reviews will be attended by the Project Team and PSI Management to objectively review and discuss process design, including process flow diagrams, piping and instrumentation diagrams, equipment sizing, mechanical and structural design, electrical instrumentation and controls. PSI will notify LIGO engineering representatives of all reviews well in advance, enabling their participation. Preliminary failure mode and hazards analysis will be conducted during design reviews. This data will be used to produce the final reports for the Final Design Review package.

10.2 Reliability Reviews

A failure mode and effects analysis (FMEA) will be conducted on the LIGO vacuum equipment system as part of the final design package.

10.3 Safety Reviews

A hazards analysis will be conducted as part of the final design package. Each hazard will be identified and rated for severity.

10.4 Comparative Design Analysis/Testing

During the engineering design phase, comparative design analysis investigations will be conducted to compare predicted LIGO vacuum system performance versus systems and experiments documented in technical papers or actual installation data.

Results from the 10 in. vessel program and the first article testing will be extrapolated to predicted full system performance.

10.5 Outside Consultants

PSI has retained outside consultants to assist PSI in reviewing and validating the LIGO Vacuum Equipment design. The outside consultants are listed in Attachment 5.

10.6 10 Inch Vessel/Viton Testing Status

A 10 in. vessel program was included as part of the Final Design Phase. This program we conducted to verify plasma welding, o-ring design, cleaning procedures and cleanroom operation. Various 10 inch vessels were fabricated, heat treated, cleaned; baked and pumped to ultimate vacuum levels.

Viton bakeout testing was also conducted as part of the 10 inch vessel program. This testing was designed to verify the proper heat/time cycle to condition the viton o-rings for UHV service.

Various cleaning protocols were investigated during the 10 inch vessel program to verify the most effective cleaning system.

Results of the 10 inch vessel testing program will be presented at the FDR and are contained in Volume II.

10.7 Prototype BSC Program Status

As part of the Final Design Phase, a full size BSC vessel is being built and tested.

Originally, the prototype BSC was scheduled to be mechanically complete before the Final Design Review meeting. The revised schedule now has the prototype being mechanically complete by the end of June. This delay was caused by late material delivery (winter flood at steel mill) and delays in placing the order with the fabricator. The prototype testing scope was also increased to include testing an 80K pump shroud in the BSC vessel.

In spite of the mechanical assembly delay, the prototype BSC will be mechanically complete before the main BSC production lot is released for fabrication.

Performance testing of prototype should be complete by mid August 1996.

11.0 CONFIGURATION MANAGEMENT

11.1 General

All PSI manufacturing and site construction is performed as shown on signed off and released engineering documents. All proposed changes are reviewed against contractual requirements and PSI design goal requirements prior to implementation.

The vacuum system design is proven via the equipment acceptance test conducted at each site. Critical equipment are also tested at the vendor's factory prior to shipment.

PSI project documentation is issued and controlled via PSI SOP-006-012 "Release of Controlled Documents".

PSI fabrication components are controlled via product structure documentation in PSI's MRP System "EMS". Product structure is controlled per PSI procedure SOP-006-002 "Drawing Tree/BOM Structure".

11.2 In-House Design Change Control

All PSI in-house design changes after the Final Design approval by LIGO will be requested and executed per PSI procedure SOP-006-001 "Requests for Change". Changes after FDR approval will be reviewed with LIGO per Section 2.0 of this volume.

11.3 Contract Change Of Scope

All changes of scope to the Vacuum Equipment project not covered by the existing contract shall be submitted to the PSI contracts department for acceptance.

Once accepted, the Change of Scope shall be implemented by the project manager via the normal design change control procedure (See Section 11.2).

12.0 PROCUREMENT

12.1 Procurement Plan

PSI utilizes a strict program for planning and executing procurement activities in accordance with documented instructions and procedures. Vendors are selected based on their ability to meet PSI technical and commercial requirements and their prior experience supplying like or similar equipment or services. Prior to purchase order placement, a material requisition is prepared by the responsible engineer. The requisition is routed to the Project Manager and Quality Assurance Department for review and signature prior to going to the Purchasing Department for processing. The purchasing agent prepares the purchase order and places the order with a vendor or subcontractor.

Changes to a purchase order are handled in the same manner as the original purchase order. Copies of purchase order and change order are routed to the Inspection and Quality Assurance Departments.

The program also provides for the verification of purchased items to procurement documentation requirements by receipt inspection.

During the LIGO Project, extensive vendor interface and surveillance is planned. Major purchased items will be monitored via vendor kickoff meetings, in progress inspections and witnessed testing as appropriate to ensure equipment quality.

The procurement time table for the LIGO Project is detailed in the project schedule. (See Attachment 2).

12.2 Expediting

All major contract purchase orders are monitored and expedited by the project management team and the purchasing department. Periodic vendor interface (and plant visits as required) is used to monitor production status. Vendor progress payments and penalties will be structured to encourage on-time deliveries.

12.3 Inspection/Testing

Major equipment deliveries will be inspected (and tested as appropriate) at the vendor's factory before shipment.

Material and equipment for LIGO project received at PSI will be inspected before release to the manufacturing department or to subvendors.

12.4 Vendor Drawing Control

Vendor drawings will be controlled per PSI procedure SOP-006-011 (also see Section 9.8).

12.5 Transportation Coordination

Transportation of LIGO raw materials and equipment will be coordinated by the Project Manager and the PSI Transportation Department.

This aspect of the project is viewed as critical to the installation phase where site storage may be limited.

12.6 Procurement Status

The Beam Tube deliverables (roughing pumps, turbo pumps and gate valves) have been ordered and are on schedule for an August 1996 delivery to the WA site.

The following purchase orders have been placed:

- Bakeout Blankets (1)
- Cleanroom Air Supply system
- Ion Pumps
- 6, 10 and 14 Inch Gate Valves
- Prototype BSC
- Water Chillers
- Vessel Heads
- Vessel Flanges
- Vessel Plate

13.0 FABRICATION

13.1 Fabrication Plan

The LIGO Vacuum Equipment System will be fabricated per FDR Volume III "Fabrication".

13.2 Fabrication Status

Detailed manufacturing planning has been conducted during Phase B.

The fabrication plan has been scheduled to support the intended site installation schedule.

PSI plans to have outside fabricators build the BSC and the HAM vessels. This will allow PSI to concentrate on the UHV cleaning and testing and the various small spools and cryopumps.

14.0 PROJECT QUALITY ASSURANCE PROGRAM

14.1 Q.A. Organization

The quality assurance organization is headed the PSI Quality Assurance Manager, with a staff of Quality Assurance Engineers/Inspectors. The Receiving Inspection Department is made up of full-time inspectors also reporting to the QA Manager. The QA Manager has the authority and is responsible for implementing of the quality program. In addition, he provides policy administrative guidance to the QA and Inspection Departments.

A lead Q.A. engineer will be assigned to the project for the life of the project. Other engineers and inspectors will be utilized as required.

14.2 Project Q.A. Plan

The LIGO Q.A. plan is detailed in V049-2-029. (See Attachment 4).

14.3 Supplier Q.A.

Suppliers of LIGO equipment and materials will be monitored for quality and technical performance by a combination of engineering and quality assurance personnel. For major equipment purchases, vendor kickout meetings, in progress reviews and witnessed performance testing will be conducted.

14.4 Training/Qualification Program

The Q.A. department will monitor that all personnel performing special skill tasks (tig welding, leak checks) on the LIGO project have been trained and qualified to perform their assigned duties.

15.0 INSTALLATION

15.1 Installation Plan

The LIGO Vacuum Equipment system will be installed per FDR Volume IV "Installation".

15.2 Installation Status

Installation for the WA site is still being planned to start in August of 1997. PSI will be bidding the installation work for WA in August/September of 1996. The LA site installation is planned to start in March of 1998. PSI will be bidding the installation work for LA in mid 1997.

16.0 PRE-OPERATIONAL TESTING

Detailed procedures have been developed during the detailed design Phase B of the LIGO project. These procedures will cover alignment, leak testing, cleanliness testing, valve and pumping operations, etc.

Pre-operational testing will be performed as detailed in FDR Volume IV "Installation".

17.0 SYSTEM COMMISSIONING/ACCEPTANCE

Detailed test procedures have been developed during Phase B covering system commissioning and acceptance testing.

System commissioning and acceptance testing will be performed as detailed in FDR Volume IV "Installation".

18.0 PROJECT TURNOVER

After project award detail plans will be developed for system turnover to LIGO.

Vacuum Equipment turnover to LIGO will be accomplished in phases as detailed in FDR Volume IV "Installation".

19.0 PROJECT CLOSEOUT

19.1 Documentation Transfer to LIGO

After each site is accepted, PSI will update the installation drawings to reflect an as built condition and transfer hardcopy and electronic files (Autocad drawings) to LIGO.

Final document packages are detailed in the project Q.A. plan V049-2-029.

19.2 PSI Documentation Archiving

After the project is complete and the systems accepted, PSI document control will transmit documententation (hard copy and electronic files) required by the contract to LIGO and will archive the electronic files to backup tapes for storage in a fireproof safe. Hard copies will be moved from the active files to the document warehouse. If LIGO needs an additional copy of a document, they may request it from PSI's Document Control Department.

19.3 Final Project Report

The project manager shall prepare an internal final project closeout report per PSI standard procedure.

ATTACHMENTS

I. Applicable Company/Department Procedures, Guidelines and Computer Program Listing

SOP-006-001	Requests For Change
SOP-006-002	Drawing Tree/BOM Structure
SOP-006-011	Document Control Department
SOP-006-012	Release of Controlled Documents

II.. Detailed Project Schedule

III. Work Breakdown Structure

IV. Project Q.A. Plan V049-2-029, Rev. 1

V. Project Safety Plan V049-2-023, Rev. 1

VI. Outside Consultants

VII. Commercial Requirement

V049-2-034 Equipment Purchase Commercial Requirements Rev. 0

V049-2-170 Equipment Installation Commercial Requirements Rev. 0

ATTACHMENT 1

APPLICABLE COMPANY/DEPARTMENT PROCEDURES AND GUIDELINES

PROCESS SYSTEMS INTERNATIONAL, INC.

WESTBOROUGH, MA.

DEPARTMENT PROCEDURE

FOR

REQUEST FOR CHANGE NOTICES

(RFC)

PROCESS SYSTEMS INTERNATIONAL – WESTBOROUGH, MA

REV	DATE	DESCRIPTION
0	9/14/93	RELEASE FOR USE

CERTIFIED FOR ISSUE

BY PRA DEPART.MGR. REB V.P. REB

NO. SOP-006-001

SHEET 1 OF 6

DATE 9/14/93

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this procedure is to define the method for processing a Request for Change (RFC) Notice and to identify the responsibilities of the persons or functions involved.

2.0 GENERAL

Due consideration to all change requests and proper closure thereof are essential routines to optimize product quality and costs as well as to empower all persons associated with that part, process or procedure to contribute to its improvement.

This procedure defines a flexible means of obtaining data necessary to evaluate change requests and implement revisions in an organized and timely fashion while allowing tracking of the process.

The RFC process is required for all drawings and documents that have been released on a Design Engineering Order (DEO) for "design", "fabrication", "construction" or "equipment purchase". The only exception to this is that a Project/Program Manager (PM) may revise and release the drawing or document directly from engineering design input thereby negating the need for an RFC. This type of change is documented by the normal DEO process.

An RFC form signed by the PM may be used to stop work.

The RFC review cycle must be the same (same sign-offs) as for the original document release.

Open RFC's (not signed off) are tracked by the document control database and reports are issued monthly.

RFC numbers for custom projects will start with 001 for each project. RFC numbers for the standard product group will use the 7014-XXXX series.

Please note that while the following generally defines changes to Engineering documents, this procedure may be applied to procedures outside the normal realm of Engineering.

Definitions

2.1 Request for Change Form (RFC) is that document that formally proposes a change and allows for analysis of related cost, effectivity and schedule impact.

2.2 Project/Product Manager (PM) refers to either that manager or his appointed designate.

2.3 Design Engineering Order (DEO) is the procedure by which drawings and specifications are formally entered into a documentation package.

2.4 Document Control Department (DCD) refers to the PSI department that issues and stores engineering/design documents

3.0 RESPONSIBILITY

3.1 Any person recognizing a defect in a drawing or document is responsible for initiating a Request for Change.

3.2 Responsibility for various steps of the process shifts during the RFC review cycle. All people in the review cycle are responsible for timely review and forwarding of the RFC. For urgent RFC's the initiator or a person designated by the project manager shall walk the RFC through the review cycle.

3.3 Responsibility for revising this procedure rests with the Vice President of Engineering.

4.0 PROCEDURE

Area numbers of Exhibit "A" are referred to in the following:

4.1 The Initiator supplies information in Areas 1 and 2. This information should be as complete as possible and may be provided in cooperation with a supervisor, manufacturing engineer or other appropriate person. Marked prints or hand sketches may be added to the RFC as needed.

Upon completing a review with the manufacturing department supervisor, lead engineer or designer, the initiator, or supervisor, forwards the RFC to DCD. At this point, the initiator's responsibility has been fulfilled; however, he may be asked for clarification at a later time.

4.2 DCD assigns an RFC number, enters the description in the RFC log (Exhibit "C")/database and retains a file copy of the RFC.

DCD forwards the RFC to the appropriate (PM) and also sends a copy to the initiator.

4.3 The PM reviews the RFC and decides whether or not to proceed with the RFC.

4.3.1 If the decision is not to proceed, the PM states the reason and returns the document to DCD.

DCD closes out the log and sends a copy of the RFC to the PM and the initiator.

4.3.2 If the decision is to proceed, the PM may add sheet 2 of the RFC (Exhibit "B") and assigns distribution to those Disciplines that are impacted by the change (Area "5") for comments and requested data.

"Urgent" written in Area "6" requests immediate attention by those parties commenting. Urgent RFC's shall be walked through the review cycle.

Under normal conditions, the RFC will be processed by each party within 24 hours of receipt and forwarded through the distribution.

Within the affected departments, the designated persons will evaluate the change and respond in the appropriate area ("8" through "12") and sign (Area "14").

When the ASME Code applies, the AI (Authorized Quality Assurance Inspector) will sign off on the RFC and the revised drawing.

4.4 The RFC is then returned to the PM for cost analysis (Area "13"), product considerations and final approval or disapproval.

4.4.1 If the RFC is not approved, the PM states the reason and returns the RFC form to DCD.

DCD closes out the log and sends a copy of the RFC to the PM and the initiator.

4.4.2 If the RFC is approved, the PM determines the disposition in Area "4" and returns the RFC to DCD for distribution and filing.

4.5 DCD updates the RFC Log/Databases and hand-writes on the original drawings as follows: "An Approved RFC (#____) is pending".

4.5.1 The DCD distributes copies of the approved RFC to concerned parties. This constitutes authorization for the shop and vendors to deviate from current specification or drawing configuration. A RFC issued for immediate action shall be updated by the design group and issued via the DEO procedure.

4.5.2 If a drawing change is to be delayed, the PM determines when the change will be scheduled and notifies DCD. DCD notes the scheduled change in the RFC log.

4.6 Upon issue of the drawing or document, DCD notes the DEO number in the RFC log and notifies the initiator of the action.

5.0 FLOW CHART

RFC Procedure Flow Chart dated 5/22/93 is attached.

6.0 REFERENCES

None.

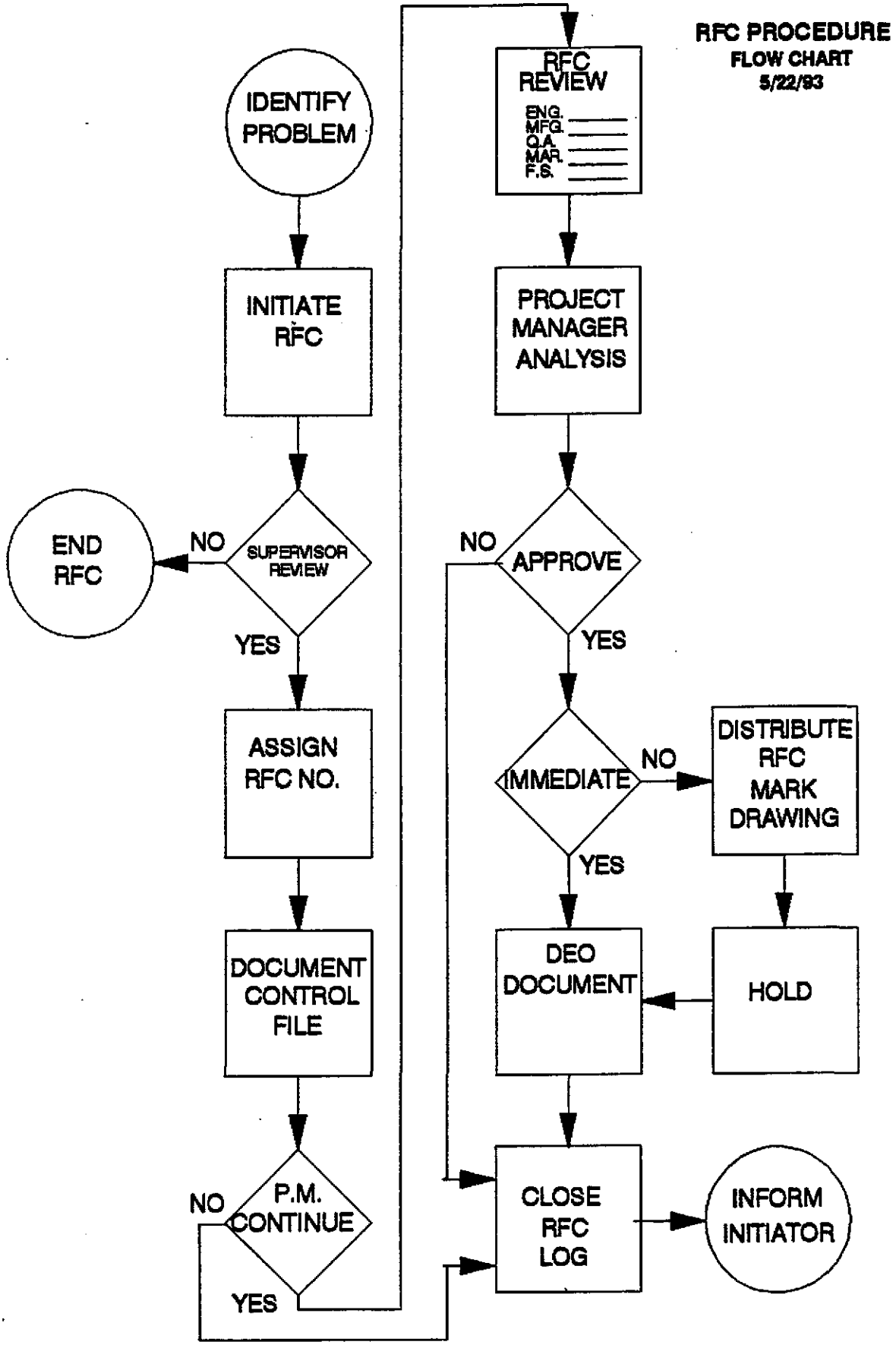
7.0 EXHIBITS

A. RFC Form, Sheet 1

B. RFC Form, Sheet 2

C. RFC Log, Blank

RFC PROCEDURE
FLOW CHART
5/22/93



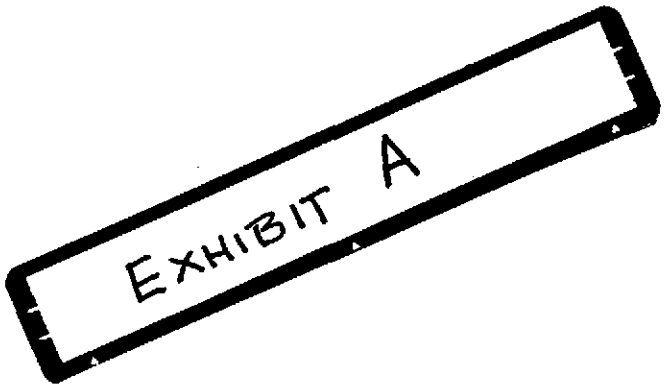
PROCESS SYSTEMS INTERNATIONAL, INC. 20 Walkup Drive, Westborough, Mass 01581

Name of component affected: (1) **Project:** (6)

Drawing Number: **Prepared By:** **Date:**

Detailed description of change and reason for making same:

(2)



DISPOSITION - PROJECT MANAGER	DISTRIBUTION
_____ IMMEDIATE DRAWING CHANGE (4) _____ HOLD FOR AS BUILT CHANGE _____ HOLD FOR ACCUMULATION CHANGE _____ NOT APPROVED (STATE REASON) BY: Date:	___QA Date ___Mfg. Date ___Elec. Date ___Stress Date ___Mech Date ___Process Date ___Project Date (5)
AI/ANI: (3) DATE:	REQUEST FOR CHANGE DATE: RFC NUMBER: (7)

ALL SECTIONS MUST BE COMPLETED OR MARKED N/A (NOT APPLICABLE)

(8) A. ENGINEERING/DRAFTING

- ☐ Revisions to existing drawings and parts lists. (Estimated cost $_____)
- ☐ New drawings and parts list required. (Estimated cost $_____)
- ☐ Spare parts/Parts List changes.
- ☐ BILL OF MATERIAL CHANGES
- ☐ Specifications and/or Procedure changes.
- ☐ Packing or Kit List changes.
- ☐ Publications changes. (Est. cost $_____)
- ☐ Change will prevent free interchangeability of parts. If "yes", explain.

Engineering time for RFC evaluation. (Estimated cost $_____)

TOTAL ENGINEERING, DRAFTING AND PUBLICATIONS ESTIMATED COST $_____

(9) B. MANUFACTURING EFFECTS

Cost changes: ☐ None ☐ Increase: $_____/Unit ☐ Decrease: $_____/Unit

Stock disposition:

	Use	*Rework	Scrap	Other	Must Conform To Change
Parts in process					
Stock and spares					
Parts on units in process					

*Estimated rework/retrofit costs. $_____

Costs for new ☐ or reworked ☐ jigs and fixtures as a result of this change. $_____

(10) C. MATERIALS STATUS/EFFECTS

Quantity of unchanged parts presently in stock. _____

Change can be scheduled to become effective on Lot No. _____ or unit serial _____ or customer _____ or other _____ if DEO is issued by _____

(11) D. MKTG/SALES/ORDER PROCESSING EFFECTS

☐ Repricing/Recosting may be required ☐ Sales/Mktg. Product or Ident. changes

(12) E. FIELD SERVICE EFFECTS

- ☐ Field Service familiarity with change mandatory because of possible future service problems.
- ☐ Rework/retrofit all field systems. (Estimated cost $_____)
- ☐ Rework/retrofit only following systems: _____ (Estimated cost $_____)
- ☐ No action.

(13) F. COST vs SAVINGS SUMMARY

Initial Costs:
- Engineering $_____
- Rework (Internal) $_____
- Rework (Field) $_____
- Jigs & Fixtures $_____
- Total $_____

Mfg. Savings or Cost:
- Per unit $_____
- Annual usage _____ units
- Annual total
  - Cost $_____
  - Saving $_____

RFC No. [redacted]

Use this space for added comments or notes.

EXHIBIT B

(1)

(14)

Appr.	Disappr.		Date
☐	☐	Engineering _____	_____
☐	☐	Engineering _____	_____
☐	☐	Mfg. Engineering _____	_____
☐	☐	Qual. Assurance _____	_____
☐	☐	PROJ./PROD. MGR. _____	_____

JOB NUMBER

DEO NUMBER/DATE

SHEET 2 OF _

RFC LOG SHEET

RFC NUMBER	PROJECT	DWG. NO.	DESCRIPTION	INITIATED BY.	DATE	PRESENT STATUS	DEO# OR REJEC.

EXHIBIT 'C'

PROCESS SYSTEMS INTERNATIONAL, INC.

WESTBOROUGH, MA.

DEPARTMENT PROCEDURE

FOR

DRAWING TREE / BILL OF MATERIAL STRUCTURES

PROCESS SYSTEMS INTERNATIONAL – WESTBOROUGH, MA

REV	DATE	DESCRIPTION
0	3-4-94	RELEASE FOR USE DEO # 006-002

CERTIFIED FOR ISSUE

BY D. Austin DEPART.MGR. R. Bagley V.P.

NO.	SOP- 006-002
SHEET	1 OF
DATE	

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1.0 PURPOSE

The purpose of this procedure is to define a uniform method of developing a drawing tree/bill of material structure to be used on PSI projects.

2.0 GENERAL

The drawing tree establishes a bill of material structure for a project and must be created at the beginning of the project. The structure of the tree should define the separation of the job into major components for PSI engineering/design, manufacturing (by packing lists for shipping), purchasing and field installation. This procedure is to be used to organize the project components into a structure of drawings and bills of material which will be entered into PSI's EMS (MRP II) Computer System. For "engineering only" type projects, formal drawing trees are only required when directed by the Project Manager.

The structure should satisfy the needs for design sequence, drawing numbers, bills of material, material control, manufacturing planning, scheduling, fabrication, shipping, field installation, commissioning, and startup. All data in the tree should be complete enough to satisfy the needs of every internal customer in the company. One of the most important uses of the structure is for proper project planning and should include all items to be scheduled by manufacturing or purchasing.

2.1 Effective Management Systems (EMS) - PSI's MRP II software system which contains numerous application packages which manage the bill of material, inventory, planning, purchasing, manufacturing, etc.

2.2 Bill of Material (BOM) - PSI's system of defining, listing, and controlling the product structure of parts which are entered into EMS. The bills must be maintained on-line in the computer to allow all users to share the same bill.

3.0 RESPONSIBILITIES

3.1 The Project Manager is responsible for convening a meeting with engineering, design, manufacturing, engineering, and material control, for the purpose of organizing the drawing tree. The drawing tree is a living document and can be added to during the project. It is critical that the trunk and major branches are defined properly at the beginning of the project and are not changed.

3.2 The Mechanical Design Department will be responsible for maintaining a master copy of the drawing tree, and updating it as required by the project manager. A formal internal issue should be made using the design engineering order (DEO) process.

4.0 PROCEDURE

The customers purchase order and the project scope report creates a demand to produce a product in the EMS system (entered by the manufacturing-scheduling department). The project manager must provide the planned ship date to manufacturing. The product drawing tree/BOM structure is developed from the scope of supply for each project. It should be noted here that the tree structure is project/product dependent.

4.1 Drawing Tree Meeting

The project manager is to convene a meeting during the early phase of the project execution and establish the separation of upper level assemblies, and subassemblies to be manufactured or purchased by PSI, i.e. skid 100, skid 200, spare parts, field parts, etc. The drawing numbering system and chart of accounts for each engineering/design/drafting discipline can be established to coincide with the component numbering, i.e. skid 100, skid 200, spare parts, field parts, etc. This should be done for each skid or unique assembly manufactured or purchased by PSI. The drawing tree structure and the bill of material structure are to be identical structures.

A key item to keep in mind, is to plan and design the structure by the way the end products are built (and shipped) and not how they are designed and drafted.

4.2 Document/Drawing Numbering Procedure

Drawing trees should be numbered in the "O" document class code system.

See PSI Procedure for Assigning and Maintaining Engineering/Design Document Numbers - SOP-006-003.

4.3 Parent - Component Relationship See Exhibit "A"

The tree is developed from the top down.

The parent and component relationship needs to be identified in the tree. A parent can be an assembly (finished product), subassembly or any other created/fabricated/produced or manufactured product. A parent item is always made up of one or more component items.

4.4 Pre-Purchased Items - *Major purchased components items with long delivery or special materials*

There are two (2) methods of getting parts on order which can be used by the project manager. Before deciding what method should be used, discuss the types of materials with manufacturing.

The items can be purchased as either advanced ordered parts and not directly linked to the project in EMS, or they can be linked to a project via a BOM structure entered into EMS.

4.4.1 Advance Ordered Items Linked to a Project Bill of Material

For special items unique to one project, the preferred method is to link ordered parts to a job. This method requires a BOM structure entered into EMS and developed down to the level where the equipment or components are identified as parts. The basic drawing tree, as developed for the project, will provide the structure of parent/component relationships for this purpose. This method will establish the project and part

demands in EMS for MRP purposes. They must also be defined in the item master database. They are to be given a custom part number (either job number and P&ID tag number or special "M" or "E" number).

4.4.1.1 Advance Ordered Items on a Temporary BOM

Advance ordered parts can be put on a temporary BOM which can easily be unlinked (*not* deleted) from the parent when the pre-ordered parts are re-assigned to real detail drawing BOM's. This method will reduce the work required to unlink the parts from the advance BOM and re-assign them to the real BOM's. When this procedure is used, the temporary BOM No. should be shown on the drawing tree. Use Job No. and Bulk 1, or Bulk 2, etc., if more than one temporary BOM is needed.

For additional information on using this method and when the re-linking process should take place, see PSI procedure for loading bills of material, SOP-006-007.

NOTE: When pre-purchased parts are entered on a drawing BOM use exactly the same characters as used in the original EMS entry, including any dashes, spaces, etc.

4.4.2 Advance Ordered Items Not Linked to a Project in EMS

Normally common items or special materials which could be used on more than one project are purchased to inventory. All items to be pre-purchased from a purchase requisition (without a DEO) or a specification need to have an item master created for the parts in EMS before the request goes to purchasing to buy. Purchasing buys the parts and updates EMS when the parts are purchased. These items will show as extra items in EMS until the demand is entered in a BOM. Pre-purchased items are initially entered in EMS at $0.0 cost. They are to be given a SCS (6 digit) standard part number or a custom part number. NOTE: When pre-purchased parts are entered on a drawing BOM use exactly the same characters as used in the original EMS entry (if the exact part number is <u>not</u> used, extra parts will be ordered).

4.5 <u>Level O</u>

The top level parent item for each job is the project number. It will always be a quantity of one. When this number is called up in EMS the complete listing of groups of packing lists, assemblies and their subassemblies, linked to the parent can be obtained from EMS. The computer can output the drawing tree in indented form.

4.5.1 Other Items Sent to Client or Site

Packing lists or shipping orders for other equipment, parts, etc., which are purchased from vendors and shipped directly to the client, are also shown in a separate branch of the tree. When these items are shown, they provide a means for planning when the transmittals will be made. These items link to the Level 0 parent.

4.6 Level 1 - Packing Lists - *Required for each unique skid or major assembly shipped as a unit*

4.6.1 Items Manufactured by PSI

The packing list is the parent item for each major Product/assembly (i.e. skid) manufactured by PSI and includes all items shipped loose from PSI to the client. This list should include installation interface drawings, valves, valve actuators (if removed for shipping), piping, mounting hardware, etc. (All items to be shipped with the system)

4.6.2 Skid Numbering/Drawing Numbering

(Refer to Document Numbering Procedure SOP-006-003, item 4.1.3)

For custom projects, normally each major skid assembly will be given a 100 series name and the drawing package for the skid will have the same 100 series number. Included in the last three (3) sequential numbers. For example: The packing list for skid 100 = PT077-1-100. The general assembly drawing for skid 100 = T077-5-100.

4.7 Level 2 - General Assembly Drawings

This is the general assembly drawing which is the parent of all the subassembly drawings for a final product or skid.

4.8 Level 3 - Discipline Assemblies

This is the top assembly drawing of each design discipline, i.e. electrical, mechanical/piping, structural, etc. The drawing number normally indicates the discipline and skid number.

4.9 Level 4 - Component Items or Sub-assemblies of Level 3 Assemblies

These items can also be used to group various sub-assemblies into one shop work order. For example: All the piping isometric piping drawings used on a skid are linked to an imaginary item called the piping spool assembly.

The use of additional BOM levels to aid manufacturing in the reduction of work orders should be determined during the development of the drawing tree.

4.10 Level 5 - Components/Parts of Level 4 Items as Required

Additional levels may be used, if required.

4.11 Parts shall be defined and numbered per PSI procedure for numbering parts SOP-740-006 (formerly S-100/S-200).

4.12 Drawings Used as Parts

All drawings in the project are considered parts or assemblies of parts and loaded into EMS with the drawing number as the part number.

The assembly drawing should be the last item in each BOM so that it is issued to the shop with the BOM kit. The revision number should also be shown.

NOTE: It is extremely important that all parts are entered into EMS via a BOM which links to a drawing. This includes all nuts and bolts, paint, insulation, etc. All parts are to be linked to the drawing which is used to install the parts in an assembly. For additional information and examples, see PSI Part Numbering Procedure SOP-006-006 (formerly STD. S-200).

4.13 Specifications Used as Parts

Specifications are only listed in the drawing tree as parts when the specification number is the part number being purchased (no tag numbers). When items have tag numbers (example: T077-FT101), the tag number becomes the part number and the specification number is shown in the part description for reference.

4.14 Manufacturing's Influence in the Tree Structure

Manufacturing should identify the following during the tree development and continue to review the structure during the design phase:

A) All components which will not be manufactured by PSI.

B) Determine what the assembly process will be for each major assembly and subassemblies.

C) Determine a plan of how the structure will be separated into shop orders and how that may affect the tree structure.

D) For advance ordered parts, determine whether they should be purchased to inventory or linked to a project.

4.15 Number of Levels

The structure should contain as few levels as possible.

4.16 Parts Manufactured Outside PSI

Parts that are to be manufactured outside PSI are to be detailed on separate drawings. This will help avoid any misunderstanding by the vendor or PSI manufacturing. Parts manufactured outside PSI do not need detailed BOM.

4.17 Drawing Title Blocks

The drawing tree should show the appropriate format to be used consistently on all the drawings used on the project. On custom projects the title will normally be shown as follows:

Drawing Name
Skid Designation or Unit Name
Client/Project Name
Site or Client Location

4.18 Drawing Tree Reference Documentation

The following items should be shown in the reference documentation branch of the drawing tree:

P&ID's
Shop Job Book
Engineering Lists (valve, instrument line)

4.19 Project Document List

A complete project document list of all issued documents is available from the Document Control Department. Only manufacturing or procurement documents are shown in a project drawing tree.

5.0 FLOW CHART: (see next page)

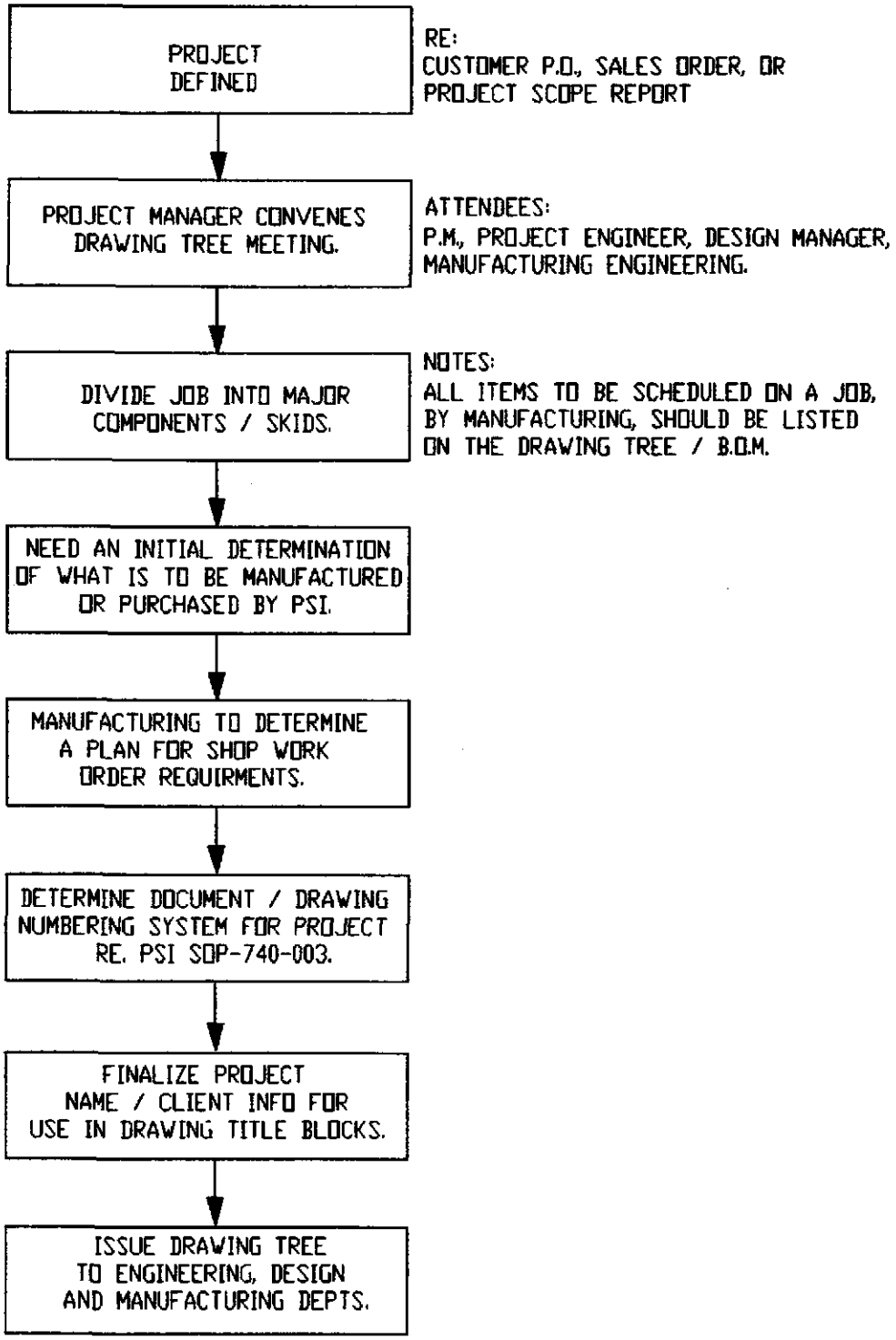
6.0 REFERENCES:

Procedure for Numbering Parts SOP-006-006 (formerly S-100/S-200).

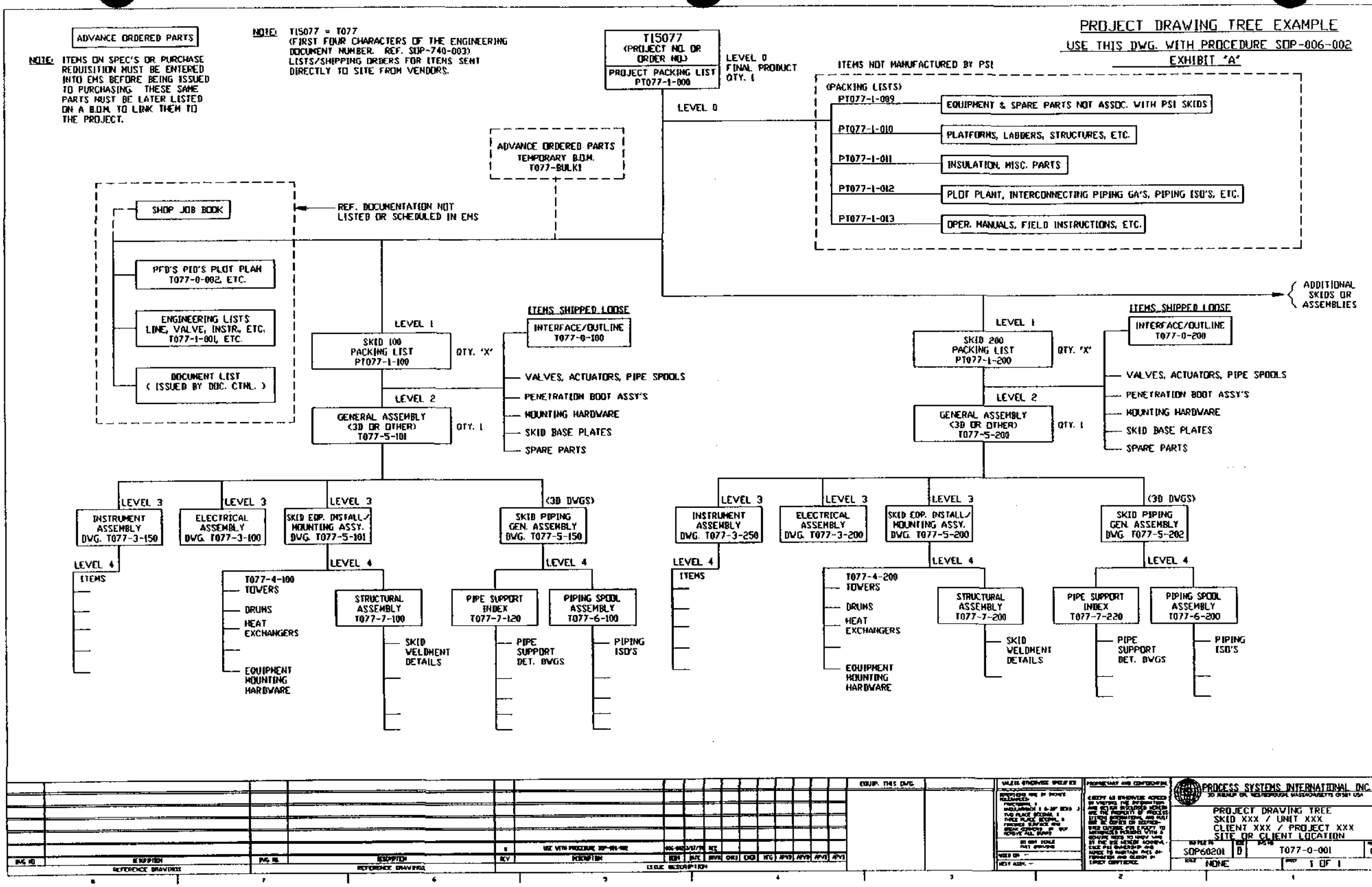
Procedure for Loading Bills of Material SOP-006-007 (formerly STD. S-200).

Procedure for Assigning Engineering/Design Document Numbers SOP-006-003.

5.0 FLOW CHART
PSI DRAWING TREE / B.O.M. STRUCTURE PROCESS

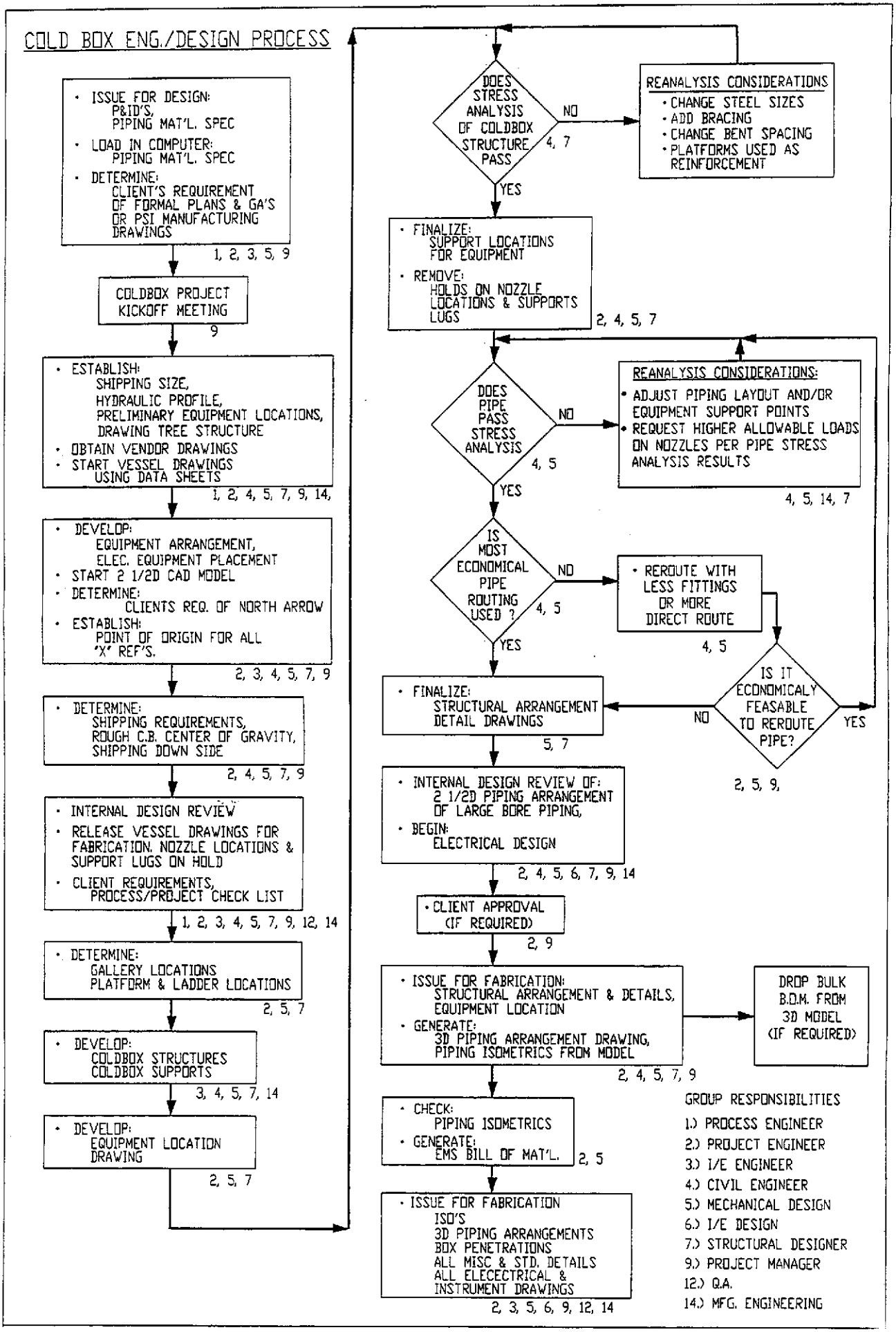


CAD FILE:SOP60202



PROJECT DRAWING TREE EXAMPLE
USE THIS DWG. WITH PROCEDURE SOP-006-002
EXHIBIT "A"
ADVANCE ORDERED PARTS
NOTE: ITEMS ON SPEC'S OR PURCHASE REQUISITION MUST BE ENTERED INTO EMS BEFORE BEING ISSUED TO PURCHASING. THESE SAME PARTS MUST BE LATER LISTED ON A B.O.M. TO LINK THEM TO THE PROJECT.
NOTE: T15077 = T077 (FIRST FOUR CHARACTERS OF THE ENGINEERING DOCUMENT NUMBER. REF. SOP-740-003) LISTS/SHIPPING ORDERS FOR ITEMS SENT DIRECTLY TO SITE FROM VENDORS.
T15077 (PROJECT NO. OR ORDER NO.)
PROJECT PACKING LIST PT077-1-000
LEVEL 0 FINAL PRODUCT QTY. 1
LEVEL 0
ITEMS NOT MANUFACTURED BY PSI
(PACKING LISTS)
PT077-1-009
EQUIPMENT & SPARE PARTS NOT ASSOC. WITH PSI SKIDS
PT077-1-010
PLATFORMS, LADDERS, STRUCTURES, ETC.
PT077-1-011
INSULATION, MISC. PARTS
PT077-1-012
PLOT PLANT, INTERCONNECTING PIPING GA'S, PIPING ISO'S, ETC.
PT077-1-013
OPER. MANUALS, FIELD INSTRUCTIONS, ETC.
ADVANCE ORDERED PARTS TEMPORARY B.O.M. T077-BULK1
SHOP JOB BOOK
REF. DOCUMENTATION NOT LISTED OR SCHEDULED IN EMS
PFD'S PID'S PLOT PLAN T077-0-002, ETC.
ENGINEERING LISTS LINE, VALVE, INSTR, ETC. T077-1-001, ETC.
DOCUMENT LIST (ISSUED BY DOC. CTNL.)
ADDITIONAL SKIDS OR ASSEMBLIES
LEVEL 1
SKID 100 PACKING LIST PT077-1-100
QTY. "X"
ITEMS SHIPPED LOOSE
INTERFACE/OUTLINE T077-0-100
VALVES, ACTUATORS, PIPE SPOOLS
PENETRATION BOOT ASSY'S
MOUNTING HARDWARE
SKID BASE PLATES
SPARE PARTS
LEVEL 2
GENERAL ASSEMBLY (3D OR OTHER) T077-5-101
QTY. 1
LEVEL 3
INSTRUMENT ASSEMBLY DWG. T077-3-150
ELECTRICAL ASSEMBLY DWG. T077-3-100
SKID EQP. INSTALL/ MOUNTING ASSY. DWG. T077-5-101
(3D DWGS)
SKID PIPING GEN. ASSEMBLY DWG. T077-5-150
LEVEL 4
ITEMS
T077-4-100
TOWERS
DRUMS
HEAT EXCHANGERS
EQUIPMENT MOUNTING HARDWARE
STRUCTURAL ASSEMBLY T077-7-100
SKID WELDMENT DETAILS
PIPE SUPPORT INDEX T077-7-120
PIPE SUPPORT DET. DWGS
PIPING SPOOL ASSEMBLY T077-6-100
PIPING ISO'S
SKID 200 PACKING LIST PT077-1-200
INTERFACE/OUTLINE T077-0-200
GENERAL ASSEMBLY (3D OR OTHER) T077-5-200
INSTRUMENT ASSEMBLY DWG. T077-3-250
ELECTRICAL ASSEMBLY DWG. T077-3-200
SKID EQP. INSTALL/ MOUNTING ASSY. DWG. T077-5-200
SKID PIPING GEN. ASSEMBLY DWG. T077-5-202
T077-4-200
STRUCTURAL ASSEMBLY T077-7-200
PIPE SUPPORT INDEX T077-7-220
PIPING SPOOL ASSEMBLY T077-6-200
PROCESS SYSTEMS INTERNATIONAL INC.
PROJECT DRAWING TREE
SKID XXX / UNIT XXX
CLIENT XXX / PROJECT XXX
SITE OR CLIENT LOCATION
SDP60201
D
T077-0-001
0
NONE
1 OF 1
REFERENCE DRAWINGS
ISSUE DESCRIPTION

COLD BOX ENG./DESIGN PROCESS



Jan 25, 1995 - 08:18:09

PROCESS SYSTEMS INTERNATIONAL, INC.

WESTBOROUGH, MA.

DEPARTMENT PROCEDURE

FOR

THE DOCUMENT CONTROL DEPARTMENT

PROCESS SYSTEMS INTERNATIONAL – WESTBOROUGH, MA

REV	DATE	DESCRIPTION
1	5-4-95	Update DEO# 5022
0	9-15-94	RELEASE FOR USE DEO# 006-011

CERTIFIED FOR ISSUE

BY _____ DEPART.MGR. _____ V.P. _____

NO.	SOP-006-011
SHEET	1 OF 18
DATE	9-15-94

Document Control Department Operating Procedures

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1.0 PURPOSE

The purpose of this procedure is to establish the responsibilities and define the any operations of the Document Control Department.

2.0 GENERAL

The Document Control Department (DCD) functions as the central point in managing and maintaining the electronic document data base, distribution, and archiving of electronic and hard copy controlled documents.

For the purpose of this document, Project Manager and Product Line Manager (PM) are synonymous.

3.0 RESPONSIBILITIES

The DCD is responsible for management, distribution, and archiving of the following documents:

A) PSI Engineering documents (electronic and hard copy)
B) Client documents, submittals, and transmittals
C) Vendor documents, submittals, and transmittals
D) Historical data base of all Projects and related Job Books
E) PSI Standard Operating Documents. These include Procedures (SOP), Work Instructions (WI), Work Standards (STD), Standard Drawings, etc.)

Any changes to this procedure must be approved by the Engineering Manager and the Vice President of Operations.

4.0 PROCEDURE

4.1 PSI ENGINEERING DOCUMENTS

4.1.1 DEO RELEASES

All PSI Engineering documents shall be released via a Design Engineering Order (DEO) as prescribed in **SOP-006-012**.

When a DEO Release is received in the DCD, the DCD shall perform the following:

A) Update the Document Control Data Base (DOCMAN) file
B) Copy and distribute according to the distribution provided by the Project Manager (PM) on the back of the DEO.
C) File the original copy of the released documents in the DCD for reference.

4.1.2 REQUESTS FOR CHANGE

A Request for Change (RFC) shall be submitted as prescribed in SOP-006-001.

Upon receiving an RFC the DCD shall:

A) Apply an RFC Number from the RFC Log Book (See WI-006-001)
B) Retain a copy of the RFC for the DCD RFC Pending File (The RFC Pending File is a hard copy "tickle" file of OPEN RFC's.)
C) Enter the RFC information in DOCMAN (the Document Management Program) with the description "OPEN"
D) Write a penciled note on the document being effected by the RFC noting the following:

1) RFC Number
2) "RFC Pending"
3) Date

E) Forward the original copy of the RFC to the appropriate PM for disposition.

When a final disposition has been determined by the PM and the RFC has been returned to the DCD for distribution, the DCD will:

A) Update the DOCMAN file with the final disposition. Available dispositions are as follows:

1) Approved
2) Void
3) DEO with DEO number

B) Correct the penciled note on the effected document indicating the RFC's final disposition (exception - DEO'd RFC's)
C) Copy and distribute the RFC according to the distribution list provided by the PM on the back of the RFC and shall include the originator of the RFC.
D) File the original copy of the RFC in the DCD Job File for reference.

See SOP-006-001 for complete details on issuing RFC's.

4.1.2 REQUESTS FOR CHANGE CONT.

The maximum number of RFC's on any document shall not exceed five (5). After five RFC's the accumulated changes shall be applied to the document by the Engineering/Design group and released via a DEO. RFC's can be "held for accumulation" and applied to the document at the end of the job as the Project Manager deems appropriate.

4.2 CLIENT DOCUMENTS

4.2.1 CLIENT SUBMITTALS

All Client submittals received in DCD will be given a document number in the "8" (or Vendor discipline) category unless otherwise directed by the PM. Client documents received in DCD will be logged in DOCMAN, copies forwarded according to the PM's direction, and the original filed in the appropriate DCD Job File.

All accompanying transmittal cover sheets will be 3-hole punched and kept in the Job Log Book for reference.

4.2.2 CLIENT TRANSMITTALS

All Client transmittals involving controlled documents will be processed through the DCD. DCD will:

A) Generate the transmittal using DOCMAN (see WI-006-002)
B) Complete the necessary shipping forms
C) Package the documents
D) Mail the documents according to the PM's instructions.
E) Retain a copy of the transmittal cover sheet in the Job Log Book for reference

4.3 VENDOR DOCUMENTS

4.3.1 VENDOR SUBMITTALS

All Vendor submittals received in DCD will be given a document number in the "8" (or Vendor discipline) category unless otherwise directed by the PM. Vendor documents received in DCD will be

4.3.1 VENDOR SUBMITTALS CONT.

logged in DOCMAN and the Review, Approval, and Status stamps applied (see ILL.1). These documents will be forwarded to the PM who will circulate them through the appropriate disciplines for review and approval.

All accompanying transmittal cover sheets will be 3-hole punched and kept in the Job Log Book for reference.

4.3.2 VENDOR TRANSMITTALS

When the Review and Approval process is complete the PM will apply his/her signature, check off the appropriate Vendor Approval Code, and return the documents to the DCD. The DCD will:

A) Make copies of the documents for the Project team according to the PMs instructions
B) Prepare a Vendor transmittal to accompany the copies being returned to the Vendor (See WI-006-002)
C) Complete the necessary shipping forms
D) Package the documents
E) Mail the documents according to the PM's instructions
F) File the original in the appropriate DCD Job File.
G) Retain a copy of the transmittal cover sheet in the Job Log Book for reference

4.4 HISTORICAL DATA

When a PSI Project, with the exception of Standard Cryogenic Systems (SCS), begins, the DCD forwards a New Project Information Package (see ILL.2) to the PM to obtain the necessary data to establish Job Log Books and Job Files for the new project.

The items included in the New Project Information Package are:

A) An explanation of the primary functions of the DCD
B) Information Checklist
C) Mail service summary
D) DCD transmittal information and cut-off times
E) Transmittal information sheet (to be completed by the PM)
F) Distribution form (to be completed by the PM)

4.4 HISTORICAL DATA CONT.

The Standard Cryogenic Systems (SCS) group differs from the Custom Project group in that the DCD perpetually maintains the SCS drawings, drawing Log Books, and related files. These products are standard equipment and sold as such with only minor modifications as specified by any given Customer. Special system configurations are documented using the standard SCS document numbering system.

4.4.1 CUSTOM PROJECT JOB LOG BOOKS AND FILES

The Custom Project Job Log Book is a 3-ring binder that contains the following Project information:

A) Discipline specific drawing/document logs
B) Computer generated drawing log from DOCMAN (see WI-006-002)
C) DEO Log
D) PSI transmittal cover sheets to Client
E) Client transmittal cover sheets to PSI
F) PSI transmittal cover sheets to Vendors
G) Vendor transmittal cover sheets to PSI

Project Job Books are not to be removed from the Document Control Department.

The Custom Project Job Files are kept in the DCD office area for reference as long as the Project is active. Job Files contain the following items:

A) Master copies of the Project's forms
B) Blank DEO forms for releases
C) Released DEOs
D) Approved RFCs
E) Bills of Material (BOMs)
F) Specifications
G) All "A" size (8 1/2" X 11") drawings and documents
H) Vendor related data

A separate flat file located in the DCD reproduction room will be labeled with the Custom Project Job number where all current B, C, D, and E size drawings will be held (see SOP-006-008 for archiving of previous revisions).

The PM notifies the DCD when a Project has been completed. At that

4.4.1 CUSTOM PROJECT JOB LOG BOOKS AND FILES CONT.

time all Job drawings, Job Log Books, and Job Files are transferred to the DCD locked storage area for archiving (see SOP-006-008).

4.4.2 STANDARD CRYOGENIC SYSTEMS DRAWING LOGS AND FILES

The SCS Drawing/Document Log Books contain only log sheets. These log sheets are organized in a specific four-digit base number system (see SOP-006-003 and 3545-2-001). Several base number logs can be contained in one Log Book; however, they must be separated by clearly marked tabs for easy reference. A separate DEO Log Book is maintained for all SCS releases.

4.4.2 SCS DRAWING LOGS AND FILES CONT.

The SCS Files are arranged in the same four-digit base number system with separate files for all SCS DEOs and RFCs. (SCS DEOs and RFCs are filed numerically from lowest to highest in front.)

Both SCS Drawing/Document Log Books and their related files are kept in the DCD office area for reference.

A separate flat file located in the DCD reproduction room will be labeled by base number where all current B, C, D, and E size drawings will be held (see SOP-006-008 for archiving of previous revisions).

4.5 OPERATING PROCEDURES AND STANDARDS (SOP)

4.5.1 SOP LOG BOOK

DCD maintains the Procedure and Standards Log Book and assigns numbers to these documents by utilizing this log book in the same manner as Engineering uses the drawing/document log for Custom projects.

The Procedure Log Book is divided into tabbed sections by Department. Each department has been assigned a permanent three-digit numeric

4.5.1 SOP LOG BOOK CONT.

indentification number. There are three document categories (denoted by their prefix below) as follows:

A) **SOP** = Standard Operating Procedures
B) **WI** = Work Instructions
C) **STD** = Standard Drawings and Guidelines

The DCD also maintains (and updates with each new entry into the Procedures Log Book) an Index listing all the pending and released procedures to date. The updated Index is distributed to all designated personnel who hold the SOP Binder for their individual department or group (see Section 4.5.3).

4.5.2 FILING AND STORAGE

The DCD maintains files for all current Procedures and Standards in the DCD office where they are kept for reference by all PSI personnel.

The SOP file contains:

A) SOP Distribution List (see ILL.3)
B) SOP Cover Sheets
    1) Company Procedures
    2) Department Procedures
C) Folders containing the original document. Folders are arranged by Department and document category (see Section 4.5.1)

4.5.3 DISTRIBUTION

The distribution of any Procedure or Standards document is determined by the Department Manager or Vice President of the department where the procedure is generated. Those personnel who are holders of SOP Binders for their department or group will receive copies of all released Procedures automatically. These persons are "flagged" on the SOP distribution list by an asterisk (see ILL.3).

4.6 OTHER DOCUMENT CONTROL FUNCTIONS

The DCD also provides the following services:

A) "Release of Original" to Engineering/Design for revisions
B) Reproduction of Job and Product Manuals
C) General copying

4.6 OTHER DOCUMENT CONTROL FUNCTIONS CONT.

D) Maintenance of Engineering Data Library
E) Archiving of documents (see SOP-006-008)
F) Generate reports from DCD data base (i.e Job Drawing Logs and RFC Aging report - see WI-006-002)

5.0 FLOWCHARTS

None

6.0 REFERENCES

None

7.0 EXHIBITS

ILL.1 Review, Approval, and Status Stamps
ILL.2 New Project Information Package
ILL.3 SOP Distribution List

REVIEW STAMP

PROCESS SYSTEMS INTERNATIONAL
DOCUMENT REVIEW CHECKLIST

PROJECT NAME: Lyondell-Citgo
PSI DOC. NO. M27004-8-499 0

CHK	BY / DATE
____ PROJECT ENG	
____ MECHANICAL	
____ STRESS	
____ ELECTRICAL	
____ PROCESS	
____ MFG. ENG.	
____ MANUF	
____ Q.A.	
____ DRAFTING	

7/29/94

APPROVAL STAMP

PROCESS SYSTEMS INTERNATIONAL
DOCUMENT APPROVAL CHECKLIST

PROJECT NAME: Lyondell-Citgo
PSI DOC. NO. M27004-8-499

NOTE: THIS REVIEW DOES NOT RELIEVE THE SELLER OR CONTRACTOR OF ANY OBLIGATIONS UNDER THE P.O. OR CONTRACT.

____ FA = FINAL APPROVAL
____ AS = APP'D AS NOTED - REVISE & RESUBMIT
____ AF = APPROVED FOR FABRICATION
____ NA = NOT APPROVED
____ RP = RELEASED FOR PROCUREMENT OF MATERIALS ONLY
____ RR = REVISE & RESUBMIT

BY _____ DATE _____

STATUS STAMP

VENDOR NAME Vattek
REVISION NO 2
SUBMITTAL NO 3rd
STATUS Review & Approval

ILL.1

PROCESS SYSTEMS INTERNATIONAL, INC. REV 2/95

NEW PROJECT INFORMATION/DATA PACKAGE

PROJECT MANAGER:

CONGRATULATIONS ON YOUR NEW PROJECT!

THE DOCUMENT CONTROL DEPARTMENT IS RESPONSIBLE FOR THE ORGANIZING AND MAINTENANCE OF PROJECT DOCUMENTS. AT THE BEGINNING OF EACH PROJECT DOCUMENT CONTROL CREATES SPECIFICATION AND DRAWING FILES, COMPUTER LOGS AND A PROJECT BOOK.

THE FOLLOWING PAGES REQUEST THE NECESSARY INFORMATION TO SET UP THESE RESOURCES. THE NEXT PAGE AFTER THIS COVER SHEET CONTAINS A CHECK LIST FOR YOUR CONVENIENCE. WHEN YOU HAVE COMPLETED THIS PACKAGE, PLEASE RETURN IT'S ENTIRE CONTENTS TO DOCUMENT CONTROL.

NOTE: IF DOCUMENT CONTROL DOESN'T RECEIVE THIS INFORMATION IN TIME FOR THE FIRST DOCUMENT RELEASES, PROCESSING MAY BE DELAYED!

IF YOU HAVE ANY QUESTIONS REGARDING THIS PACKAGE OR THE FORMS CONTAINED IN THESE PAGES, PLEASE DON'T HESITATE TO ASK.

SINCERELY,

THE DOCUMENT CONTROL DEPARTMENT

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

NEW PROJECT INFO PACKAGE

CONTENTS

CHECK OFF WHEN DONE		
____	1)	MAIL SERVICE SUMMARY (FOR YOUR REFERENCE)
____	2)	TRANSMITTAL CUT-OFF TIMES (FOR YOUR REFERENCE)
____	3)	TRANSMITTAL INFORMATION SHEET (PLEASE FILL IN APPROPRIATE INFO)
____	4)	BLANK DISTRIBUTION FORM WITH INSTRUCTIONS (PLEASE FILL IN APPROPRIATE INFO)
____	5)	SPECIAL INSTRUCTIONS AND REQUIREMENTS OF PROJECT (LIST BELOW)

INFORMATION COMPLETED BY _____ DATE _____

MAIL SERVICE SUMMARY

EXPRESS MAIL: (DOMESTIC)

COST - MOST ECONOMICAL OF ALL METHODS AVAILABLE
DELIVERY - GUARANTEED TWO DAYS

FEDERAL EXPRESS: (DOMESTIC & INTERNATIONAL)

COST - RANGES BETWEEN HIGH TO ECONOMICAL DEPENDING ON REQUESTED DELIVERY
DELIVERY - PRIORITY OVERNIGHT: 10:30AM NEXT DAY
STANDARD OVERNIGHT: 3:00PM NEXT DAY
ECONOMY TWO-DAY: 4:30PM 2ND DAY
SATURDAY DELIVERY: 1:30PM SATURDAY

SPECIAL REQUIREMENTS: - ALL PACKAGES MUST HAVE A STREET ADDRESS. **NO P.O. BOXES ARE ACCEPTED!**

NOTE: FEDERAL EXPRESS PROVIDES AN EXCELLENT PACKAGE TRACKING SYSTEM THAT PROVIDES DATE THE PACKAGE WAS DELIVERED, TIME OF DELIVERY, AND NAME OF CONSIGNEE.

DHL WORLDWIDE: (USE ONLY IF REQUESTED BY CLIENT)

COST - RANGES BETWEEN HIGH TO MEDIUM DEPENDING ON REQUESTED DELIVERY
DELIVERY - AS INDICATED IN SERVICE MANUAL.

CLIENT/VENDOR TRANSMITTAL
CUT-OFF INFORMATION

IN ORDER TO PROCESS SAME DAY TRANSMITTALS, DOCUMENT CONTROL HAS THE FOLLOWING REQUIREMENTS:

RECEIVED IN DOCUMENT CONTROL		WILL SHIP
BEFORE	2:00PM	SAME DAY
AFTER	2:00PM	NEXT DAY

TRANSMITTALS CONTAINING **30 OR MORE** DRAWINGS, THAT REQUIRE REPRODUCTION COPIES, RECEIVED AFTER 12:00 NOON MIGHT NOT MAKE SAME DAY SHIPPING DUE TO PREP AND PROCESS TIME.

REMEMBER: THE EARLIER IN THE DAY THE DOCUMENT CONTROL DEPARTMENT RECEIVES THE TRANSMITTAL CONTENTS THE BETTER.

IF YOU ANTICIPATE A LARGE TRANSMITTAL, LET US KNOW AS SOON AS POSSIBLE SO WE CAN ORGANIZE OUR WORK LOAD ACCORDINGLY.

THANK YOU FOR YOUR COOPERATION.

TRANSMITTAL INFORMATION SHEET

PROJECT MANAGER: _____

PROJECT NUMBER: _____

NAME OF CLIENT: _____
STREET ADDRESS: _____
CITY/STATE/ZIP: _____

ATTN: _____

PREFERRED SHIPPING METHOD:

_____

_____

NUMBER OF PRINTS REQUIRED: _____ REGULAR PRINTS
_____ REPRODUCIBLES

OTHER EXTERNAL DISTRIB:

NAME: _____ # COPIES _____
NAME: _____ # COPIES _____
NAME: _____ # COPIES _____

ADDITIONAL INFORMATION: _____

_____

_____

_____

DISTRIBUTION FORM INSTRUCTIONS

THE PURPOSE OF THE DISTRIBUTION FORM IS TO AID IN THE INTERNAL AND EXTERNAL DISTRIBUTION OF DOCUMENTS FOR EACH PROJECT. (IT CAN ALSO BE USED AS A CHECK LIST FOR THE INTERNAL REVIEW OF DOCUMENTS BEFORE THEY ARE OFFICIALLY RELEASED ON A DEO.)

THE DISTRIBUTION LIST IS CONVENIENTLY PHOTOCOPIED ON THE REVERSE SIDE OF EACH DEO AND IS SPECIFIC TO EACH PROJECT. AFTER FILLING OUT THE FRONT OF EACH DEO WHEN RELEASING A DOCUMENT, YOU WILL NEED TO CIRCLE THE APPROPRIATE QUANTITIES FOR DISTRIBUTION ON THE BACK. THIS WILL PROVIDE DOCUMENT CONTROL WITH THE INFORMATION NEEDED TO DISTRIBUTE EACH DEO CORRECTLY.

THE DOCUMENT CONTROL DEPARTMENT WILL <u>NOT</u> TRY TO "SECOND GUESS" THE DISTRIBUTIONS YOU HAVE NOTED ON EACH DEO; THEREFORE, IT IS IMPORTANT THAT YOU FILL THIS INFORMATION OUT CORRECTLY.

IF, AT ANY TIME, YOU NEED TO MODIFY THE DISTRIBUTION LIST FOR ANY GIVEN PROJECT. PLEASE INFORM THE DOCUMENT CONTROL DEPART- MENT SO IT CAN BE CORRECTED PROMPTLY.

PLEASE FILL OUT THE FOLLOWING PAGE ACCORDING TO THE INSTRUCTIONS PROVIDED.

DISTRIBUTION FORM FOR:

PROJECT NAME: (1)

PROJECT NUMBER: (2)

IF COPIES OF THE ATTACHED DOCUMENTS ARE REQUIRED PLEASE CIRCLE THE QUANTITY IN THE APPROPRIATE COLUMN.

___CODE (3) ___NON CODE

DEO #_____	DWG	SPEC	DEO	RFQ	BOM	RFC
		(4)				

PURCHASING, QUALITY ASSURANCE, MAT'L PROCUREMENT (TO BE COMPLETED BY DOCUMENT CONTROL)

A BRADBROOK						
D BILODEAU			(5)			
B SCHRAMM						

NOTES (6)

EXTERNAL DISTRO		(7)				
TOTAL COPIES		(8)				

HOW TO FILL IN YOUR INITIAL DISTRIBUTION FORM

(1) FILL IN PROJECT NAME

(2) FILL IN PROJECT NUMBER

(3) CHECK OFF IS JOB IS "CODE" OR "NON-CODE" (i.e. PRESSURE VESSELS)

(4) FILL IN NAMES OF PSI STAFF AND THE QUANTITIES OF COPIES THEY WILL REQUIRE. BE SURE TO THINK OF ALL THE POSSIBLE DISTRO'S THIS JOB WILL HAVE TO BE SURE NO ONE WILL BE OMITTED.

(5) LEAVE THIS AREA BLANK. DOCUMENT CONTROL WILL FILL IN THESE TOTALS AS EACH DEO REQUIRES.

(6) LIST SPECIAL INSTRUCTIONS SUCH AS "EXTERNAL: 1 REPRO & 2 PRINTS".

(7) FILL IN THE NUMBER OF COPIES THE CUSTOMER HAS REQUESTED TO BE SENT TO THEM FOR INFO AND/OR APPROVAL

(8) PLEASE LEAVE BOTTOM LINE BLANK. DOCUMENT CONTROL USES THIS AREA FOR PROCESSING YOUR RELEASES.

PLEASE FILL OUT DISTRO FORM PROVIDED ON THE NEXT PAGE ACCORDING TO THE INSTRUCTIONS GIVEN ABOVE.

DISTRIBUTION FORM FOR:

PROJECT NAME:_____

PROJECT NUMBER:_____

IF COPIES OF THE ATTACHED DOCUMENTS ARE REQUIRED PLEASE CIRCLE THE QUANTITY IN THE APPROPRIATE COLUMN.

___CODE ___NON CODE

DEO #_____	DWG	SPEC	DEO	RFQ	BOM	RFC

PURCHASING, QUALITY ASSURANCE, MAT'L PROCUREMENT (TO BE COMPLETED BY DOCUMENT CONTROL)

A BRADBROOK						
D BILODEAU						
B SCHRAMM						

NOTES

EXTERNAL DISTRO						
TOTAL COPIES						

COMPANY PROCEDURE DISTRIBUTION LIST

4/95

GENERAL

* TOM ANKERMANN
* RICH BAGLEY
* BETH BARKLEY
DON BENERE
RON BENTO
TED BITOMSKI
* CHRIS CONNOR
DEBBIE COX
TED DESIRAKIAN
* DICK DERY
* DOUG DUCOTE
BOB ERIKSSON
MIKE FREEMAN
* KENT HIGGINS
KRIS HILLENBURG
* MAURICE KING
NORM MacKAY
MIKE MAGLIO
JOE McNAMARA
* BOB MOSELEY
BILL MURPHY
JOHN O'BRIEN
HERB PETERS
ELAINE PIGNATARO
BOB POWELL
TOM STARR
* PETER VanDUYNE
* KEN WEISMANTEL
B WOJNAROWSKI

PROC/PROJ ENG

* PAUL DOHERTY
LYNDA ENGSTROM
DICK ERIKSSON
BRETT FORLANO
JIM FRASER
JOHN FUCCI
M HENNESSEY
* DICK HOPEWELL
TED KOBEL
* D McWILLIAMS
AL MEISINGER
DAVE MOORE
STU MOTEW
MUSTAFIZ RAHMAN
KRIS ROBERTS
BILL ROCHELLE
L SYLVESTRE
ROBERTO THAN
STEVE TOTH
HANK VALCOUR

I/E ENG

FADI BARK
DICK BRAZER
STEVE CHIAVAROLI
RALPH GESE
MAX KOZYRCZAK
DAN PARENTI
GEORGE ROGERS
PETE SCHMIDT
LYNEL TRAVESI

CIVIL/STRUCT

JOHN ALMONTE
* FRED CORDELLA

I/E DESIGN

GLENN DAVIDSON
* ALAN GAGNON
BRUCE ROTH
RUSS WOOLEY
SHARON WILCOX
WELLS WHOOTEN
KARL YAO

MECH DESIGN

HARRY BASELICE
BILL BATES
BOB BATTISTA
MARK BROSS
* LEON COOK
* DICK CURTIS
LAURIE DAYTON
JOE GRANT
ED LAWS
ROCKY MAZO
LEO MITCHELL
GARY OWENS
RON PETERSON
KAARLO RINTARA
CONNIE SALVUCCI
PAUL VAUGHN
GARY WESLEY

Q/A

* A BRADBROOK
PAUL CLARKE
GENE SENECAL
STEVE SOKEL

NPS

LARRY BAILEY
ALAN HENRIKSON
LISA SIMARD
* JACK WALLER

PURCH/MAT'L

DIANE BILODEAU
PHIL FERLAND
BARRY SCHRAMM
DICK WEDGE
BOB VARIEUR

SHOP

M BROUWERS
GENE GAGNE
JOHN GESSNER
RON SULLIVAN

* = INDICATES HOLDER OF PROCEDURE BINDER FOR GROUP OR AREA. PLEASE SEND COPY OF EVERY RELEASE THREE HOLE PUNCHED FOR BOOK.

20 Binders

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9 of 9

PROCESS SYSTEMS INTERNATIONAL, INC.

WESTBOROUGH, MA.

DEPARTMENT PROCEDURE

FOR

RELEASE OF CONTROLLED DOCUMENTS

PROCESS SYSTEMS INTERNATIONAL – WESTBOROUGH, MA

REV	DATE	DESCRIPTION
1	6/6/96	Revised for "DEO" subdirectory addition DEO# S057
P1	2/2/95	RELEASE FOR USE DEO# S012

CERTIFIED FOR ISSUE

BY REB DEPART.MGR. REB V.P. D. DUCOTE/REB

NO.	SOP- 006 - 012
SHEET	1 OF 9
DATE	2/2/95

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this procedure is to detail the process of releasing/revising all "controlled documents", including Specifications, Drawings, Bills of Material, Standard Operating Procedures, Work Instructions, SCS Sales Orders, etc.

2.0 GENERAL

Engineering documents must be prepared, released and archived in an efficient manner to promote cost-effective project execution. This procedure details the process for sign-off, distribution and archiving of engineering documents.

The release of PSI "Controlled Documents" is controlled via a Design/Engineering Order (DEO). The DEO is used to record document information, document changes from the last issue, routing for sign-off, internal and external distribution, etc.

A white DEO is used for general releases and a different blue DEO is used for ASME code vessel releases.

This procedure is applicable to all PSI product lines except for NPS Products. NPS is covered by its own procedures.

Glossary

BOM	Bill of Material
DEO	Design Engineering Order
RFC	Request for Change
EMS	PSI Material/Financial Management Computer System
CAD	Computer Aided Design
SCS	Standard Cryogenic Systems

3.0 RESPONSIBILITIES

Each product line manager is responsible for their product line complying with PSI procedures.

The Document Control Department is responsible for issuing and archiving all engineering documents.

The Vice President of Engineering is responsible for approving all revisions to this procedure.

4.0 PROCEDURE

The procedure for releasing engineering documents varies slightly depending on the product line and equipment type. The following sections detail the different requirements.

4.1 General Document Release Procedure

Preparer

For drawings, DEO is prepared by the responsible designer who developed the drawing or revision. For specification and other documents, the DEO is prepared by the responsible engineer who prepared the document or revised it.

Once the DEO is prepared, the preparer shall have the Project Manager fill in the sign-off routing (as required for each type of document) and hand-carry the document/DEO to the next reviewer.

If the document does not order material or call for PSI fabrication, entry into the EMS is not required. The Project Manager should put N/A in the EMS routing block.

Documents must be revised and acted on as soon as possible. The **maximum** delay in review time for a reviewer should be one day.

DEO/Document Sign-off

Preliminary issue revision (P1, P2, etc.) may be issued with only the project managers' sign-off (or their designee) on the DEO. The DEO number and reason for issue should be filled in on all preliminary drawing releases.

Draft copies of the documents to be released should always be circulated to the applicable project team members (including *Manufacturing*) prior to the document sign-off to minimize delays in releasing the document.

The following signatures are mandatory on DEO's releasing formal numbered issues (0, 1, 2, etc.)

For the Standard Cryogenic Systems (SCS) product line, the mandatory sign-offs for release are: The Preparer and the Engineering Supervisor. ASME Code Vessel releases shall comply with paragraph 4.2.

For the Custom/High Vacuum product lines, the mandatory sign-offs for release are: The Preparer, the Checker, Discipline Engineer of the type of drawing or specification being issued, and the Project Manager (or their designee). ASME Code Vessel releases shall comply with paragraph 4.2.

A data entry sign-off is required to issue or revise a Bill of Material (BOM). The DEO is signed off after the BOM is entered and "linked" to the project in the Paradox System. When a BOM is modified, an add/change/delete report shall be attached to the DEO and distributed.

Note: A RFC cannot be used to issue or revise a BOM.

A data entry sign-off is mandatory for all documents and BOM issued for PSI purchase or manufacture. The Project Manager shall note N/A in the EMS routing block if data entry into EMS is not required.

Note: The actual transfer of BOM data from the Paradox System to EMS is controlled by the Document Control Department. "System Nets" (add/change/delete information) are done twice daily and downloaded to EMS.

For CAD drawings, all sign-offs for the current issue shall be manual signatures or initials. The previous issue's sign-offs shall be electronically added to the document file during the revision process.

All documents and the DEO will continue to be signed off by all disciplines which have contributed to or reviewed the document.

For samples of the new DEO forms, see Exhibit II (used mainly for new releases) and Exhibit III (used mainly for releases of revised documents). Continuation pages are also available from the Document Control Department for each type DEO.

If the document also has a customer number, both numbers should be shown on the DEO so that the Document Control Department database can cross-reference the drawing numbers.

This sign-off procedure is applicable to all current and new PSI projects.

SCS Sales Orders

SCS sales are issued via a DEO. See "Controlling SCS Sales Orders", WI-010-003, for details.

DEO Numbering and Stickers

For Custom/High Vacuum projects, DEO's will be numbered consecutively starting from 001 for each project. DEO number stickers are provided for each project to avoid double numbering the DEO's.

For SCS projects, DEO's will continue to use the four-digit series. DEO numbers will be assigned by the Document Control Department and logged into the project book.

Projects that are in progress shall continue to use their current system.

Document Distribution

The Project Manager is responsible for setting up the project document distribution with the Document Control Department. A "New Project Information/Data" package is available from the Document Control Department for this purpose.

As each person reviews the document and signs off, they must also circle their required number of copies on the form on the back of the DEO. The Project Manager is responsible for document distribution to parties (Material Control, etc.) that have not reviewed the documents.

An add/change/delete report shall be distributed with the DEO when a BOM is revised.

Electronic Document Archiving 

Note: This archiving procedure applies to all electronic documents except for 3-D models.

When a document/drawing is ready for DEO release the DEO preparer (i.e. Designer) will move (or copy if the drawing will be modified while the DEO is being processed) the electronic file from the "IN" (Inprogress) subdirectory to the "DEO" subdirectory. Once the DEO has been officially signed off and delivered to the Document Control Department, the Document Control Department (DCD) will move the electronic file from the "DEO" subdirectory into the "IS" (Issued) subdirectory. All subsequent revisions to documents or drawings are to be made using the *controlled* copy of the electronic file located in the "IS" subdirectory. This electronic file is to be copied from the "IS" subdirectory into the "IN" subdirectory where it may be revised.

Should the Designer be instructed to work on the document/drawing while the document is being reviewed and prior to being moved by the DCD from the "DEO" subdirectory into the "IS" subdirectory, the Designer should copy the document from the "IN" subdirectory into the "DEO" subdirectory at the time the DEO is routed for sign offs and then they may work on the document/drawing in the "IN" subdirectory without fear of altering the DEO'd version. The DCD will only move documents/drawings from the "DEO" subdirectory to the "IS" subdirectory. The Designer is responsible for managing documents/drawings in the "IN" subdirectory.

All superseded documents will be moved by the Document Control Department into the "SU" subdirectory for storage. The electronic file name of the old file will be modified to prevent accidental usage of the superseded file (see SOP-006-003 for details).

*NOTE: It is **highly** recommended that electronic file information* (File/Date/Time/Bytes) *be written on the DEO in the appropriate location for proper identification and archiving.*

This electronic document file archiving system will be used for all projects as each document is released or revised.

A diagram of the Electronic File Structure is attached to this memo (Exhibit IV).

3-D Models

3-D models will be archived per WI-009-001.

Document and Electronic File Numbering

The PSI document and electronic file numbering system is generally based on a project number based system. Occasionally, a product family numbering system will be used for Custom Services/High Vacuum projects when generic components and sub-assemblies are used across a family of products. See SOP-006-003 titled, "Department Procedure for Assigning and Maintaining Engineering Document Numbers" for complete details.

SCS uses a separate system. For details, see "Document Numbering System for SCS", A3545-2-001.

Material Disposition

When previously purchased material is affected by a BOM change, material disposition information shall be added to the DEO by the Project Manager (or Engineering Supervisor).

Revisions to Document/Title Blocks

Back-circles, Revision Marks

For specifications and other documents, all changes shall be detailed on the DEO as well as noted with a revision mark in the page margin.

For Custom Services/High Vacuum projects, all drawing revisions (CAD and manual drawings) shall be detailed on the DEO in addition to being back-circled (with revision mark) on the drawing. Changes can also be detailed by reference to an RFC. Large revisions may be generally noted on the DEO, but all drawing and BOM changes must be identified on the documents or with an add/change/delete report.

For SCS product line, back-circles are not required.

Title Blocks

For Custom Services/High Vacuum projects, the DEO number and the reason for issue (preliminary, for design, etc.) should always be shown in the drawing revision block.

For SCS, the exact changes to the document should be filled in the revision block (up to a maximum of two lines) along with the DEO number.

Request for Change (RFC)

When a DEO issues a document incorporating changes requested by an RFC, the RFC number shall be shown on the DEO.

4.2 ASME Code Vessel Procedure

The system for releasing documentation for ASME coded vessels must meet

the requirements of the ASME pressure vessel code. The procedure is fully documented in the PSI Section VIII ASME Q.A. manual. This special ASME code procedure covers only vessels that will be fabricated by PSI under their ASME Section VIII stamp. All outside vendor purchases of ASME vessels (or design only) shall use the normal DEO process.

Documents for PSI ASME code work use a different DEO form (color blue) and a modified release procedure.

The ASME code document procedure follow Section 4.1 procedures with the following exceptions:

1. DEO form is blue and has different sign-offs and distribution.

2. All releases must be approved and signed off by Preparer, Design Engineer, Manufacturing Engineer, Quality Assurance (Q.A.), Project Manager (or Engineering Supervisor) and EMS Data Entry.

3. Distribution:

   a) The bill of Material (BOM) and the add, change, delete reports are always issued with the drawing.

   b) Two (2) copies of the DEO are sent to the Material Control Department. One (1) copy is signed and returned to Document control confirming its receipt by Material Control.

5.0 FLOWCHART

See Exhibit I.

6.0 REFERENCES

WI-010-003 "Controlling SCS Sales Orders"

SOP-006-003 "Assigning Engineering Document Numbers"

A3534-2-001 "Document Numbering System for SCS"

7.0 EXHIBITS

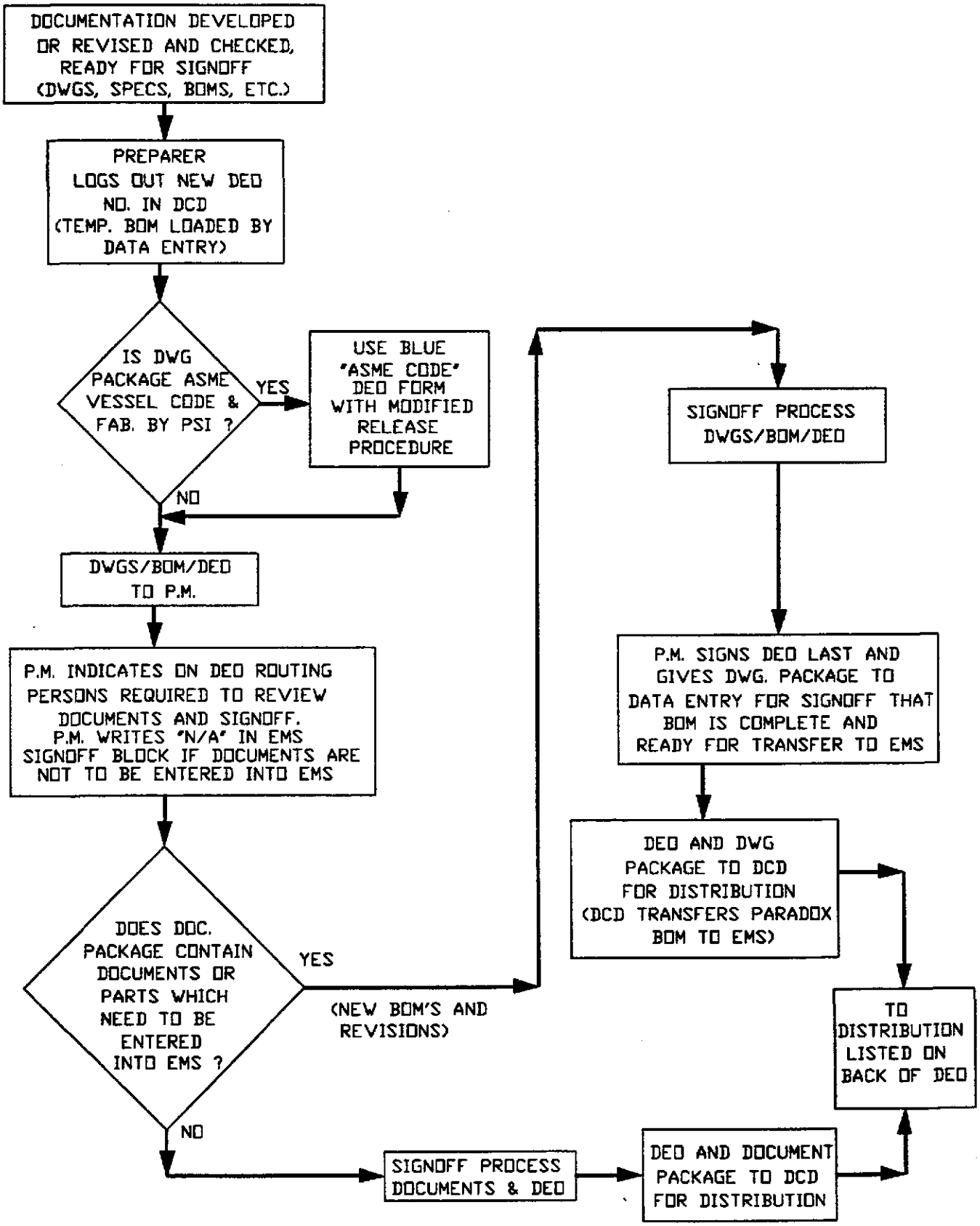
I. "DEO Process Flow Chart"

II. Sample DEO - Initial Release

III. Sample DEO - Revised Documents

IV. Archiving Electronic File Structure

EXHIBIT I



Feb 06, 1995 - 13:34:26

DEO PROCESS FLOW DIAGRAM

CAD# SOP06112

SOP-006-112

EXHIBIT II

DESIGN ENGINEERING ORDER			DEO NO.	
JOB NO.:			ELEC. FILES DIRECTORY	
CLIENT NAME:			DWG:	
PROJECT NAME:			SPEC:	
LOCATION:			OTHER:	
DOC. NO.	REV.	DESCRIPTION	FILE\DATE\TIME\BYTES	ARCH.

RFC NO.

DETAILED DESCRIPTION

MATERIAL DEPOSITION:

ACTION BY:

DISTRIBUTION		ROUTING	SIGN–OFF	DATE:
EXTERNAL	INTERNAL		Prepared By:	
SUBMIT TO CLIENT FOR:	CHECK ONE:		App'd DESIGN	
			App'd I/E	
_____Approval	_____Quotation		App'd ELEC	
	_____P.O. Change		App'd CIV/STR	
_____Info Only	_____Resubmit to Vendor		App'd PROJECT	
	_____Purchase		App'd PROCESS	
_____Review/Comment	_____Mat'l Procurement		App'd QA	
	_____Fabrication		App'd EMS	
_____Distribution	_____Information		App'd MFG	
			App'd DISCIP MGR	
			App'd PROJECT MGR	

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MA SHEET 1 OF

EXHIBIT II

ASME CODE VESSEL

DESIGN ENGINEERING ORDER	DEO NO.
JOB NO.:	ELEC. FILES DIRECTORY
CLIENT NAME:	DWG:
PROJECT NAME:	SPEC:
LOCATION:	OTHER:

DOC. NO.	REV.	DESCRIPTION	FILE\DATE\TIME\BYTES	ARCH.

RFC NO.

DETAILED DESCRIPTION

MATERIAL DEPOSITION:

ACTION BY:

DISTRIBUTION		ROUTING	SIGN–OFF	DATE:
EXTERNAL	INTERNAL		Prepared By:	
SUBMIT TO CLIENT FOR:	CHECK ONE:			
_____Approval _____Info Only _____Review/Comment _____Distribution	_____Quotation _____P.O. Change _____Resubmit to Vendor _____Purchase _____Mat'l Procurement _____Fabrication _____Information		App'd DESIGN ENG.:	
			App'd Q.A.:	
			App'd EMS:	
			App'd MFG ENG:	
			App'd PROJ. MGR.:	

PROCESS SYSTEMS INTERNATIONAL WESTBOROUGH, MA SHEET 1 OF

EXHIBIT II

DISTRIBUTION FORM FOR:

STANDARD PRODUCTS

IF COPIES OF THE ATTACHED DOCUMENTS ARE REQUIRED PLEASE CIRCLE THE QUANTITY IN THE APPROPRIATE COLUMN.

DEO #	DWG	SPEC	DEO	RFQ	BOM
TOM ANKERMANN			1	1	
PAUL DOHERTY	1	1	1	1	1
HANK VALCOUR	1	1	1		
RALPH GESE	1		1		
LEO MITCHELL	1	1	1	1	1
CHRIS McPHEATOR					
PAUL CLARKE	1	1	1		1
RON SULLIVAN	1	1	1		
NORM MACKAY	1	1	1		1
BOB VARIEUR	1	1	1		
DICK WEDGE	1	1	1	1	1
BARRY SCHRAMM			1		
MARK FULHAM		1			
BETTY NUTTAL (P/L)					
MIKE PICKETT					
WELLS WHOOTEN					
M. HENNESSEY					
JOHN FLYNN					
MIKE LAVERTU					
MIKE BELHUMEUR					
RON HIBBARD			1		
NOTES					
TOTAL COPIES					

EXHIBIT III

DESIGN ENGINEERING ORDER			DEO NO.	
JOB NO.:			ELEC. FILES DIRECTORY	
CLIENT NAME:			DWG:	
PROJECT NAME:			SPEC:	
LOCATION:			OTHER:	
DOC. NO.	**REV.**	**DESCRIPTION**	**FILE\DATE\TIME\BYTES**	**ARCH.**
RFC NO.	**DETAILED DESCRIPTION**			
DOC. NO.	**REV.**	**DESCRIPTION**	**FILE\DATE\TIME\BYTES**	**ARCH.**
RFC NO.	**DETAILED DESCRIPTION**			
MATERIAL DEPOSITION:			ACTION BY:	

DISTRIBUTION		ROUTING	SIGN–OFF	DATE:
EXTERNAL	**INTERNAL**		Prepared By:	
SUBMIT TO CLIENT FOR:	CHECK ONE:		App'd DESIGN	
_____Approval	_____Quotation		App'd I/E	
_____Info Only	_____P.O. Change		App'd ELEC	
_____Review/Comment	_____Resubmit to Vendor		App'd CIV/STR	
_____Distribution	_____Purchase		App'd PROJECT	
	_____Mat'l Procurement		App'd PROCESS	
	_____Fabrication		App'd QA	
	_____Information		App'd EMS	
			App'd MFG	
			App'd DISCIP MGR	
			App'd PROJECT MGR	

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EXHIBIT IV

ATTACHMENT III

Engineering Document Electronic File Structure

I. Primary Directories:

a. Custom Services Projects ("CS")

Each custom project shall have a dedicated directory named for its PSI Project number (e.g. "T15077").

b. High Vacuum Projects ("HV")

Each high vacuum shall have a dedicated directory named for its PSI Project number (e.g. "V59014").

c. NPS Projects ("NP")

Each NPS project shall have a dedicated directory named for its PSI Project number (e.g. "N00581").

d. Standard Cryogenic Products ("SCS")

Each standard product shall have a dedicated directory named for its model number (e.g. "1400"). Special drawings modified for a project should be stored under the job number also.

e. Standards ("STD")

A directory named "STANDARD" shall contain all engineering standard documents.

f. Proposals ("PRO")

A directory named "PROPOSAL" shall contain all proposal documents with subdirectories for each product line and proposal number.

g. General ("GEN")

A directory named "GENERAL" shall contain all general documents.

II. ISSUED / INPROGRESS ("IS"/"IN") Subdirectories:

Each primary directory shall have two (2) subdirectories for issued documents and in-progress work. The "IS" subdirectory shall be "Read Only" for all network users except the Document Control Department. The in-progress directory shall have open access for all network stations.

EXHIBIT IV

III. **Discipline Subdirectories:**

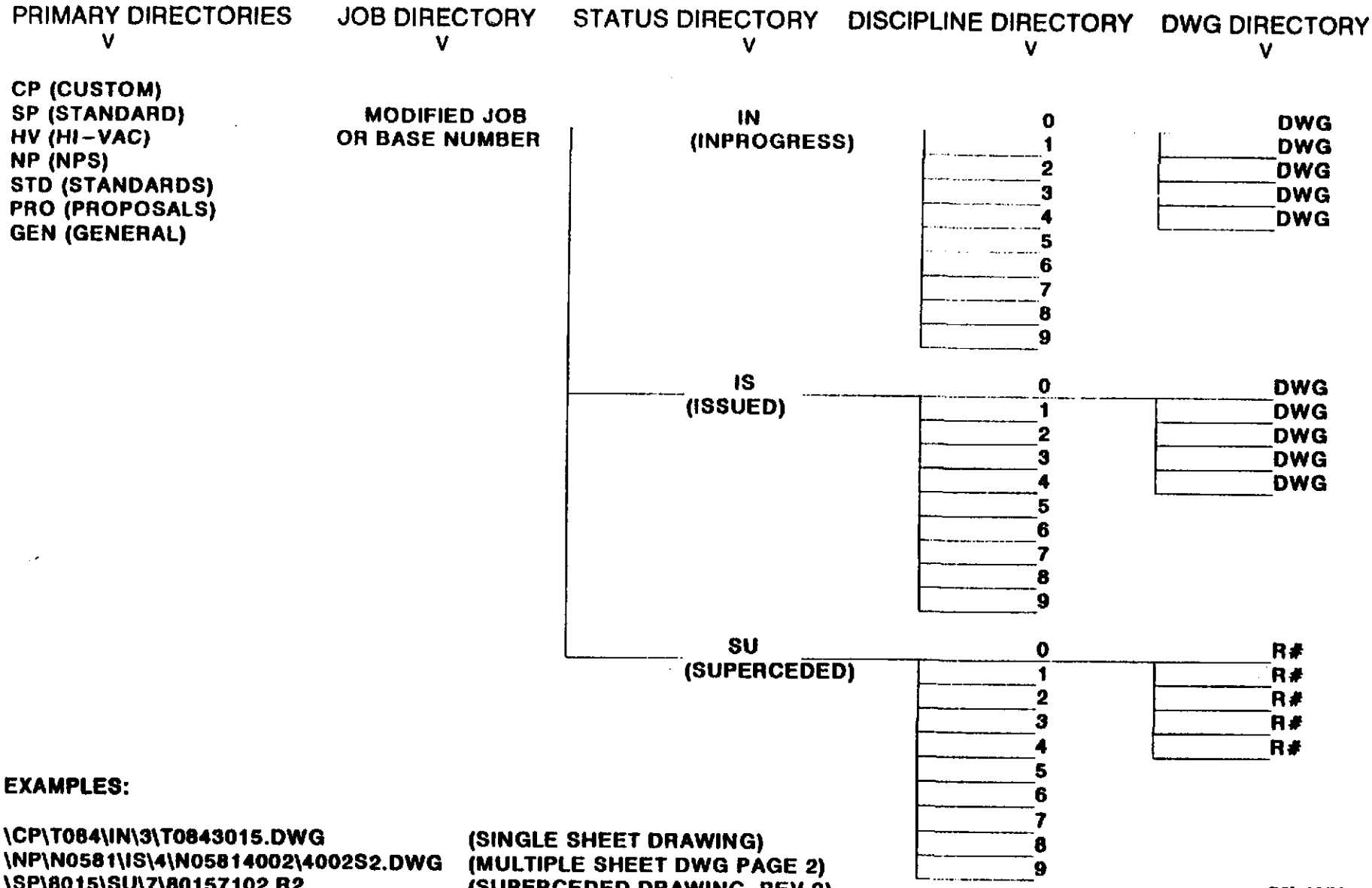
The "IS" and "IN" subdirectories shall contain the following subdirectories as needed:

"0" for PFD's and P&ID's
"1" for engineering lists
"2" for engineering specifications
"3" for I/E drawings
"4" for mechanical/equipment drawings
"5" for piping drawings
"6" for piping isometric drawings
"7" for structural drawings
"8" for vendor drawings
"9" for instrument loop drawings

"SU" for superseded issues of categories 0-9.

Superseded drawings will be periodically moved to tapes to save room on the network.

ELECTRONIC FILE STRUCTURE



EXAMPLES:

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\SP\8015\SU\7\80157102.R2	(SUPERCEDED DRAWING, REV 2)

PSI 12/93

EXHIBIT IX

ATTACHMENT 2

DETAILED PROJECT SCHEDULE

See the monthly PSI Vacuum Equipment Status Report for up to date schedule information.

ATTACHMENT 3

WORK BREAKDOWN STRUCTURE

See the monthly PSI Vacuum Equipment Status Report Schedule for a list of WBS activities.

ATTACHMENT 4

PROJECT Q.A. PLAN V049-2-029

SPECIFICATION FOR

PROJECT QUALITY ASSURANCE PLAN

FOR

LIGO VACUUM EQUIPMENT

Hanford, Washington
and
Livingston, Louisiana

MANUFACTURING ENGINEER: Phillip Fralick

QUALITY ASSURANCE: Alan L Bradbook

TECHNICAL DIRECTOR: D A M C W Allen

PROJECT MANAGER: Richard Bagley

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
1	D M W 11-15	REB 11/15/96	RELEASED PER DEO 351
Ø	4/24/96		RELEASED PER DEO 137

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number A V049-2-029	Rev. 1
	A L B	4-24-96	REB	4/24/96		

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ATTACHMENTS

1.0 PURPOSE

The purpose of the QA Plan is to establish the quality requirements for the scope of work intended. This plan contains the PSI quality standards that will be imposed on the LIGO High Vacuum System.

2.0 GENERAL

The outlined plan will be imposed at PSI as well as all major component vendors.

3.0 RESPONSIBILITIES

The manager of Quality Assurance and the assigned Project Manager are responsible for the implementation of this plan.

4.0 PROCEDURE

4.1 Quality Review And Planning

4.1.1 Prior to fabrication the Quality Assurance Engineer will establish the hold/witness points from the Customers specification; the PSI inspection points and the applicable PSI procedures for the contract. From this information, the QAE will prepare a PSI Quality Plan, for each chamber or assembly built at PSI. The Quality Plan will define all of the inspection steps that require witness and/or verification during the course of manufacturing and assembly at PSI. Subcontractual work will be subject to the same planning, by the subcontractor, at his plant with witnessed HOLD points and inspections by PSI.

4.2 Receiving Inspection

4.2.1 All raw materials that are procured with Material Test Reports will be receipt inspected prior to use.

4.2.2 Procured components and items will be inspected at the vendor's plant. If inspection is not performed at the vendors plant, they will be receipt inspected upon arrival.

4.3 Material Certification

4.3.1 All vacuum chamber and flange materials will be procured with Material Test Reports. Other nozzle, small parts, small flange nozzles and bolting materials will be procured with a Certificate of Compliance. At receiving inspection, the materials will be verified against the Purchase Order for quantity, material markings and the Material Test Report will be verified to the applicable ASME and/or ASTM material specification for compliance.

4.3.2 If primary vacuum boundary materials are purchased from foreign (outside of USA), PSI will conduct independent lab analysis to verify material composition.

4.4 In-Process Inspection

4.4.1 QA/QC will verify material traceability throughout the manufacturing cycle. They will monitor the quality of welding and the qualifications of personnel, verify the final cleaning and verify/witness the testing required by the customers specification.

4.5 Cleaning

4.5.1 All materials will be cleaned free of grease, oil, rust and foreign matter prior to welding. After the welding and machinery operations, the assemblies will be cleaned to the required level, for the intended service.

4.5.2 Final cleaning will be performed in accordance with the LIGO cleaning procedure.

4.6 Welding

4.6.1 All welding exposed to the vacuum will be performed by the PAW or the GTAW (TIG) welding process, with a 100% Argon shield gas or plasma arc welding with 100% Argon shield gas. All open or closed root, butt welding will be purged with 100% Argon (backing gas). Slip-on-flanges and lap joint designs that allow for fillet welds will not require baking gas. All vacuum welding will performed utilizing ASME Section IX qualified welding procedures and qualified welders.

4.6.2 Welding operations will be monitored on a daily basis by the QA/QC department for compliance with the LIGO Project Procedures and the applicable codes.

4.7 Final Inspection

4.7.1 Final inspection will be accomplished on all components prior to shipment. This inspection will include but is not limited to the following: serialization of components, final cleaning, final acceptance testing and packaging for shipment.

4.8 Testing

4.8.1 Vacuum components shall meet pumpdown and helium leak rates per the LIGO Project Procedures.

4.8.2 Pumps and valves will be performance tested at the vendor plant. These tests will be witnessed by PSI.

4.8.3 All testing will be performed in accordance with LIGO Project procedures. All shop testing performed will be witnessed/verified by QA/QC.

4.8.4 Written test reports will be generated for all testing and will be included in the final documentation package.

4.9 Documentation

4.9.1 Final documentation on this project will consist of signed off Quality Plans, Material Test Reports for vacuum chamber and flange materials, certificates of conformance of all nozzle materials, small parts and bolting materials, final cleaning certificate, Helium leak test reports, pumpdown test report and a Certificate of Conformance to the codes and standards.

For PSI fabricated equipment, the final documentation summary sheet shall indicate the drawing revisions which fabricated the component.

For purchased components, the purchase order indicates the revision level of procurement documents.

4.10 Vendor Surveillance

4.10.1 Prior to fabrication, each vacuum vessel fabricator shall submit quality plans to PSI for approval. PSI QA and engineering will set mandatory hold points and perform periodic inspections at the vendor's plant. The vendor shall provide final documentation as detailed in the procurement specification for all PSI fabricated components, documentation shall be provided as shown in Attachment 1 "Final Documentation Summary".

4.10.2 For major purchased components, QA requirements are detailed in "QA Requirements Summary" form attached to each procurement specification.

4.11 Engineering Plan Review

4.11.1 QA will be part of the design review team as the design develops.

4.12 Procurement Specification Review

4.12.1 QA will be part of the review team for all major component specifications.

Attachment I
V049-2-029

LIGO VACUUM EQUIPMENT
FINAL DOCUMENTATION SUMMARY

Component
Model No.:
Serial No.:

Date:
Prepared By:

1.	Quality Plan Doc. No.:		Rev.
2.	Material Test Reports:		Date
3.	Certification of Conformance:		
4.	Heat Treat Charts:		
5.	Final Cleaning Certification:		
6.	Bakeout Certification:		
7.	Final Vacuum Leak Reports:		
8.	Non-Conformance Reports:		
9.	Certificate of Conformance:		

Number
Rev.

Notes:

SPECIFICATION

Number		Rev.
A	V049-2-029	

ATTACHMENT 5

PROJECT SAFETY PLAN V049-2-023

PROJECT SAFETY PLAN

FOR

LIGO VACUUM EQUIPMENT

Hanford, Washington
and
Livingston, Louisiana

QUALITY ASSURANCE: Alan L Bradbrook

LIGO SAFETY OFFICER:

PROJECT MANAGER: Richard Boyle

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
1	D.McW	RCB 11/15/96	RELEASED PER DEO 351
Ø	4/24/96		RELEASED PER DEO 137

PROCESS SYSTEMS INTERNATIONAL, INC.			SPECIFICATION	
INITIAL APPROVALS	PREPARED DATE	APPROVED DATE	Number A V049-2-023	Rev. 1
	JLE 25APR96	REB 4/24/96		

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ATTACHMENTS

1.0 PURPOSE

This plan defines and establishes the safety requirements for the LIGO Project vacuum equipment supply and installation. The program requirements include safety management systems as well as safety engineering controls necessary to ensure the identification and resolution of all safety issues relative to this project.

This program provides for the review and approval of all operations, facilities equipment, and manpower application for safety and environmental controls necessary to provide maximum protection and to minimize risk of personnel, facilities, and hardware/equipment, etc.

2.0 SCOPE

The requirements as stated herein, will apply to all PSI facilities and construction sites.

All facility and site managers report to the PSI president located in the Westobrough, MA facility.
Each PSI facility and site manager is responsible for safety at their location.

3.0 APPLICABLE DOCUMENTS

The current revisions of the following documents dictate the requirements relative to the implementation of this plan.

a. 29 CFR Occupational Safety and Health Administration (OSHA) General Industry Standards

b. 40 CFR Environment Protection Agency (EPA) Protection of Environment

c. 49 CFR Department of Transportation (DOT) Transportation

d. National Fire Protection Association (NFPA) Fire Codes, Handbook Of Fire Protection, Life Safety Code Handbook, National Electrical Code.

e. American National Standards Institute (ANSI) Safety Standards.

f. National Safety Council (NSC) Accident Prevention Manual for Industrial Operations.

g. Toxic Substances Control Act (TSCA).

PSI has in place safety policies to meet general OSHA, Government and State requirements (regulations) which have been qualified by implementations/audits and by on-site visitation of these agencies.

4.0 PLAN MAINTENANCE

During the execution of this program, PSI's safety philosophy will be dictated by its Safety Policy Statement.

PSI is committed to providing a safe workplace for all employees. Program objectives are the prevention of injury, an the prevention of injury, and the prevention of employee and visitor exposure to hazardous conditions or materials. In order to achieve these objectives, environmental health and safety issues will be addressed as integral components of our business strategy. Our goal is to provide quality products and services while actively conserving our human and natural resources. It is our belief that accidents and undesirable environmental incidents are preventable by active participation from each employee.

All managers and leaders are responsible for ensuring that each employee receives the training and instruction necessary to perform his job safely. Each employee has the responsibility to comply with the company work rules following safe work practices and procedures established to protect the environment, and for reporting to leaders and managers all unsafe acts and hazardous conditions which may impact the environment. PSI's scope of operations range from manufacturing facilities to administrative offices. Therefore, safety programs will be tailored to each situation.

All PSI employees are required to read and follow the PSI Safety Manual as a condition of employment. (See Attachment I.)

6.0 SAFETY OBJECTIVES

6.1 To carry out the PSI safety policy, the following objectives have been identified relative to the Safety Program.

a. All work will be performed in the safest possible manner to reduce accidents involving personal injury, environmental impact, and equipment, facility or product damage.

b. A formal safety program has been established to define safety responsibilities, safety management controls, procedures, industrial safety requirements, industrial hygiene requirements, environmental functions, and other provisions to meet regulatory agency requirements. (See PSI Safety Manual.)

c. The PSI Safety program has the active support of all PSI employees. All levels of management will support the program and the concept of individual responsibility for safe operations will be established and reinforced.

d. The primary responsibility for safe operations will rest with the supervisor, who supported by the Safety Committee, is charged with conducting assigned tasks in the safest possible manner. Each supervisor will assure that organizational procedures provide safe working conditions and that team members comply with all Safety Committee requirements associated with the task.

e. The value of personnel training and certification as an accident preventive measure will be emphasized. Employees will be trained to be familiar with the systems, equipment and facilities which are required for the safe performance of their assigned tasks.

f. The Safety Program will be responsible for all safety related contractual directions.

g. To ensure site safety programs comply with PSI Safety Standards.

6.2 Organization

To accomplish the safety objectives relative to this program, a Safety Committee has been established at PSI. The Safety Committee has been designated and charged with the responsibility of coordinating the safety program to meet company and contractual safety requirements. The committee reports to the President of PSI. There are 12 to 14 people on the safety committee representing each PSI department including Humor Resources. The committee normally meets every two weeks. Special meetings may be called by the chairman if required.

6.3 Responsibilities

Throughout the performance of this project, responsibilities have been established to carry out the requirements of this plan. Each Safety Committee chairman (or individual members) are responsible for informing the President of PSI if an unsafety condition is allowed to exist at PSI after it has been identified. Each PSI facility maintains its own safety committee.

a. Each PSI facility and department has the responsibility for identifying potential hazardous operations, facilities and equipment; for providing required documentation and information incorporating safety requirements for continuing the safe conduct of activities; and for developing procedures and controls necessary for the safe processing of fabricated articles/items throughout all phases of manufacturing and delivery of products.

b. Supervisors/Team Leaders are responsible for assuring safe workmanship practices, including training, certification and qualification of personnel to approved training requirements. Supervisor/operators are trained in equipment operation (i.e. crane, forklift, welding) as well as general fabrication safety.

c. All involved personnel are responsible for reporting to any potential unsafe condition throughout the performance of their duties/responsibilities - to the Safety Committee Chairman or to the LIGO safety officer for resolution.

7.0 MAINTENANCE OF SAFETY CONTROLS

7.1 The Safety Manual, which is available to all personnel, will be revised/updated when new information is obtained, or when new development of processes/equipment dictate changes, and for training/qualification of personnel as determined by growth/expansion/development, etc.

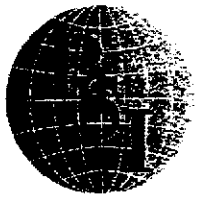
7.2 Safety meetings will be held based on a "as needed" basis and as a minimum monthly. Meeting minutes (with assigned action items) are issued to all supervisors and the PSI president.

8.0 SITE SAFETY PLAN

Weekly safety meetings are mandatory on all PSI jobsites, and are administered by the PSI site manager. PSI subcontractors will be required to maintain a formal safety program. Site specific safety plans will be developed inconjunction with the selected PSI installation contractor. This will result in a cohesive document that has been proved to be successful in application. It also results in more familiarity by the people performing and supervising the work.

Subcontractor safety plans are evaluated based on OSHA requirements and the requirements of PSI's safety program.

SAFETY MANUAL



PROCESS SYSTEMS INTERNATIONAL, INC.

PROCESS SYSTEMS INTERNATIONAL, INC.

SAFETY MANUAL

JUNE 1994

1. INTRODUCTION

This manual provides a comprehensive description and approach to PSI's Safety Program. The Program has been designed with one major goal; to ensure that every employee is provided the opportunity to work in a facility that does not endanger his health. The manual will be updated from time to time to incorporate both new and revised OSHA and state regulations.

The safety and health rules documented in this manual are intended to comply with OSHA regulations for general industry. Where a plant practice or rule conflicts with OSHA, the latter will dominate.

The management of the company intends to comply with both the spirit and letter of laws and regulations pertaining to employee safety at the work place. TO THIS END ALL EMPLOYEES ARE NOT ONLY URGED, BUT REQUIRED TO BE FAMILIAR WITH THE PROGRAMS OUTLINED IN THIS MANUAL, AND BRING TO THE ATTENTION OF THE SAFETY COMMITTEE OR THEIR SUPERVISOR ANY INFORMATION RELATING TO CONDITIONS OR SITUATIONS WHICH COULD RESULT IN SAFETY HAZARDS.

Remember that safety is a full-time job and your participation in the program is essential.

All employees are expected to learn all the safety aspects of their jobs and cooperate with both supervision and other employees in complying with our safety rules.

All employees and temporary contract personnel will be provided with a copy of PSI's Safety Manual.

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2. COMMON SENSE

The keynote to any Safety Program is common sense. Employees are required to know and follow the written safety policies. However, where no firm fast rule applies to a given situation, it is expected that employees will act prudently and reasonably.

Personal equipment must comply with all safety related standards.

The fact that a safety item may not be addressed in this manual does not relieve each and every employee from using common sense and employing safe practices and procedures in the performance of his or her work.

For example, when carrying or handling pipe or when using grinders it is expected that employees will avail themselves of safety gloves and other safety equipment provided by the company.

3. THE PSI SAFETY COMMITTEE

The PSI Safety Committee as an advisory board, will monitor all safety and occupational health-related subjects, and will advise Management on necessary corrective action to maintain a satisfactory level of safety throughout the company.

They will interpret governmental safety and health regulations as they apply to PSI, and conduct general inspections.

The Safety Committee consists of a Chairman, Secretary and other concerned employees who, as a unit, represent manufacturing and office areas. From time to time, a vacancy may occur on the Committee and such a vacancy will be announced by posting a notice on the bulletin board.

The remaining Committee members will, at a scheduled meeting attended by all the remaining members, review the list of interested applicants and vote to elect a new member to fill the vacancy.

The Company is a member of the Central Massachusetts Chapter of the National Safety Council and will continue to utilize the programs and benefits of this organization to its fullest extent.

Duties and Responsibilities of the Chairman

1) Schedule and preside over committee meetings.

2) Appoint members to special projects and programs, and follow up on reports and recommendations.

3) Act as company liaison with outside representatives, such as State Inspectors, insurance investigators, and OSHA Compliance Officers.

4) Coordinate the activities of the Safety Committee.

5) Issue reports of unsafe or housekeeping conditions to management.

6) Make available all committee minutes, inspection reports, and other documents relating to the safety program to interested employees.

7) Consult with and advise individuals or groups on safety matters, and keep management informed on basic safety principles and OSHA regulations.

Duties and Responsibilities of the Secretary:

1) Take and issue all minutes of the Safety Committee.

2) Act for the Chairman or as designated by the Chairman as company liaison with outside representatives, such as State Inspectors, insurance investigators, and OSHA Compliance Officers.

3) Issue reports to management of unsafe or housekeeping problems.

4) Maintain all committee minutes, inspection reports, and other documents relating to the safety program.

Duties of the Other Members are as Follows:

1) Conduct educational programs to employees on safety including, but not limited to, periodic safety films.

2) Transmit safety recommendations from other employees and from department managers and supervisors to the Safety Committee.

3) Consider the merits of all safety recommendations and assist in their implementation.

4) Carry out special projects as assigned by the Chairman.

5) Assist in general safety inspections.

The Goals of the Safety Committee are:

1) To ensure that PSI maintains a healthy and safe working environment for all employees.

2) To report safety suggestions to managers or appropriate supervisors.

3) To communicate and train each employee on an ongoing basis to do the job in the safest way.

4. TREATMENT AND REPORTING OF INJURIES

All injuries, no matter how minor, require treatment to prevent infection or to forestall complications.

Work related injuries/illness must be reported immediately to the employee's supervisor who will notify Health Services. The decision as to whether professional treatment is required should be made by the Company Doctor, Company Nurse or in their absence an employee who has passed the Red Cross First Aid Course, if available. A list of such employees will be maintained on the bulletin board. When in doubt, the injured employee should be sent for professional treatment.

A public or private ambulance service should be utilized in all cases which require emergency treatment and in which there appears to be imminent danger to an employee's health or well-being or where there is evidence of chest pains, cardiac symptoms or respiratory distress.

Other than emergency situations, in cases where it becomes necessary to transport a sick or injured person to a medical facility for further treatment, a Company vehicle should be utilized. If possible, the driver should be accompanied by another person.

An employee and/or his supervisor must report the details of any accident to the Personnel Department and/or Health Services either in person or by phone. After receiving professional treatment, the employee should discuss the details of the accident, and the doctor's findings as to whether the injury will result in lost time from work with the Personnel Department. This information is required for personal safety, work scheduling, insurance and OSHA purposes. Employees and/or their supervisor are required to promptly complete an accident report on a form and in the format required by the company. This form must be signed and forwarded to the company nurse within two (2) working days after the date of the accident.

All employees requiring professional medical treatment due to a work-related accident or illness may, at the sole discretion of the company, be seen by the Company Doctor, regardless of whether they are under their own doctor's care.

Employees injured on the job must submit a physician's statement, noting the length of disability and the expected work date to the Personnel Department prior to returning to work.

The injured employee should receive all follow-up treatment from the attending physician unless circumstances warrant treatment by another physician or nearest hospital.

Following a work related injury, your doctor may allow you to return to work with restrictions. As soon as possible, forward your Medical Status Report or Doctor's note to your supervisor in order to develop adjusted work duties. You are not allowed to resume working without a medical status report.

Employees who do not return to work on the day specified in the physician's statement may be scheduled for a follow-up visit with the attending physician and/or the Company Doctor to determine any change in the original recommendation for a return to work date.

All industrial accidents involving personal injury and illness other than basic first aid, will be subject to a formal follow-up investigation conducted by the employees' supervisor. The completed request will be forwarded to the Personnel Dept. within 3 working days. Discussion of the findings and action to be taken to correct the problem and eliminate a similar accident in the future will be handled by the Safety Committee.

5. SAFETY EMPHASIS AND TRAINING

It is the intent of PSI to ensure that safety is of utmost importance. To this end, no work shall be performed in the manufacturing, testing and facilities areas unless there are at least two (2) people physically present in the building.

Each supervisor is responsible to orientate new employees on safe practices, procedures and the hazards of chemicals, if any, in their work area. Further, each supervisor is responsible for the day-to-day safety of all personnel and equipment and for the continued enforcement of all safety policies and practices. All visitors are the responsibility of the PSI host.

Periodic training sessions on equipment operation, test procedures and safety are conducted by PSI supervisors and occasionally by outside consultants

Training will be implemented from time to time when results of shop inspections or other factors indicate a need for such training.

Additional training will be offered periodically to ensure that there are adequate personnel trained and certified to render First Aid and Emergency Treatment.

6. SAFETY EQUIPMENT

Employees working in manufacturing, painting and testing areas where their jobs require special safety apparatus such as face shields, gloves, ear protectors, respirators, face masks, etc. will be required to wear such items.

All major purchases of safety equipment will be made through the Operations Manager or his designee. Procurement of specialty safety items may be recommended by the Safety Committee. The Operations Manager will coordinate purchase requests to ensure that proper equipment is being purchased and that unnecessary duplication is avoided.

First aid kits and eyewash stations will be placed in strategic locations around the building. Employees are encouraged to use them as needed. Health Services and/or the Safety Committee is responsible for maintaining these kits and replenishing supplies. Please alert the Health Service or Safety Committee if supplies are needed in the kit in your department or area.

7. SAFETY GLASSES PROGRAM

PSI supports the policy of providing proper eye protection to all employees who by the nature of their job or working area require such protection. Individual supervisors have the responsibility of supporting and enforcing this policy for their employees.

Certain areas of the facility have been specified as safety glass areas, identified as such in writing or by posted signs. All production areas are designated as safety glass areas.

All employees will be provided with OSHA approved industrial type safety glasses. The cost of these glasses, including prescription glasses, but excluding eye examinations, will be borne by PSI. Thereafter, PSI will pay for the full cost of replacement glasses, provided that replacement is due to change of prescription, normal wear or industrial damage. In other cases, such as loss of glasses or non-industrial damage, the employee may be required to replace the glasses at his expense. The Company reserves the right to disapprove purchase of safety glasses if the policy appears to be abused.

Employees who do not normally work in safety glass areas, but who may periodically pass through these areas are also required to wear eye protection. However, temporary-type visitor glasses may be worn in such cases. This also applies to customers and other visitors. It is the duty of the hosting PSI employee to provide glasses for visitors. These may be obtained at all designated entrances to the shop production areas.

Lenses which become pitted or scratched lose their impact resistance and thus diminish their effectiveness as protection. In these instances, new safety glasses shall be obtained from the tool room. Prescription replacement lenses, however, can be obtained from the Company's designated optician.

An employee requiring prescription lenses will be issued a pair of prescription safety glasses through the designated optician. Regular prescription glasses do not provide adequate protection and should not be worn in lieu of safety glasses. Employees should obtain a form from health services which must be approved by their immediate supervisor. This form, together with the employee's prescription, will be forwarded to the designated optician. Employees will be required to pick up their own prescription glasses.

A representative from the Company's designated optician will visit PSI periodically to adjust safety glasses and advise employees in their use.

8. RESPIRATORS

In order to control potential occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the Company's primary objective shall be to prevent atmospheric contamination, in as far as feasible. This is normally done by accepted engineering control measures including an enclosed paint spray booth, wall fans and air scrubbers or filters.

In cases where the use of these controls are not feasible, it is the Company's policy to require the use of respirators which are suitable for the protection of the health of the employee. In particular and with respect to potential airborne lead, PSI requires the mandatory use of respirators by all employees when painting or performing operations incident to painting.

PSI Health Services will supervise its respirator program and perform, as required by OSHA, qualitative or quantitative fit tests at the time of initial fitting and periodically thereafter.

At regular intervals, evaluations will be conducted by the Safety Committee to determine the continued effectiveness of the program and to assure that respirators are properly selected, used, cleaned and maintained.

Written standard operating procedures governing the selection, use, training, inspection and maintenance of respirators are on file in the tool room and with the Company Nurse.

9. SAFETY SHOE PROGRAM

PSI supports the policy of providing proper foot protection in order to protect its employees in the work place.

Employees in the maintenance, stockroom, shipping, production, and test areas or whose duties require them to work periodically in such areas, as well as all Field Service Engineers, are required to wear approved protective footwear. Newly-hired employees who are employed in the above areas should report to work with safety footwear.

Foot protectors are available in the Tool Room for visitors use.

Approved footwear normally follows the guidelines of being boot-like in nature to cover the ankles, having a reinforced steel toe, and having soles of a rubber base (neoprene or gum), not leather. The Personnel Department may advise employees of other guidelines to be followed in selecting safety footwear.

Safety footwear may be ordered through PSI. However, employees have the option of purchasing their own safety shoes from a store of their choice.

An employee who is required to wear safety footwear and wishes to purchase it on his own should obtain approval from his supervisor and submit the receipt to the Accounting Department for reimbursement. Reimbursement/payment by the Company will be made upon presentation of proper receipts and is limited to the cost of the shoes up to a maximum set by PSI. The Company reserves the right to disapprove purchase of safety shoes if the policy appears to be abused.

10. HOUSEKEEPING

Employees are expected to keep their work areas clean and neat and void of safety hazards. This includes, but is not limited to, disposing of trash in proper receptacles, electrical wires and cords pulled out of pathways, keeping desks and file drawers closed when not in use, keeping items away from electrical space heaters, turning off such equipment when not in use, cleaning up liquid spills in office areas and hallways, and returning tools and equipment to the proper storage area.

A shop-wide cleanup is encouraged to be done on a weekly basis. Both scheduled and unscheduled plant inspections are made by members of the Safety Committee from time to time to ensure a safe working environment.

11. DISCIPLINE

A disciplinary program has been established to ensure compliance with PSI's Safety Program. An employee who violates safety rules will be given a written warning. This form will be sent to the Personnel Manager for filing. A progressive series of disciplinary measures may be administered up to and including termination. EMPLOYEES SHOULD BE AWARE THAT IN CERTAIN CIRCUMSTANCES, SUCH AS A SERIOUS INFRACTION OF A SAFETY RULE, WARNINGS MAY NOT FOLLOW A PROGRESSIVE SYSTEM AND MAY RESULT IN SUSPENSION OR DISCHARGE.

Individual supervisors are the primary individuals responsible for the enforcement of proper discipline and compliance with all safety policies and regulations, however, group leaders, managers and the safety committee are also responsible for enforcement of safety policies and procedures.

12. FIRE LANES AND COMMON AISLEWAYS

Employees should park only in prescribed parking lines in the parking lot. All other areas are designed as fire and emergency access lanes.

Employees should keep all common aisleways accessible and free from clutter and storage of material. Designated aisleways will be properly marked.

13. FIRE EXTINGUISHERS

Fire extinguishers have been strategically placed throughout the plant and each location marked and identified. It is imperative that all fire extinguishers be accessible at all times. If a fire extinguisher is being blocked, it should be reported to any supervisor or safety committee member.

All fire extinguishers throughout the plant are routinely inspected on a monthly basis and serviced when necessary by PSI's maintenance personnel. The accessablity, proper functioning of these extinguishers and keeping of necessary records is the responsibility of the Maintenance Department.

14. STORAGE OF FLAMMABLES

In accordance with OSHA regulations, all flammable and combustible chemicals are stored by PSI in a separate outside shed or approved storage cabinets.

Certain small quantities of flammables and combustibles may be kept in work areas when actually being used provided proper safety containers are used and properly labeled.

15. STORAGE OF GAS BOTTLES

All gas cylinders are stored in a covered designated area which is well protected, well ventilated, dry and located no less than 20 feet from highly combustible materials, sparks, open flames and excessive heat.

Cylinders connected for use must be lashed or chained to prevent them from toppling over. When cylinders are not connected for use, valve protection caps must be in place.

Partially used tanks are to be properly marked.

Inside storage of oxygen cylinders must be separated from stored fuel gas cylinders or combustible material by at least 20 feet or by a noncombustible barrier, said barrier to be at least 5 feet high and have a fire resistance rating of one-half hour.

Employees using gas bottles will be expected to return them to the designated storage area, properly marked, with a cap and chain properly secured to said bottles.

16. HAZARDOUS MATERIAL

In cases where employees may be potentially exposed to chemicals such as liquid, vapors, dust, etc., which may be hazardous to their health, it is their supervisor's responsibility to ensure that they are provided with adequate and proper protective equipment and that they are notified of such potential exposure.

The company supports current regulations pertaining to hazardous and toxic chemicals and has implemented a compliance program to ensure all requirements are met.

PSI is considered to be a very small generator of hazardous waste and maintains an EPA identification number of MAD004378782.

A hazardous waste technician is responsible to ensure that collections, temporary storage and shipment of this material is in strict compliance with all regulations.

Specific programs are in place which comply fully with Massachusetts Regulation 310CM30, OSHA 29 CFR 1910, resourse conservation recovery act and the federal landfill ban of Nov. 7, 1986.

17. FORKLIFTS

The operation of forklifts is restricted to those employees who have passed the forklift operator training course and who have been found qualified by a certified training instructor to operate forklifts. Any unauthorized employee operating a forklift will be subject to disciplinary action.Forklift operators must obey all OSHA rules and standards as specified in the Code of Federal Regulations (Section 1910.178).

New employees will be instructed in the proper use of forklifts and tested periodically by certified training instructors.

18. CRANES AND LIFTING DEVICES

All cranes and associated lifting equipment (slings, chains, etc.) shall be inspected every 6 months by a qualified inspector. A log shall be maintained and all equipment have a tag attached showing date inspected and date due.

19. X-RAY

All x-rays at PSI are performed by properly experienced and certified personnel. Currently all x-rays are performed by independent contractors at our facility.

It is the policy of PSI to have all x-rays performed after normal working hours and after such work areas have been roped off. Signs are placed at the entrance to all affected areas.

20. GENERAL WELDING SAFETY

Essentially welding is not a hazardous occupation if proper precautionary measures are always observed. This requires continuous awareness of possibilities of danger and habitual safety precaution by the welder. In addition, it requires that the supervisor be alert, responsible and tough in enforcing safety regulations. The following safety precautions should always be practiced when welding and cutting:

Make sure your welding equipment is installed properly and grounded and is in good condition.

Always wear protective clothing suitable for the welding to be done.

Always wear proper eye protection, when welding, grinding or cutting.

Keep your work area clean and free of hazards. Make sure that no flammable, volatile or explosive materials are in or near the work area.

Handle all compressed gas cylinders with extreme care. Keep caps on when not in use.

Make sure that compressed gas cylinders are secured to the wall or to other structural supports, or the machine.

When compressed gas cylinders are empty, close the valve and mark the cylinder "EMPTY" and return empty to appropriate area.

Do not weld in a confined space without extra special precautions.

Do not weld on containers that have held combustibles without taking extra special precautions.

Do not weld on sealed containers or compartments without providing vents and taking special precautions.

Use mechanical exhaust at the point of welding when appropriate, e.g., flux core, aluminum, brazing, etc.

When it is necessary to weld in a damp or wet area, wear rubber boots and stand on a dry insulated platform.

When the electrode holder is not in use, hang it on brackets provided. Never let it touch a compressed gas cylinder.

Dispose of electrode stubs in proper container since stubs on the floor are a safety hazard.

Shield others from the light rays produced by your welding arc.

Do not weld near degreasing operations.

When working above ground make sure that scaffold, ladder or work surface is solid, with appropriate safety equipment in place.

When welding in high places without railings, use safety belt or lifeline.

When using water-cooled equipment, check for water leakage.

Before disconnecting the welding machine, make sure the main power disconnect on wall is turned off.

21. EMERGENCY PROCEDURES

A separate written contingency plan is on file in the Personnel Department and copies have been forwarded to all group managers. This plan will be utilized to minimize health hazards to employees or visitors from imminent or potential danger associated with a fire, bomb threat, chemical spill or other hazard. This will include a procedure to evacuate the facility or affected area and notification to local police, fire department, D.E.Q.E. and other regulatory authorities.

Emergency exit routes are posted on all bulletin boards.

Emergency phones for outgoing calls are maintained on each floor. Refer to telephone list.

In the event of a power failure, a Safety Committee Representative or the Maintenance Department will be responsible to assess the damage and report the same to the President or person in charge at the time who will decide the course of action to be implemented.

22. EMERGENCY COORDINATOR

The duties of the emergency coordinator or his designee will include the following:

Evaluate the nature of the emergency and notify management.

Coordinate emergency response, both in-house and with outside assistance.

Ensure evacuation procedures are carried out and that all personnel are accounted for.

Responsible for notification of other agencies.

Responsible for implementation and adherence to the "Right-to-Know Program".

Oversee the Hazardous Chemical Program.

23. ILLEGAL DRUGS, NARCOTICS AND ALCOHOL

It has been a long standing policy of the company to maintain for all its employees a work environment conducive toward maximum safety and optimum work standards. To this end, P.S.I. has a separate written policy on illegal drugs, narcotics and alcohol.

The company supports and complies with the Federal Drug Free Work Place Act.

24. ENVIRONMENT, HEALTH AND SAFETY POLICY

Process Systems' policy is to manage all operations in a manner that protects the environment and the health and safety of employees, customers, contractors and the public.

25. SAFETY MANUAL MODIFICATIONS

PSI reserves the right, at any time, to make alterations, modifications and revisions to its Safety Policies and Procedures. All changes will be communicated to PSI's employees.

ACKNOWLEDGEMENT

I _____ have been issued a copy
(Name)

of the Process Systems International, Inc. Safety Manual on
_____ by my supervisor _____.
(Date)

I understand that it is my responsibility to read the manual and to comply with all the safety policies of Process Systems International, Inc. Further, I understand that failure to comply with safety rules could result in disciplinary action by my supervisor.

I hereby make the commitment to PSI that I will work in a safe manner at all times and will comply with the published safety rules.

_____
(Employee's Signature)

_____ _____
(Supervisor's Signature) (Date)

ATTACHMENT 6

OUTSIDE CONSULTANTS

PROJECT MANAGEMENT PLAN
OUTSIDE CONSULTANTS

1. **Steve Dangel**
   Dangel Robots and Machinery
   Area: Machine Design/Robots

2. **Barry Newark**
   Consultant
   Area: Welding and Metallurgical Engineering

3. **Prof. Dennis Manos**
   College of William and Mary
   Area: Material Scientist and UHV Design

4. **Dr. Norman Peacock**
   Consultant
   Area: Viton O-Ring Design and UHV Design

5. **Metrowest Engineering Inc.**
   Civil Engineering/Surveying
   Area: Laser Alignment/Surveying

Title: SPECIFICATION FOR EQUIPMENT PURCHASE COMMERCIAL REQUIREMENTS

SPECIFICATION FOR

EQUIPMENT PURCHASE COMMERCIAL REQUIREMENTS

FOR

LIGO VACUUM EQUIPMENT

Hanford, Washington
and
Livingston, Louisiana

PREPARED BY: William J. Murphy

QUALITY ASSURANCE: Allen L Bradbury

TECHNICAL DIRECTOR: D.A. McWilliams

CONTRACTS MANAGER: William J Murphy

PROJECT MANAGER: Richard Bagley

MATERIALS MANAGER: Ronald Berto

REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE
0	W.J. MURPHY		INITIAL RELEASE / DEO 0008

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION	
INITIAL APPROVALS	PREPARED W. M.	DATE 10/31/95	APPROVED RBB	DATE 10/31/95	Number V049-2-034 Rev. 0

SPECIFICATION TABLE OF CONTENTS

Attachments:

Number

Rev.

SPECIFICATION

Number A V049-2-034 Rev. 0

PS-997

1.0 GENERAL

In the event of any inconsistency in this Purchase Order, the inconsistency shall be resolved by giving precedence in the following order:

a. Purchase Order
b. Specification(s)
c. General Provisions
d. Additional Terms and Conditions
e. Terms and Conditions

2.0 GENERAL PROVISIONS

General Provisions, Articles 6 through 32, and the National Science Foundation Grant Policy Manual, Section 750 are incorporated herein as Attachment A. For interpretation and implementation of these provisions, Buyer and Seller is to be inserted as appropriate.

3.0 ADDITIONAL GENERAL PROVISIONS

Additional General Provisions are incorporated herein as Attachment B.

4.0 TERMS AND CONDITIONS

Terms and Conditions are incorporated herein as Attachment C.

5.0 CERTIFICATIONS

Certifications that must be completed prior to award of any resulting Purchase Order are incorporated herein as Attachment D.

(e) Nothing in this Article shall excuse the Contractor from proceeding with the Contract as modified.

ARTICLE 5 - Required Notices

Unless otherwise specified in this Contract, any notice which the Contractor is required to provide to Caltech shall be directed to the Manager of Caltech Purchasing Department, with a copy to the LIGO cognizant Technical Manager.

✓ ARTICLE 6 - Subcontracts / Prior Review and Comment

Unpriced purchase order in excess of $100,000 shall be submitted to LIGO's cognizant Technical Manager. Additionally, Caltech shall have unrestricted access to all subcontractors under this Contract.

✓ ARTICLE 7 - Competition

All procurement transactions under this Contract including those of subcontractors, shall be conducted in a manner providing to the maximum extent practical, open and free competition.

✓ ARTICLE 8 - Utilization of Small Business Concerns

It is the policy of the United States Government that small business concerns including those owned and controlled by socially and economically disadvantaged individuals, shall have the maximum practicable opportunity to participate in performing in contracts sponsored by any Federal agency. It is further the policy of the United States, that contractors establish procedures to ensure timely payment of amounts pursuant to the terms of their subcontracts with such small businesses. The Contractor agrees to implement and support this policy to the maximum practicable extent in the performance of this Contract.

The substance of this Article shall be included in all subcontracts issued under this Contract exceeding $10,000.

✓ ARTICLE 9 - Acknowledgment of Support

The Contractor and their subcontractors, as appropriate, shall acknowledge NSF support in any publication of any material based on or developed under this Contract, in the following terms:

> "This material is based upon work supported by the National Science Foundation under the Cooperative Agreement with the California Institute of Technology, No. PHY-9210038. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the view of the National Science Foundation."

✓ARTICLE 10 - Metric System

All reports and publications resulting from this Contract shall use metric system of weights and measures, unless its use is impractical or is likely to cause significant inefficiencies.

✓ ARTICLE 11 - Assignment of Rights and Delegation of Duties

(a) The Contractor may assign monies due or to become due under this Contract, subject to the following conditions:

1. Any assignment, or subsequent reassignment, shall cover all amounts payable under this Contract and not paid as of (i) the effective date of assignment, or (ii) the date Caltech receives written notice of assignment, whichever is later.

2. No assignment may be made to more than one party.

3. Two copies of the notice of assignment, signed by the assignor, shall be furnished to Caltech.

4. No assignment may be made which includes, either specifically or by implication, any delegation of Contractor's duty to perform the work or provide the items required by this Contract without the prior written consent of Caltech, provided however, that nothing contained herein shall be deemed to prohibit the Contractor from placing subcontracts.

✓ARTICLE 12 - Liability and Indemnification / Land Holders

In addition to provisions in Article 32, Insurance and Indemnification, the following protection is assured to the "land holders" for the LIGO Hanford, WA and Livingston, LA sites:

1. Although the Louisiana State University (LSU) is the beneficial owner of the land on which the LIGO facility in the State of Louisiana is to be constructed and operated, the real party in interest obtaining the benefit of this contract performance is the California Institute of Technology (Caltech/LIGO Project), acting as the awardee of the National Science Foundation (NSF). LSU is not associated with, nor represented by, either NSF or the LIGO Project, and as such, neither NSF nor the LIGO Project may bind LSU to any action of the subcontract responsibility with respect to the subject Contract. Therefore, neither LSU nor the State of Louisiana, shall be liable, directly or indirectly, for the payment of any sums, or the performance of any obligations which are the subject of this Contract.

2. The Contractor agrees to indemnify and save harmless DOE, the contractors of DOE and the officers, employees, authorized representatives and subcontractors of DOE from any claims, costs (including, but not limited to attorney fees, consultant fees and/or expert witness fees) or liabilities (including, but not limited to sums paid in settlement of claims), arising during the term of this Contract or thereafter form the injury or death of any person

or persons or the damage of any property directly attributable to the performance under the subject Contract and not otherwise attributable to any preexisting conditions. This provision shall not apply if injury, death or damage to any property is attributable to the negligence or willful misconduct on the part of DOE, the contractors of DOE or the officers, employees, authorized representatives or subcontractors of DOE.

3. The substance of this Article shall be included in all subcontracts issued under this contract.

✓ ARTICLE 13 - Audit Rights

The Comptroller General of the United States, NSF and Caltech, and any of their duly authorized government representatives, shall have access to any books, documents, papers and records of the Contractor and their subcontractors, as appropriate, and their subcontractors, as which are directly pertinent to the subject Contract for the purpose of making audits, examinations, excerpts and transcripts. The subject access to books, documents, papers and records shall be available until three (3) years after the final payment under this Contract.

✓ ARTICLE 14 - Audit / Negotiations

If, pursuant to law, the Contractor has been required to submit cost or pricing data in connection with pricing this Contract or any modifications of this Contract, the authorized representatives of the Government shall have the right to examine and audit all books, records, documents and other data of the Contractor (including computations and projections) related to negotiating, pricing, or performing the Contract or Contract modification, in order to evaluate the accuracy, completeness and currency of the submitted cost or pricing data.

The substance of this Article shall be included in all negotiated subcontracts issued under this Contract exceeding $100,000.

✓ ARTICLE 15 - Authorization and Consent / Government Patents

The Government authorizes and consents to all use and manufacture of any Government owned inventions and licensing rights in the performance of the Contract or any subcontract issued under this Contract regardless of tier.

✓ ARTICLE 16 - Rights to Inventions and Materials

Matters regarding rights to inventions and materials generated under this Contract are subject to the NSF Grant policy, contained in the NSF Grant Policy Manual. Section 750, Intellectual Property, Exhibit V.

✓ ARTICLE 17 - Rights in Data

(a) Allocation of Rights

1. Except as provided in paragraph (b) of this Article regarding copyright, the Government and in support and furtherance of its Government contract obligations, Caltech, shall have unlimited rights in:

   A. Data first produced in the performance of this Contract;

   B. Form, fit, and function data delivered under this Contract;

   C. Data delivered under this Contract that constitute manuals or instructional and training material for installation, operation, or routine maintenance and repair of items, components, or processes delivered or furnished for use under this Contract; and

   D. All other data delivered under this Contract unless provided otherwise in this Contract.

2. The Contractor shall have the right to:

   A. Use, release to others, reproduce, distribute, or publish any data first produced or specifically used in the performance of this Contract;

   B. Protect from unauthorized disclosure and use those data which are limited rights data to the extent provided in this Contract;

   C. Substantiate use of, add or correct limited rights, restricted rights, or copyright notices and to take other appropriate action, in accordance with paragraphs (d) and (e) of this Article; and

   D. Establish claim to copyright subsisting in data first produced in the performance of this Contract to the extent provided in Article 16, Rights to Inventions and Materials and subparagraph (b) below.

(b) Copyright

1. Data first produced in the performance of this Contract. When claim to copyright is made, the Contractor shall affix an acknowledgment of Government sponsorship as indicated in Article 9, Acknowledgment of Support. The Contractor grants to the Government, and in support and furtherance of its Government contract obligations, Caltech, and others acting on their behalf, a paid-up, nonexclusive, irrevocable worldwide license in such copyrighted data to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly by or on behalf of the Government.

2. Data not first produced in the performance of this Contract. The Contractor shall not, without prior written permission of Caltech, incorporate in data delivered under this Contract any data not first produced in the performance of this Contract, unless the Contractor identifies such data and grants to the Government, and in support and furtherance of its Government contract obligations, Caltech, or acquires on their behalf, a license of the same scope as set forth in subparagraph above.

(c) Release, Publication and Use of Data

1. The Contractor shall have the right to use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Contractor in the performance of this Contract, except to the extent such data may be subject to the Federal export control or national security laws or regulations, or unless otherwise provided in this Contract.

2. The Contractor agrees that to the extent it receives or is given access to data necessary for the performance of this Contract which contain restrictive markings, the Contractor shall treat the data in accordance with such markings unless otherwise specifically authorized in writing by Caltech.

(d) Subcontracting. The Contractor has the responsibility to obtain from its subcontractors all data and rights therein necessary to fulfill the Contractor's obligation to the Government and Caltech under this Contract. If a subcontractor refuses to accept terms affording the Government or Caltech such rights, the Contractor shall promptly bring such refusal to the attention of Caltech and not proceed with subcontract award without further authorization.

(e) Relationship to Patents. Nothing contained in this Article shall imply a license to the Government or Caltech under any patent or be construed as affecting the scope of any license or other right otherwise granted to the Government or the Institute.

✓ ARTICLE 18 - Notice and Assistance Regarding Patent and Copyright Infringement

(a) The Contractor shall report to Caltech promptly, and in reasonable written detail, each notice or claim of patent or copyright infringement based on the performance of this Contract.

(b) In the event of any claim or suit against the Government and/or Caltech on account of any alleged patent or copyright infringement arising out of the performance of this Contract or out of the use of any supplies furnished or work or services performed under this Contract, the Contractor shall furnish to Caltech, when so requested, all evidence and information in possession of the Contractor pertaining to such suit or claim. Such evidence and information shall be furnished at the expense of Caltech except where the Contractor has agreed to indemnify Caltech.

✓ ARTICLE 19 - Equal Employment Opportunity

By acceptance of this Contract, the Contractor assures Caltech that it and its subcontractors will comply with and implement the following Acts:

(a) Title VI of the Civil Rights Act of 1964 (PL 88-352), the regulations issued pursuant to this Act by the NSF (45 CFR 611), and the Assurance of Compliance the Contractor has filed with Caltech.

(b) Section 504 of the Rehabilitation Act of 1973 (29 U.S.C. 794) and NSF's implementing regulations (45 CFR 605, as amended at 55 Federal Register 52142).

(c) Age Discrimination Act of 1975 as implemented by the Department of Health and Human Service regulations at 45 CFR 90 and the regulations of NSF at 45 CFR 617.

(d) Vietnam Era Veterans Readjustment Assistance Act of 1972, as amended, and

(e) Americans with Disabilities Act 42 U.S.C. Section 12101 et. seq. and all implementing regulations.

✓ ARTICLE 20 - Notice of Labor Disputes

The Contractor shall give prompt notice to Caltech of any actual or potential labor disputes which delay or may delay timely performance of this Contract.

✓ ARTICLE 21 - Labor Regulations

It is anticipated that this Contract will involve employment of mechanics and laborers as defined within the scope of the below Acts.

> Davis Bacon Act, Contract Work Hours and Safety Standards Act-Overtime Compensation, Apprentices and Trainees, Payrolls and Basic Records, Compliance with Copeland Regulations, Withholding of Funds, Subcontracts, Contract Termination-Debarment, Buy American Act-Construction, and Disputes Concerning Labor Standards.

All Contracts in excess of $2,500 involving employment of mechanics and laborers shall include a provision for compliance with Sections 103 and 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-330) as supplemented by the Department of Labor regulations (29 CFR, Part 5) and as indicated in the Additional General Provisions, Article 2, Contract Work Hours and Safety Standards Act-Overtime Compensation.

The substance of this Article shall be included in all subcontracts issued under this Contract in excess of $2,500 involving employment of mechanics and laborers and in excess of $2,000 for construction, alteration or repair that are within the scope of the above Acts, regardless of tier.

✓ ARTICLE 22 - Safety and Health

The Contractor shall take all reasonable safety and health measures in performing under this Contract, and shall comply with all applicable Federal, state and local laws relating to safety and health in effect on the date of this Contract.

✓ ARTICLE 23 - Hazardous Materials

The Contractor shall comply with all applicable Federal, State, and local laws, codes, ordinances, and regulations (including the obtaining of licenses and permits) in connection with hazardous material. Neither the requirements of this Article nor any act or failure to act by the Government or Caltech shall relieve the Contractor of any responsibility or liability for the safety of Government, Caltech, Contractor, or subcontractor personnel or property.

The Contractor agrees to submit to Caltech material safety information and a plan for handling of any and all hazardous materials delivered under this Contract which will involve exposure to hazardous materials or items containing these materials. The handling including disposition of hazardous materials shall be in accordance with the plan and as approved by Caltech.

The substance of this Article shall be included all in subcontracts issued under this Contract involving hazardous material.

✓ ARTICLE 24 - Drug Free Workplace

The Contractor agrees to inform all Contractor and subcontractors personnel, prior to their first entrance upon Caltech-controlled premises, of Caltech's compliance with the Drug-Free Workplace Act and of requirements for that Contractor and subcontractor personnel to comply with this policy of maintaining a drug-free workplace in all Caltech-controlled premises.

✓ ARTICLE 25 - Convict Labor

The Contractor including its subcontractors agree not to employ any person undergoing sentence of imprisonment in performing this Contract except as provided by 18 U.S.C. 4082(c)(2) and Executive Order 11755, December 29, 1973.

✓ ARTICLE 26 - Buy American Act

The Buy American Act (41 U.S.C. 10) provides that the Government give preference to domestic supplies and construction materials. Accordingly, the Contractor agrees to deliver only domestic end products, as defined by the Buy American Act including exceptions therein. in the performance of this Contract.

The substance of this Article shall be included in all subcontracts issued under this Contract for procurement of significant supplies and/or materials subject to the Buy American Act.

✓ ARTICLE 27 - Preference for Privately owned U.S.-Flag Air Carriers and Commercial Vessels

The Contractor and their subcontractors, as appropriate, shall use privately owned U.S. Air Carriers and U.S.-flag commercial vessels and no others, in the air and/or ocean and river transportation of any personnel, supplies and materials, to be furnished under this Contract.

✓ ARTICLE 28 - Anti-Kickback

The Contractor and their subcontractors shall comply with the Anti-Kickback Act of 1986 (41 U.S.C. 51-58) (the Act).

✓ ARTICLE 29 - Restrictions on Subcontractor Sales

Except as provided below, the Contractor nor any subcontractor, shall not enter into any agreement with an actual or prospective subcontractor, nor otherwise act in any manner, which has or may have the effect of restricting sales by such subcontractors directly to Caltech or the Government of any item or process made or furnished by the subcontractor under this Contract.

The prohibition above does not preclude the Contractor from asserting rights that are otherwise authorized by law or regulation.

✓ ARTICLE 30 - Clean Air and Water

The Contractor shall comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act of 1970 (42 U.S.C. 1857 et seq.) and the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.) as amended. Violations shall be reported to NSF and the Regional Office of the Environmental Protection Agency.

The substance of this Article shall be included in any nonexempt subcontract exceeding $100,000.

ARTICLE 31 - Prohibition of Contractor Use of Privately Owned Aircraft

The Contractor, its employees, agents and subcontractors shall not use privately owned (non commercial) aircraft in the performance of this Contract without having in effect Aircraft Liability Insurance coverage of not less than $5,000,000 for all deaths, injuries and property damage arising from one accident or occurrence.

The substance of this Article shall be included in any subcontract issued under this Contract involving air transportation travel regardless of tier.

✓ ARTICLE 32 - Insurance and Indemnification

The Contractor shall take such steps as may be deemed necessary to insure or protect itself, its employees and its property. Accordingly, the Contractor shall provide appropriate insurance coverage for all supplies, equipment and personnel involved with the Contract effort. Neither

Caltech, NSF, Department of Energy (DOE) or Louisiana State University (LSU), shall assume any liability for accidents, illnesses, or claims arising out of any work supported by this Contract.

(a) Insurance. The Contractor shall, at its own expense, provide and maintain during the entire performance period of this Contract, following kinds and minimum amounts of insurance:

1. Workers' Compensation and Employer's Liability Insurance, as required by applicable Federal and state workers' compensation and occupational disease statutes. If occupational diseases are not compensable under those statutes, they shall be covered under the Employer' Liability section of the insurance policy, except when Contract operations are so commingled with the Contractor's commercial operations that this would not be practical. The employer's Liability coverage shall be $500,000 per accident, except in states with exclusive or monopolistic funds that do not permit worker's compensation to be written by private carriers. However, the Contractor in fulfillment of its obligation to provide Workers' Compensation Insurance may maintain a self-insurance program if the Contractor is qualified pursuant to statutory authority to do so.

2. Comprehensive Liability Insurance, including automobiles (owned, non-owned, or leased), completed operations, products, and contractual liability, for a combined single limit of $1,000,000 for all deaths, injuries, and property damage arising from one accident or occurrence.

(b) The Contractor shall include as additional insureds, Caltech, NSF, Department of Energy (DOE) and LSU, which are third parties of interest, and as indicated in the Attachment to this General Provisions.

(c) Insurance Certificates. Before commencing work under this Contract, the Contractor shall furnish certificates of insurance for the coverages required hereunder. Such certificates shall provide that any cancellation or material change in the insurance policies shall not be effective (i) for such period as the laws of the State in which this Contract is to be performed prescribe, or (ii) until 30 days after the insurer or the Contractor gives written notice to Caltech, whichever period is longer. Also, such certificates shall (i) cover contractual liability assumed under this Contract, and (ii) be primary and non-contributing to any insurance procured by Caltech.

(d) Indemnification. The Contractor agrees to indemnify and hold harmless the Government and Caltech, its trustees, officers, and employees, from any third party loss, cost, damage, expense or liability, or any suit therefore, by reason of actual or alleged property damage or personal injury of whatsoever kind or character arising out of or in connection and occurring during the performance of work hereunder by the Contractor or any of its subcontractors, howsoever the same may be caused, excepting only such loss, cost, damage, expense or liability attributable to and to the extent of the negligence or fault of the Government or of Caltech, its trustees, officers or employees.

(e) The substance of this Article, including this paragraph (d), shall be included in all subcontracts issued under this Contract regardless of tier on LIGO remote sites. At least five days before entry of each such subcontractor's personnel on the Caltech-controlled premises, the Contractor shall furnish (or ensure that there has been furnished) to Caltech a current certificate of insurance, meeting the requirements of paragraph (b) above, for each such subcontractor.

ARTICLE 33 - Permits and Responsibilities

The Contractor shall, without additional expense to Caltech, be responsible for obtaining any necessary licenses and permits, and for complying with any Federal, State, and municipal laws, codes, and regulations applicable to the performance of the work. The Contractor shall also be responsible for all damages to persons or property that occur as a result of the Contractor's fault, or negligence, and shall take proper safety and health precautions to protect the work, the workers, the public, and the property of others. The Contractor agrees to indemnify Caltech and the Government against any loss, cost, liability or damage by reason of the Contractor's violation of or failure to comply with any applicable laws, executive orders or regulations. Caltech will obtain the necessary project permits, including but not limited to, building occupancy and operating permits for each site as required. No special permits will be required by Caltech, DoE or NSF.

ARTICLE 34 - Other Contracts

(a) Caltech may undertake or award other contracts for additional work at or near the site of the work under this Contract. The Contractor shall fully cooperate with the other contractors and with Caltech employees and shall carefully adapt scheduling and performing the work under this Contract to accommodate the additional work, heeding any direction that may be provided by Caltech. The Contractor shall not commit or permit any act that will interfere with the performance of work by any other contractor or by Caltech employees.

(b) Where the Contractor's work is associated with that of another contractor, the Contractor shall examine the adjacent work and report in writing to Caltech any defect or condition preventing the proper performance of this Contract. If the Contractor proceeds without giving such notice, the Contractor shall not be relieved of the obligation of any warranty because of any such condition or imperfection.

(c) The Contractor's work at the site will be performed on a joint occupancy non-interference basis as defined in Article 1 and as specified in the Contract.

750 INTELLECTUAL PROPERTY

751 Patents and Inventions

751.1 Background

a. The disposition of rights to inventions made by *small* business firms and nonprofit organizations, including universities and other institutions of higher education, during NSF-assisted research is governed by chapter 18 of title 35 of the United States Code, commonly called the Bayh-Dole Act. In accordance with a Presidential Memorandum entitled "Government Patent Policy" issued February 18, 1983 and under the authority of section 12 of the National Science Foundation Act of 1950, as amended (42 U.S.C. Section 1871), NSF applies the policies of that Act of all its grantees. The Department of Commerce is the lead agency for implementing the Bayh-Dole Act and has published guidance to Federal agencies as part 401 of title 37 of the Code of Federal Regulations. The Foundation's implementing rules are published as part 650 of title 45 of the Code of Federal Regulations.

b. NSF's standard Patent Rights clause, published at 45 CFR Section 650.4(a) and below at GPM 751.3, is identical to that prescribed in the DOC guidelines (37 CFR Section 401.14(a)) except that:

1. NSF has tailored the clause to apply to grants and to identify NSF;
2. pursuant to section 401.5(d) of the DOC guidance (37 CFR Section 401.5(d). NSF has added to paragraph (b) of the clause a stipulation that the Foundation reserves the right to direct a grantee to transfer to a foreign government or research performer such rights to any subject invention as are required to comply with any international treaty or agreement identified when the grant is made as being applicable to the assisted research;
3. as permitted by sections 401.5(f) of the DOC guidance (37 CFR Section 401.5(f)), NSF has added two subparagraphs to the end of paragraph (f) of the clause to require grantees or their representatives to send to the Foundation confirmations of the Government licenses for and copies of any United States patents on subject inventions; and
4. since NSF normally uses the same clause for all subcontractors, the first two subparagraphs of paragraph (g) of the clause specified in the DOC guidance have been reduced to one.

751.2 National Science Foundation Patent Policy

As authorized by the National Science Board at its 230th meeting, October 15-16, 1981, the Director of the National Science Foundation has adopted the following statement of NSF patent policy.

(a) In accordance with, by the Bayh-Dole Act and the Presidential Memorandum entitled "Government Patent Policy" issued February 18, 1983, the Foundation will use the Patent Rights clause prescribed by the Department of Commerce in all its funding agreements for the performance of experimental, developmental, or research work, including awards made to foreign entities, unless the Foundation determines that some other provision would better serve the purposes of that Act or the interests of the United States and the general public.

(b) In funding agreements covered by a treaty or agreement that provides that an international organization or foreign government, research institute, or inventor will own or share patent rights, the Foundation will acquire such patent rights as are necessary to comply with the applicable treaty or agreement.

(c) If an awardee elects not to retain rights to an invention, the Foundation will allow the inventor to retain the principal patent rights unless the awardee, or the inventor's employer if other than the awardee, shows that it would be harmed by that action.

(d) The Foundation will normally allow any patent rights not wanted by the awardee or inventor to be dedicated to the public through publication in scientific journals or as a statutory invention registration. However, if another Federal agency is known to be interested in the relevant technology, the Foundation may give it an opportunity to review and patent the invention so long as that does not inhibit the dissemination of the research results to the scientific community.

751.3 Standard Patent Rights Clause

The following Patent Rights clause will be used in every funding agreement awarded by the Foundation that relates to *scientific or engineering* research unless a special patent clause has been negotiated (see GPM 753.1). When the clause is used in a funding agreement other than a *grant*, "*grant*" and "grantee" may be replaced by "contract" and "contractor" or other appropriate terms.

PATENT RIGHTS (APRIL, 1992)

(a) Definitions

(1) "Invention" means any invention or discovery which is or may be patentable or otherwise protectable under title 35 of the United States Code, to any novel variety of plant which is or may be protected under the Plant Variety Protection Act (7 USC 2321 et seq.).

(2) "Subject Invention" means any invention of the grantee conceived or first actually reduced to practice in the performance of work under this grant, provided that in the case of a variety of plant, the date of determination (as defined in section 41(d) of the Plant Variety Protection Act (7 USC 2401(d)) must also occur during the period of grant performance.

(3 "Principal application" means to manufacture in the case of a composition or product, to practice in the case of a process or method, or to operate in the case of a machine or system; and, in each case, under such conditions as to establish that the Invention is being utilized and that its benefits are to the extent permitted by law or Government regulations available to the public on reasonable terms.

(4) "Made" when used in relation to any Invention means the conception or first actual reduction to practice of such invention.

(5) "Small business firm" means a domestic small business concern as defined act section 2 of Pub. L. 85-536 (15 USC 632) and implementing regulations of the Administrator of the Small Business Administration. For the purpose of this Patent Rights clause, the size standard for small business concerns involved in Government procurement and subcontracting at 13 CFR 121.3-8 and 13 CFR 121.3 -12, respectively, will be used.

(6)"Nonprofit organization" means a domestic university or other institution of higher education or an organization of the type described in section 501(c)(3) of the Internal Revenue Code of 1954 (26 USC 501(c)) and exempt from taxation under section 501(a) of the Internal Revenue Code (28 USC 501(a)) or any domestic nonprofit scientific or educational organization qualified under a State nonprofit organization statute.

(b) Allocation of Principal Rights

The grantee may retain the entire right, title, and interest throughout the world to each subject Invention subject to the provisions of this Patents Rights clause and 35 USC 203. With respect to any subject Invention in such the grantee retains title, the Federal Government shall have a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States the subject Invention throughout the world. If the award indicates it is subject to an identified International agreement or treaty, the National Science Foundation (NSF) also has the right to direct the grantee to convey to any foreign participant such patent rights to subject inventions as are required to comply with that agreement or treaty.

(c) Invention Disclosure, Election of Title and Filing of Patent Applications by Grantee

(1) The grantee will disclose each subject Invention to NSF within two months after the Inventor discloses it in writing to grantee personnel responsible for the administration of patent matters. The disclosure to NSF shall be in the form of a written report and shall identify the grant under which the invention was made and the Inventor(s). It shall be sufficiently complete in technical detail to convey a clear understanding of the nature, purpose, operation, and, to the extent known, the physical, chemical, biological or electrical characteristics of the invention. The disclosure shall also identify any publication, on sale or public use of the Invention and whether a manuscript describing the invention has been submitted for publication and, if so, whether it has been accepted for publication at the time of disclosure. In addition, after disclosure to NSF, the grantee will promptly notify NSF of the acceptance of any manuscript describing the invention for publication or of any on sale or public use planned by the grantee.

(2) The grantee will elect in writing whether or not to retain title to any such inventory by notifying NSF within two years of disclosure to NSF. However, in any case where publication, on sale, or public use has initiated the one year statutory period wherein valid patent protection can still be obtained in the United States, the period for election of the title may be shortened by NSF to a data that is no more than 60 days prior to the end of the statutory period.

(3) The grantee will file its initial patent application on an invention to which it elects to retain title within one year after election of title or, if earlier, prior to the end of any statutory period wherein valid patent protection can be obtained in the United States after a publication, or sale, or public use. The

grantee will file patent applications in additional countries or international patent offices within either ten months of the corresponding initial patent application, or six months from the date when permission is granted by the Commissioner of Patents and Trademarks to file foreign patent applications when such filing has been prohibited by a Secrecy Order.

(4) Requests for extension of the time for disclosure to NSF, election, and filing under subparagraphs (1), (2), and (3) may, at the discretion of NSF, be granted.

(d) Conditions When the Government May Obtain Title

The grantee will convey to NSF, upon written request, title to any subject invention:

(1) If the grantee fails to disclose or elect the subject invention within the times specified in paragraph (c) above, or elects not to retain title; provided that NSF may only request title within 60 days after learning of the failure of the grantee to disclose or elect within the specified times.

(2) In those countries in which the grantee fails to file patent applications within the times specified in paragraph (c) above; provided, however, that if the grantee has filed a patent application in a country after the times specified in paragraph (c) above, but prior to its receipt of the written request of NSF, the grantee shall continue to retain title in that country.

(3) In any country in which the grantee decides not to continue the prosecution of any application for, to pay the maintenance fees on, or defend in a reexamination or opposition proceeding on, a patent on a subject invention.

(e) Minimum Rights to Grantee

(1) The grantee will retain a nonexclusive royalty-free license throughout the world in each subject invention to which the Government obtains title, except if the grantee fails to disclose the subject invention within the times specified in paragraph (c) above. The grantee's license extends to its domestic subsidiaries and affiliates, if any, within the corporate structure of which the grantee is a party and includes the right to grant sublicenses of the same scope to the extent the grantee was legally obligated to do so at the time the grant was awarded. The license is transferable only with the approval of NSF except when transferred to the successor of that part of the grantee's business to which the invention pertains.

(2) The grantee's domestic license may be revoked or modified by NSF to the extent necessary to achieve expeditious practical application of the subject invention pursuant to an application for an exclusive license submitted in accordance with applicable provisions at 37 CFR Part 404. This license will not be revoked in that field of use or the geographical areas in which the grantee has achieved practical application and continues to make the benefits of the invention reasonably accessible to the public. The license in any foreign country may be revoked or modified at the discretion of NSF to the extent the grantee, its licensees, or its domestic subsidiaries or affiliates have failed to achieve practical application in that foreign country.

(3) Before revocation or modification of the license, NSF will furnish the grantee a written notice of its intention to revoke or modify the license, and the grantee will be allowed thirty days (or such other time as may be authorized by NSF for good cause shown by the grantee) after the notice to show cause why the license should not be revoked or modified. The grantee has the right to appeal, in accordance with applicable regulations in 37 CFR Part 404 concerning the licensing of Government-owned inventions, any decision concerning the revocation or modification of its license.

(f) Grantee Action to Protect Government's Interest

(1) The grantee agrees to execute or to have executed and promptly deliver to NSF all instruments necessary to: (i) establish or confirm the rights the Government has throughout the world in those subject inventions for which the grantee retains title, and (ii) convey title to NSF when requested under paragraph (d) above, and to enable the Government to obtain patent protection throughout the world in that subject invention.

(2) The grantee agrees to require, by written agreement, its employees, other than clerical and non-technical employees, to disclose promptly in writing to personnel identified as responsible for the administration of patent matters and in a format suggested by the grantee each subject invention made under this grant in order that the grantee comply with the disclosure provisions of paragraph (c) above, and to execute all papers necessary to file patent applications on subject inventions and to establish the Government's rights in the subject inventions. The disclosure format should require, as a minimum, the information requested by paragraph (c)(1) above. The grantee shall instruct such employees through the employee agreements or other suitable educational programs on the importance of reporting inventions in sufficient time to permit the filing of patent applications prior to U.S. or foreign statutory bars.

(3) The grantee will notify NSF of any decision not to continue prosecution of a patent application, pay maintenance fees, or defend in a reexamination or opposition proceeding on a patent, in any country, not less than thirty days before the expiration of the response period required by the relevant patent office.

(4) The grantee agrees to include, within the specification of any United States patent application and any patent issuing thereon covering a subject invention, the following statement: "This invention was made with Government support under (identify the grant) awarded by the National Science Foundation. The Government has certain rights in this invention."

(5) The grantee or its representative will complete, execute, and forward to NSF a confirmation of a License to the United States Government within two months of filing any domestic or foreign patent application.

(6) The grantee or its representative will forward to NSF a copy of any United States patent covering a subject invention within two months after it is issued.

(g) Subcontracts

(1) The grantee will include this Patents Rights clause, suitably modified to identify the parties, in all subcontracts, regardless of tier, for experimental, developmental, or research work. The subcontractor will retain all rights provided for the grantee in this Patents Rights clause, and the grantee will not, as part of the consideration for awarding the subcontract, obtain rights in the subcontractor's subject inventions.

(2) In the case of subcontracts, at any tier, when the prime award by the Foundation was a contract (but not a grant or cooperative agreement), NSF, subcontractor, and contractor agree that the mutual obligations of the parties created by this Patents Rights clause constitute a contract between the subcontractor and the Foundation with respect to those matters covered by this Patents Rights clause.

(h) Reporting on Utilization of Subject Inventions

The grantee agrees to submit on request periodic reports no more frequently than annually on the utilization of a subject invention or on efforts at obtaining such utilization that are being made by the grantee or its licensees or assignees. Such reports shall include information regarding the status of development, date of first commercial sale or use, gross royalties received by the grantee, and such other data and information as NSF may reasonably specify. The grantee also agrees to provide additional reports in connection with any march-in proceeding undertaken by NSF in accordance with paragraph (j) of this Patents Rights clause. As required by 35 USC 202(c)(5), NSF agrees it will not disclose such information to persons outside the Government without the permission of the grantee.

(i) Preference for United States Industry

Notwithstanding any other provision of this Patents Rights clause, the grantee agrees that neither it nor any assignee will grant to any person the exclusive right to use or sell any subject invention in the United States unless such person agrees that any products embodying the subject invention or produced through the use of the subject invention will be manufactured substantially in the United States. However, in individual cases, the requirement for such an agreement may be waived by NSF upon a showing by the grantee or its assignee that reasonable but unsuccessful efforts have been made to grant licenses on similar terms to potential licensees that would be likely to manufacture substantially in the United States or that under the circumstances domestic manufacture is not commercially feasible.

(j) March-in Rights

The grantee agrees that with respect to any subject invention in which it has acquired title, NSF has the right in accordance with procedures at 37 CFR 401.6 and NSF regulations at 45 CFR 650.13 to require the grantee, an assignee or exclusive licensee of a subject invention to grant a nonexclusive, partially exclusive, or exclusive license in any field of use to a responsible applicant or applicants, upon terms that are reasonable under the circumstances, and if the grantee, assignee, or exclusive licensee refuses such a request, NSF has the right to grant such a license itself if NSF determines that:

(1) Such action is necessary because the grantee or assignee has not taken, or is not expected to take within a reasonable time, effective steps to achieve practical application of the subject invention in such field of use;

(2) Such action is necessary to alleviate health or safety needs which are not reasonably satisfied by the grantee, assignee, or their licensees;

(3) Such action is necessary to meet requirements for public use specified by Federal regulations and such requirements are not reasonably satisfied by the grantee, assignees, or licensee; or

(4) Such action is necessary because the agreement required by paragraph (i) of this Patents Rights clause has not been obtained or waived or because a licensee of the exclusive right to use or sell any subject invention in the United States is in breach of such agreement.

(k) Special Provisions for Grants with Nonprofit Organizations

If the grantee if a nonprofit organization, it agrees that:

(1) Rights to a subject invention in the United States may not be assigned without the approval of NSF, except where such assignment is made to an organization which has as one of its primary functions the management of inventions, provided that such assignee will be subject to the same provisions as the grantee;

(2) The grantee will share royalties collected on a subject invention with the inventor, including Federal employee co-inventors (when NSF deems it appropriate) when the subject invention is assigned in accordance with 35 USC 202(e) and 37 CFR 401.10;

(3) The balance of any royalties or income earned by the grantee with respect to subject inventions, after payment of expenses (including payments to inventors) incidental to the administration of subject inventions, will be utilized for the support of scientific research or education; and

(4) It will make efforts that are reasonable under the circumstances to attract licensees of subject inventions that are small business firms and that it will give preference to a small business firm if the grantee determines that the small business firm has a plan or proposal for marketing the invention which, if executed, is equally likely to bring the invention to practical application as any plans or proposals from applicants that are not small business firms; provided that the grantee is also satisfied that the small business firm has the capability and resources to carry out its plan or proposal. The decision whether to give a preference in any specific case will be at the discretion of the grantee. However, the grantee agrees that the Secretary of Commerce may review the grantee's licensing program and decisions regarding small business applicants, and the grantee will negotiate changes to its licensing policies, procedures, or practices with the Secretary when the Secretary's review discloses that the grantee could take reasonable steps to implement more effectively the requirements of this paragraph (k)(4).

(l) Communications

All communications required by this Patents Rights clause should be sent to:

Patent Assistant
Officer of the General Counsel
National Science Foundation
Washington, DC 20550

[END OF CLAUSE]

752 Copyright

752.1 Rights to Copyrightable Material

The following principles governing the treatment of copyrightable material produced under NSP awards were adopted by the National Science Board on March 26, 1984.

a. The Foundation normally will acquire only such rights to copyrightable material as are needed to achieve its purposes or to comply with the requirements of any applicable government-wide policy or international agreement.

b. To preserve incentives for private dissemination and development, the Foundation normally will not restrict or take any part of income earned from copyrightable material except as necessary to comply with the requirements of any applicable government-wide policy or international agreement.

c. In exceptional circumstances, the Foundation may restrict or eliminate an awardee's control of NSF-supported copyrightable material and of income earned from it, if the Foundation determines that this would best serve the purposes of a particular program or award.

752.2 Standard Copyrightable Material Clause

The following copyrightable material clause will be used in every funding agreement awarded by the Foundation that relates to scientific or engineering research unless a special copyrightable material clause has been negotiated. (See GPM 753.2) When the clause is used in a funding agreement other than a grant, "grant" and "grantee" may be replaced by "contract" or other appropriate terms.

COPYRIGHTABLE MATERIAL

a. "Subject writing" means any material that:

1. is or may be copyrightable under Title 17 of the United States Code, and
2. is produced by the grantee or its employees in the performance of work under this grant.

"Subject writings include such items as reports, books, journal articles, software, sound recordings, video tapes, and video discs.

b. Copyright Ownership, Government License. Except as otherwise specified in the grant or by this paragraph, the grantee may own or permit others to own copyright in all subject writings. The grantee agrees that if it or anyone else does own copyright in a subject writing, the Federal government will have a nonexclusive, nontransferable, irrevocable, royalty-free license to exercise or have exercised for or on behalf of the United States throughout the world all the exclusive rights provided by copyright. Such license, however, will not include the right to sell copies or phonerecords of the copyrighted works to the public.

c. Grants Affected by International Agreements. If the award indicates it is subject to an identified international agreement or treaty, the Foundation can direct the grantee to convey to any foreign participant or otherwise dispose of such rights to subject writings as are required to comply with that agreement or treaty.

d. Grantee Action to Protect Government Interests. The grantee agrees to acquire, through written agreement or an employee relationship, the ability to comply with the requirements of the preceding paragraphs and, in particular, to acquire the ability to convey rights in a subject writing to a foreign participant if directed by the Foundation under the previous paragraph. The grantee further agrees that any transfer of copyright or any other rights to a subject writing, by it or anyone whom it has allowed to own such rights, will be made subject to the requirements of this article.

[END OF CLAUSE]

753 Special Patent and Copyright Situations

753.1 Special Award Provisions

At the request of the prospective awardee or on recommendation from NSF staff, a Grants or Contracts Officer, with the concurrewnce of the cognizant Program Manager, may negotiate special patent or copyright provisions when he or she determines that exceptional circumstances require restriction or elimination of the right of a prospective awardee to control principal rights to subject inventions or writings in order to better achieve the objectives of the program, the National Science Foundation Act, or (in the case of inventions) Chapter 18 of Title 35 of the United States Code. Unless doing so would be inconsistent with an obligation imposed on the Foundation by statute, internationial agreement, or pact with other participants in or supporters of the research, every special copyright or patent provision will allow the awardee, after an invention has been made or copyrightable material created, to request that it be allowed to retain principal rights to that invention or material.

753.2 Awards Not Primarily for Research

a. Awards not primarily intended to support scientific or enginee3ring research need contain no patent or copyrightable material provision. Examples of such aweards are travel, conference, and equipment grants.

b. NSF Fellowships and Traineeships. In accordance with section 212 of title 35 of the United States Code, the Foundation claims no rights to inventions made by fellows or trainees. The following provision will be included in each fellowship or traineeship program announcement and made part of the award:

INTELLECTUAL PROPERTY RIGHTS

The National Science Foundation claims no rights to any inventions or writings that might result from its fellowship or traineeship awards. However, fellows and trainees should be aware that the NSF, another Federal agency, or some private party may acquire such rights through other support for particular research. Also, fellows and trainees should note their obligation to include an Acknowledgment and Disclaimer in any publication.

[END OF PROVISION]

753.3 Awards Affected by International Agreements

a. Many of the bilateral and multilateral treaties and agreements underlying the Foundation's international cooperative research programs contain provisions on allocation of rights to inventions or writings. These sometimes require an allocation of rights different from that provided by the standard Copyrightable Material or Patent Rights clauses. In those cases, the standard clauses will be modified through the addition of the following to the award letter:

"This project is supported under the cooperative science program listed below. Your rights in invention, writings, and data may be affected."

The applicable agreement or treaty will be identified immediately beneath that sentence.

b. After an invention is disclosed to the Patent Assistant, the recipient of an award subject to an international agreement will be informed as to what rights, if any, it must transfer to foreign participants. Recipients may also ask the NSF Program Officer for copies of the identified international agreement before or after accepting an award.

754 Dissemination and Sharing of Research Results

a. Investigators are expected to promptly prepare and submit for publication, with authorship that accurately reflects the contributions of those involved, all significant findings from work conducted under NSF grants. Grantees are expected to permit and encourage such publication by those actually performing that work, unless a grantee intends to publish or disseminate such findings itself.

b. Investigators are expected to share with other researchers, at no more than incremental cost and within a reasonable time, the primary data, samples, physical collections, and other supporting materials created or gathered in the course of work under NSF grants. Granters are expected to encourage and facilitate such sharing. Privileged or confidential information should be released only in a form that protects the privacy of individuals and subjects involved. General adjustments and, where essential, exceptions to this sharing expectation may be specified by the funding NSF Program or Division for a particular field or discipline to safeguard the rights of individuals and subjects, the validity of results, or the integrity of collections or to accommodate legitimate interests of investigators. A grantee or investigator may also request a particular adjustment or exception from the cognizant NSF Program Officer.

c. Investigators and grantees are encouraged to share software and inventions created under the grant or otherwise make them or their products widely available and usable.

d. The NSF normally allows grantees to retain principal legal rights to intellectual property developed under NSF grants to provide incentives for development and discrimination of inventions, software, and publications that can enhance their usefulness, accessibility, and upkeep. Such incentives do not, however, reduce the responsibility that investigators and institutions have as members of the scientific and engineering community to make results, data and collections available to other researchers.

ATTACHMENT B

ADDITIONAL TERMS AND CONDITIONS

1. Shipping Terms

The terms of shipment are F.O.B. Destination. Seller is responsible for providing adequate insurance for repair or replacement of goods lost or damaged in transmit, filing and processing any claim, and expediting such repair or replacement to minimize impact on schedule and cost.

2. Warranty

The warranty period for the goods provided hereunder is for one (1) year after the date of final acceptance by Buyer's Customer at the sites. Seller is responsible for all cost arising out of any warrenty defect and will correct such defect on an expedited basis. Final acceptance will be on a site basis and can be on multiple dates for specific goods at each site. Final acceptance at Hanford Reservation, WA site is expected to be around May 1998 and at Livingston, LA site is expected to be around November, 1998. This warranty shall pass directly to Buyer's Customer and is enforceable by Buyer and/or Buyer's Customer. The warranty conditions are specified in Attachment C, Terms and Conditions, Article 6.

3. Supply Bond

Seller will provide a Supply Bond, reference Attachment B-1, at no cost to Buyer within fifteen (15) days of placement of the Purchase Order with Seller. Buyer retains the option to cancel the Purchase Order for default should Seller not provide an acceptable Surety Bond in the time period specified. No progress payments will be made under this Purchase Order should a required Supply Bond not be provided by Seller.

4. Liquidated Damages

Time is of the essence and Buyer is relying on Seller's representation that it can meet its commitments undertaken in this Purchase Order. In the event that these commitments are not met, Buyer will be materially damaged. In view of the difficulty of estimating such damages, it is agreed upon, fixed, and determined by Seller and Buyer that Seller shall be liable to Buyer, as the proper measure of liquidated damages, the sum of 0.2% per day for each and every day of delay beyond the date(s) specified for delivery of the goods. The per-day assessment of liquidated damages will be measured against the value of the goods late. Imposing liquidated damages does not relieve the Seller of its obligations hereunder nor preclude Buyer from its remedies herein or by law.

5. **Payment Terms**

Buyer will pay invoices Net 30 Days from the date of receipt by Buyer of a valid invoice with all required supporting documentation.

Buyer will pay 90 percent of the value of the approved invoice and the final 10 percent upon final acceptance of the specific goods.

6. **Notification of Adverse Conditions**

Seller shall, within twenty-four (24) hours, notify Buyer of any adverse condition(s) that will impact Seller's performance under this Purchase Order. Failure to notify Buyer will have a material impact on Buyer and create a severe hardship. Seller will be liable for all costs resulting from such failure to notify Buyer. This notification does not relieve Seller of its obligations and liabilities hereunder.

Attachment B_1

Bond

SUPPLY CONTRACT BOND

KNOW ALL BY THESE PRESENTS:

That we, _____ as Principal,

and _____,

a _____ corporation, authorized to transact surety business in the State of

_____; as Surety, are held and firmly bound unto _____

_____ as Obligee,

in the sum of _____

_____ ($ _____),

lawful money of the United States of America, for the payment of which, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, on the _____ day of _____, 19____, the Principal entered into

a supply contract with the Obligee for furnishing _____

_____

_____ which supply contract is by reference

made a part hereof and is hereafter referred to as the Contract;

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, That if the Principal shall faithfully perform said supply contract according to its terms, covenants, and conditions, then this obligation shall be void; otherwise it shall remain in full force and effect.

DATED this _____ day of _____, 19 ____.

_____
Principal

By: _____

_____
Title

_____

_____
Attorney-in-Fact

Attachment C

PROCESS SYSTEMS INTERNATIONAL, INC.

TERMS AND CONDITIONS

1. **ACCEPTANCE AND MODIFICATIONS:** Seller's acknowledgement of this Purchase Order, commencement of performance hereunder or shipment of the goods ordered hereby shall conclusively evidence Seller's acceptance of this Purchase Order and the terms and conditions thereof, and this Purchase Order shall be the complete and exclusive contract and statement of the terms of the agreement between Seller and Buyer. Any provision, term or condition of Seller's which is additional to, different from or inconsistent with those contained or referred to herein are hereby objected to.

2. **PRICES AND PAYMENTS:** Buyer shall pay the price stipulated in this Purchase Order less deductions, if any, provided. Payment shall be due after delivery and inspection by Buyer of the goods, services, or work subject to this Purchase Order at Buyer's plant, or such other place as may be specifically designated in this Purchase Order, or upon the receipt by Buyer of proper invoices or vouchers, whichever is later. Buyer shall have the right to defer payment on advance deliveries until time such payment would have been due if the deliveries have been made as scheduled.

   Seller agrees that Buyer may withhold any payment herein provided to the extent reasonably necessary to protect Buyer from loss on account of (a) defective work or goods not remedied, (b) claims filed or reasonable evidence indicating probable filing of claims, or (c) any reasonable doubt that this Purchase Order can be completed within the stated time for its completion.

3. **SHIPPING AND PACKING:** All goods must be suitably packed and prepared for shipment so as to prevent damage or deterioration, secure lowest transportation rates and comply with carrier tariffs. No charges will be paid by Buyer for packing, crating or cartage unless separately stated in this Purchase Order. Packing sheets showing the order number must be included with each shipment. Each container must be marked to show the order number and the container and order numbers must be indicated on the bill of lading. Seller shall make no declaration concerning the value of goods shipped, except on goods where the tariff rating or rate is dependent upon the release or declared value, in which event such value shall be released or declared at the maximum value for the lowest rating or rate.

4. **DELIVERIES:** Unless otherwise specifically stated on the face of this Purchase Order, all goods hereunder shall be delivered F.O.B. Buyer's plant. Title to all the goods specified in this Purchase Order shall pass to the Buyer on the date the goods are accepted by the Buyer. Seller agrees to bear all risk of loss which occurs prior to delivery and acceptance of the goods by the Buyer. Time is therefore of the essence. If any such goods are not completed by the date specified on the face hereof, Buyer reserves the right, without liability or waiver of any rights or remedies Buyer may have hereunder or otherwise, to cancel this Purchase Order, by notice deemed effective when received by Seller, as to goods not yet shipped or services not yet rendered, or to purchase substitute items or services elsewhere, and to charge Seller with any loss incurred. Any provisions hereof for delivery by installments shall not be construed as making the obligations of Seller severable. Seller shall notify Buyer in writing promptly of any delays (however caused) of any actual or potential labor dispute which delays, or threatens to delay, the timely performance of this Purchase Order. If Seller is unable to complete performance at the time specified for delivery hereunder, by reason of strikes, labor difficulties, riot, war, fire, or other causes beyond Seller's reasonable control, Buyer, at its option, may elect to take delivery of goods hereunder in their uncompleted state at such proportion of the contract prices as the work then completed bears to the total work hereunder, and to cancel this Purchase Order, without liability, as to the balance of the goods covered hereunder.

5. **INSPECTION:** Seller's manufacture, fabrication, testing or procurements under this Purchase Order shall be subject to independent inspection and expediting by Buyer and quality assurance audits by Buyer. For these purposes, Seller shall provide reasonable access to Buyer and its representatives to its manufacturing, fabricating, testing and construction sites and facilities. Such access shall be given by Seller to enable Buyer to determine Seller's orderly, timely and satisfactory compliance with the requirements of the Purchase Order for planning, design procurement, manufacture, fabrication, furnishing, construction, shipping, quality assurance and quality control of material manufactured, fabricated or procured under this Purchase Order.

   Quality assurance audits and inspections performed by Buyer shall not relieve Seller and Seller Subcontractors for responsibility to perform all inspection tests and quality assurance measures required by this Purchase Order, applicable codes, standards and good practices.

   Seller shall not deny Buyer access to its manufacturing, fabricating, testing and construction facilities pursuant to this Section on the basis of a claim that proprietary work or documents would be exposed to inspection by Buyer or for any other reason.

   Any work or item which fails to meet the requirements of the Purchase Order shall be considered defective and may be rejected. If delivered to the Buyer or destination, rejected work or items shall be removed promptly by Seller unless the deficiencies are corrected promptly by Seller, in a manner satisfactory to Buyer and the expense shall be borne by Seller.

   The acceptance of any material or equipment by Buyer or failure to require tests or satisfactory completion thereof or failure to require approvals or inspections shall in no event limit or discharge the obligation of the Seller to comply with the provisions of this Purchase Order.

   Seller shall specifically require Seller's Subcontractors to comply with the provisions of this Section.

   All material or equipment ordered which has been inspected and designated for use under this Purchase Order shall not be transferred or used on any other project or contract without written authorization from Buyer.

6. **WARRANTY:** Seller warrants that all goods delivered under this Purchase Order will conform to the requirements of this Purchase Order (including but not limited to all applicable descriptions, specifications, drawings, data and samples), will be merchantable, of good material and workmanship and free from defects, and will, to the extent not manufactured pursuant to detailed design and specifications furnished by Buyer, be free from defects in design and fit for the intended purposes. Seller agrees that goods shall be deemed not to meet the warranties expressed herein if they include any tolerance or variation not provided for in the specifications, if any, submitted by Buyer. The warranties of Seller in this paragraph shall not be deemed exclusive or limiting in any manner, but are in addition to any and all other warranties, express or implied, that may exist, arise or be created by operation of law or otherwise.

   Seller's warranties (and any more favorable warranties, service warranties or guarantees, or similar undertakings of Seller) shall survive inspection, test, acceptance of any payment for the goods and shall run to and be enforceable by Buyer, its successors, assigns and customers and any subsequent owner, operator or user of the goods.

   Buyer shall notify Seller if any goods delivered hereunder are rejected and, at Buyer's election and Seller's risk and expense, such goods shall be held by Buyer or returned to Seller. No replacement or correction of non-conforming goods shall be made by Seller unless agreed to in writing by Buyer.

7. **CHANGES:** Buyer shall have the right to make changes, within the general scope of this Purchase Order, from time to time, by written order, in any of the designs, specifications, packing, destination, delivery schedule or quality of goods subject to this Purchase Order. Seller shall proceed immediately to perform this Purchase Order as so changed. If such changes cause an increase or decrease in the cost of performance of this Purchase Order or in the time required for its performance, and equitable adjustment shall be negotiated promptly and this Purchase Order shall be modified in writing accordingly. Any claim by Seller for adjustment under this clause must be asserted in writing within 30 days from the date of receipt by Seller of such written order or within such further time as may be agreed upon in writing by the parties. Following receipt of such written order, Seller shall forthwith provide Buyer with a written statement specifying the amount claimed and providing support cost figures.

8. **PATENT INDEMNITY:** Seller shall defend Buyer, Buyer's Customers, and any subsequent user of the goods against all claims and proceedings alleging infringement or violation of any United States or foreign patent, trademark, or proprietary right by any goods delivered under this Purchase Order, and Seller shall hold them harmless from and indemnified against any expense (including reasonable attorney's fees), costs, damages, claims, demands, losses and liabilities for actual or alleged infringement of any such patents, trademarks or proprietary rights, provided Seller is reasonably notified of such claims and proceedings. Seller's obligation shall not apply to goods manufactured pursuant to detailed designs developed and furnished by Buyer not to any infringement arising from the use of sale goods in combination with items not delivered by Seller if such infringement would not have occurred from the use or sale of such goods solely for the purpose for which they were designed or sold to Buyer.

9. **INDEMNIFICATION:** Seller agrees to defend, indemnify, and hold Buyer harmless from and against any and all damages, claims, demands, expenses (including reasonable attorney's fees), or liabilities of any nature whatsoever involving injury or damage to person or property, arising or from or attributable to Seller's goods herein ordered or from the use thereof by Buyer or its customers. Buyer agrees to give Seller reasonable notice of any of the aforegoing. Seller shall also maintain such Public Liability, Property Damage, Employer's Liability, Workers Compensation Insurance and Motor Vehicle Liability as will protect Buyer from said risks.

10. **CONFIDENTIALITY:** All specifications, drawings, samples, designs and other technical and proprietary information furnished by Buyer to Seller shall be maintained in confidence by the Seller, and shall not be reproduced, disclosed, duplicated, or used, except to the extent required for the performance of this Purchase Order without the prior written consent of Buyer. Upon completion of this Purchase Order, Seller shall promptly return to Buyer, all specifications, drawings, samples, and other data, furnished by Buyer in connection with this Purchase Order, together will all copies or reprints then in Seller's possession or control, and Seller shall thereafter make no further use, either directly or indirectly, of any such specifications, drawings, samples, data or any information derived therefrom without Buyer's written consent.

11. **TOOLING:** All tools, dies, patterns, molds, jigs, fixtures and the like, required to execute this Purchase Order are to be furnished by Seller. However, if any of these are furnished or specifically paid for by Buyer, they shall be the property of Buyer, shall be subject to removal at any time without additional cost upon Buyer's demand, shall be used only in filling orders from Buyer, shall be kept separate from other materials or tools and shall be identified as the property of Buyer. Seller assumes all responsibility for loss or damage, with the exception of normal wear or tear, and agrees to maintain such equipment and keep it in satisfactory working condition at its sole cost and expense.

12. **BUYER MATERIAL:** Any material supplied by Buyer for use on this Purchase Order shall be held by Seller on consignment, and Seller agrees to use such material only for the purpose of this Purchase Order and to pay for all such material spoiled or not otherwise satisfactorily accounted for, and to keep such material fully insured at Seller's cost for the benefit of Buyer.

13. **RELEASE OF NEWS INFORMATION:** Seller shall not, without the prior written consent of the Buyer, make any news release or public announcement of any part of the subject matter of this Purchase Order.

14. **SUBCONTRACTING:** No goods, except spare parts and standard commercial supplies, to be delivered under this Purchase Order shall be procured by Seller from a third party without Buyer's prior written consent.

15. **ASSIGNMENT:** This order, its performance, any interest herein or in any monies due or to become due hereunder, may not be assigned by Seller without the prior written consent of Buyer.

16. **WAIVER:** The failure of Buyer in any one or more instances to insist on performance of any of the provisions of this Purchase Order, or any part of any such provision, shall in no way be construed to be a waiver of such provisions, or any part thereof.

17a. **TERMINATION FOR CONVENIENCE:** Buyer may, at its option, terminate this Purchase Order, in whole or in part, for Buyer's convenience, by written or telegraphic notice to the Seller. Upon termination hereunder, Seller shall forthwith stop work under this Purchase Order or the terminated portion thereof and the placement of further orders or subcontracts hereunder, terminate or assign to Buyer work under orders or subcontracts outstanding hereunder, and take any necessary action to protect property in the Seller's possession in which the Buyer has or may acquire an interest. If the parties cannot agree within a reasonable time upon the amount of fair compensation to the Seller for such termination, Buyer will pay Seller, without duplication:

   (a) the Purchase Order price for articles which have been completed,

   (b) the actual costs incurred by the Seller which are properly allocable or apportionable, under good commercial accounting practices, to the terminated portion of this Purchase Order, except that when the Purchase Order provides for progress payments, settlement of Seller's costs shall be on the basis of actual progress made through the termination date,

   (c) reasonable expenses of the Seller in making settlement hereunder and under Seller's subcontracts hereunder and in protecting property in which the Buyer has or may have an interest, and

   (d) such allowance for profit on the work performed as may be reasonable under the circumstances.

   Payments under this article shall in no event exceed the aggregate price specified in this Purchase Order. Seller will transfer title to and deliver on Buyer's instructions any property the cost of which is reimbursed and (b) above, or, with Buyer's approval, may retain same at an agreed price and credit or pay the amount so agreed or received as Buyer directs. Buyer may audit elements of any terminated claim including any purchase order and subcontract that Seller has terminated in accordance with this Article.

   The foregoing provisions for payment to Seller shall not apply in the case of cancellation for cause.

17b. **CANCELLATION FOR CAUSE:**

   (1) If the Seller should be adjudged a bankrupt or if it should make general assignment for the benefit of its creditors, or if a receiver should be appointed on account of its insolvency, or if it should persistently or repeatedly refuse or should fail, except in cases for which extension of time is provided, to perform any of the other provisions of this Purchase Order or so fail to make progress as to endanger performance of this Purchase Order in accordance with its terms, or if it should fail to make proper payment to its suppliers and subcontractors, or to fail to comply with laws, ordinances, and regulations of proper authorities or the instructions of Buyer or otherwise be guilty of a substantial violation of any provision of the Purchase Order, then Buyer may, without prejudice to any other right or remedy, give Seller written notice specifying the receipt of such notice, may be written notice to Seller forthwith terminate the right of the Seller to proceed with the work and may take title and possession of all supplies, products, data, and tools intended to be purchased hereunder and may finish the work or have it finished by whatever method it may deem expedient, and the Seller and it sureties, if any, shall be liable to Buyer for any excess cost occasioned by such default. Payment for completed supplies, products, itemized in this Purchase Order, and for those that are uncompleted for which prices are not separately itemized, payment will be at their fair values.

   The exercise of Buyer's rights hereunder shall not prejudice or waive any other rights which Buyer may have at law or under this Purchase Order against the Seller or its sureties, if any. If it shall be determined for any reason that a written notice served to the Seller under 17b. was improper, then at the Buyer's election the rights and obligations of the parties shall be the same as if the notice had been served under paragraph 17a. Termination For Convenience.

18. **REMEDIES:** The rights and remedies provided Buyer herein shall be cumulative and in addition to any other rights and remedies provided by law or equity.

19. **GOVERNING LAW:** This agreement shall be construed in accordance with the laws of the Commonwealth of Massachusetts. SELLER agrees that it will comply with all applicable federal, state, and local laws, rules, and regulations.

20. **ADDITIONAL REQUIREMENTS:** The following clauses are incorporated as required, by reference, with the same force and effect as if reproduced in their entirety.

   (a) Contracts for $2,500 or more Executive Order 11758, Employment of the Handicapped,

   (b) Contracts for $5,000 or more Executive Order 11458, Utilization of Minority Business Enterprises,

   (c) Contracts for $10,000 or more, Executive Order 11246 and 11375, Equal Opportunity Clause and Non-Segregated Facilities Clause,

   (d) Contracts for $3,000 or more Executive Order 11701, Job Listing Requirements - Employment of the Vietnam Era Veterans and Disabled Veterans.

21. PSI IS AN EQUAL OPPORTUNITY EMPLOYER AND HAS AN AFFIRMATIVE ACTION PLAN FOR MINORITIES, WOMEN, HANDICAPPED & VIETNAM VETERANS. "The Equal Employment Opportunity Clause in Section 202 of Executive Order 11246, as amended relative to equal employment opportunity and the implementing rules and regulations of the Office of Federal Contracts Compliance are incorporated herein by specific reference."

ATTACHMENT D

CERTIFICATIONS

Certification of Nonsegregated Facilities, Clean Air and Water and Anti-Kickback Compliance

Certification Regarding Lobbying

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transaction

Assurance of Compliance and National Foundation Regulation Under Title VI of the Civil Right Act of 1964

Americans With Disabilities Certification

Public Law 95-507 Certification

I. NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES

A Certification of Nonsegregated Facilities, as required by the May 9, 1967, order on Elimination of Segregated Facilities, by the Secretary of Labor (32 Fed. Reg. 7439, May 19, 1967), must be submitted prior to the award of a subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semi-annually, or annually).

CERTIFICATION OF NONSEGREGATED FACILITIES

By the submission of this proposal, the proposer certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. He certifies further that he will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he will not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. The proposer agrees that a breach of this certification is a violation of the Equal Opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom or otherwise. He further agrees that (except where he has obtained identical certifications from proposed subcontractors for specific time periods) he will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that he will retain such certifications in his files; and that he will forward the above notice titled "NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CER-

TIFICATIONS OF NONSEGREGATED FACILITIES," to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods).

II. CLEAN AIR AND WATER

A Clean Air and Water Certification is required for the award of any nonexempt subcontract. A "nonexempt subcontract" is defined as:

(A) A subcontract for supplies and nonpersonal services in excess of $10,000, or a subcontract for construction in excess of $2,000, if any facility to be used in performance of the work has been the subject of a conviction under the Clean Air Act [42 U.S.C. 1857c-8(c)(1)] or the Federal Water Pollution Control Act [33 U.S.C. 1319(c)] and is listed, on the date of award of the subcontract, on the Environmental Protection Agency "List of Violating Facilities";

(B) any other subcontract in excess of $100,000;

(C) any indefinite quantity subcontract if the offeror has reason to believe the amount to be ordered in any contract year may exceed $100,000.

Proposers are advised that the Additional General Provision entitled "Clean Air and Water" must be included in any nonexempt subcontract entered into as the result of this solicitation.

III. CLEAN AIR AND WATER CERTIFICATION

By the submission of this proposal, the proposer certifies as follows:

(A) No facility to be utilized in the performance of the proposed contract is listed on the Environmental Protection Agency "List of Violating Facilities".

(B) He will promptly notify the Institute, prior to award, of the receipt of any communication from the Director, Office of Federal Activities, U.S. Environmental Protection Agency, indicating that any facility which he proposes to use for the performance of the contract is under

consideration to be listed on the EPA "List of Violating Facilities".

IV. ANTI-KICKBACK COMPLIANCE

A Certification of Anti-Kickback Compliance must be submitted prior to award.

CERTIFICATION OF ANTI-KICKBACK COMPLIANCE

By submission of a proposal in response to this solicitation incorporating this form, the offeror certifies that it has read the General Provision entitled "Anti-Kickback Procedures", contained in the solicitation and that neither it nor any of its employees have performed or participated in any prohibited actions, as defined in that provision, relating to the award of the Contract. By commencing performance of the Contract work, the selected contractor certifies to Anti-Kickback Compliance.

(NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 10001.)

CERTIFICATION REGARDING LOBBYING

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying" in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certified by:

Proposal or Award Identification Information:

_____ _____

Signature Date

_____

Name

_____

Title

_____

Institution

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

ASSURANCE OF COMPLIANCE WITH NATIONAL SCIENCE FOUNDATION REGULATION UNDER TITLE VI OF THE CIVIL RIGHTS ACT OF 1964

_____ (hereinafter called the "Applicant") HEREBY AGREES THAT it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-362) and all requirements imposed by or pursuant to the Regulation of the National Science Foundation (45 CFR Part 611) issued pursuant to that title, to the end that, in accordance with Title VI of that Act and Regulation, no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives Federal financial assistance from the Foundation; and HEREBY GIVES ASSURANCE THAT it will immediately take any measures necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Applicant by the Foundation this Assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this Assurance shall obligate the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this Assurance shall obligate the Applicant for the period during which the Federal financial assistance is extended to it by the Foundation.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, cooperative agreements, loans, contracts, property, discounts or other Federal financial assistance extended after the date hereof to the Applicant by the Foundation including installment payments after such date on account of applications for Federal financial assistance which were approved before such date. The applicant recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this Assurance, and that the United States shall have the right to seek judicial enforcement of this Assurance. This Assurance is binding on the Applicant, its successors, transferees, and assignees.

PLEASE TYPE OR PRINT	
NAME OF APPLICANT, STREET ADDRESS OR P.O. BOX, CITY, STATE, ZIP CODE	
I CERTIFY THAT THE ABOVE INFORMATION IS COMPLETE AND CORRECT TO THE BEST OF MY KNOWLEDGE	
SIGNATURE AND TITLE OF AUTHORIZED OFFICIAL	DATE

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION - LOWER TIER COVERED TRANSACTION

(a) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

(b) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

_____

Name and Title of Authorized Representative

_____

Signature and Date

AMERICANS WITH DISABILITIES ACT CERTIFICATION

(a) The Contractor agrees to comply with the provisions of the Americans with Disabilities Act 42 U.S.C. section 12101 et. seq. and all implementing regulations.

(b) The Contractor agrees that it will be responsible to the Institute and will indemnify and hold harmless the Institute, its trustees, officers, and employees from any loss, cost, damage, expense or liability or suit therefore, by reason of actual or alleged property damage or personal injury of whatever kind or character, arising out of, or in connection with performance of the requirements of paragraph (a) above by the contractor or any of its Subcontractors, howsoever the same may be caused, excepting only such loss, cost, damage, expense or liability attributable to the sole or contributory active negligence of the Institute, its trustees, officers or employees.

(c) The Contractor agrees to insert the provision of this Article, including this (c), in all subcontracts and purchase orders hereunder.

The Contractor represents and certifies as part of its offer that:

The Contractor certifies compliance with the Americans with Disabilities Act, 42 U.S.C. 12101 et. seq.

_____

Company Name

_____ _____

Signature of Authorized Representative Date

_____ _____

Name (typed) Title

EXHIBIT V

NATIONAL SCIENCE FOUNDATION GRANT POLICY MANUAL SECTION 750, INTELLECTUAL PROPERTY LIGO-C950365-A-P

PROCESS SYSTEMS INTERNATIONAL, INC.

ATTENTION: Sales Manager

SUBJECT: Public Law 95-507

As the result of Public Law 95-507 amending the Small Business Act of 1958, our company is required to obtain certain information from its current or prospective suppliers concerning their status as a small or small disadvantaged business. Additionally, we are required to report on the volume of subcontracted work being performed or to be performed in areas of persistent or substantial labor surplus.

Therefore, would you please complete each of the certifications indicated below as defined on the reverse side of this letter, sign, date and return to me at your earliest convenience.

Very truly yours,

PROCESS SYSTEMS INTERNATIONAL, INC.

Ronald B. Bento
Purchasing Manager

BUSINESS TYPE CERTIFICATION

1. CHECK ONE (Mandatory)
   - Small Business _____
   - Large Business _____
   - Non-Profit Concern _____
   - Foreign Owned Business _____

2. CHECK ONE (If Applicable)
   - Disadvantage Business _____
   - Women-Owned Business _____

3. Also, indication if your location is in labor surplus area. _____ Yes

Business Name _____

Address _____

City _____ State _____ Zip Code _____

Authorized Signature _____ Phone _____

Name/Title _____ Date _____

Fax Number _____

PLEASE RESPOND AS SOON AS POSSIBLE. FAX: 508-898-0351

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

Title: SPECIFICATION FOR EQUIPMENT INSTALLATION COMMERCIAL REQUIREMENTS

SPECIFICATION FOR

EQUIPMENT INSTALLATION COMMERCIAL REQUIREMENTS

FOR

LIGO VACUUM EQUIPMENT

Hanford, Washington

PREPARED BY: William J. Murphy

QUALITY ASSURANCE: N/A

TECHNICAL DIRECTOR: D. A. McWilliams

CONTRACTS MANAGER: William J. Murphy

PROJECT MANAGER: [signature]

MATERIALS MANAGER: Ron Bento /RES

Ø	—	—	RELEASED PER DEO 0377
REV LTR.	BY-DATE	APPD. DATE	DESCRIPTION OF CHANGE

PROCESS SYSTEMS INTERNATIONAL, INC.		SPECIFICATION	
INITIAL APPROVALS	PREPARED DATE: W.J. Murphy 12/4/96	APPROVED DATE: RES 12/4/96	Number V049-2-170	Rev. Ø

SPECIFICATION TABLE OF CONTENTS

Attachments:

1.0 GENERAL

In the event of any inconsistency in this Purchase Order, the inconsistency shall be resolved by giving precedence in the following order:

a. Purchase Order
b. Specification(s)
c. General Provisions
d. Additional General Provisions
e. Special Terms and Conditions
f. Construction General Provisions

2.0 GENERAL PROVISIONS

General Provisions, Articles 6 through 36, Attachment to General Provisions and the National Science Foundation Grant Policy Manual, Section 750 are incorporated herein as Attachment A. For interpretation and implementation of these provisions, Buyer and Seller is to be inserted as appropriate.

3.0 ADDITIONAL GENERAL PROVISIONS

Additional General Provisions are incorporated herein as Attachment B.

4.0 SPECIAL TERMS AND CONDITIONS

Special Terms and Conditions are incorporated herein as Attachment C.

5.0 CONSTRUCTION GENERAL PROVISIONS

Construction General Provisions are incorporated herein as Attachment D.

6.0 CERTIFICATIONS

Certifications that must be completed prior to award of any resulting Purchase Order are incorporated herein as Attachment E.

7.0 SALES TAX EXEMPTION

This project is exempt from Washington sales tax, reference Attachment F.

(e) Nothing in this Article shall excuse the Contractor from proceeding with the Contract as modified.

ARTICLE 5 - Required Notices

Unless otherwise specified in this Contract, any notice which the Contractor is required to provide to Caltech shall be directed to the Manager of Caltech Purchasing Department, with a copy to the LIGO cognizant Technical Manager.

✓ ARTICLE 6 - Subcontracts / Prior Review and Comment

Unpriced purchase order in excess of $100,000 shall be submitted to LIGO's cognizant Technical Manager. Additionally, Caltech shall have unrestricted access to all subcontractors under this Contract.

✓ ARTICLE 7 - Competition

All procurement transactions under this Contract including those of subcontractors, shall be conducted in a manner providing to the maximum extent practical, open and free competition.

✓ ARTICLE 8 - Utilization of Small Business Concerns

It is the policy of the United States Government that small business concerns including those owned and controlled by socially and economically disadvantaged individuals, shall have the maximum practicable opportunity to participate in performing in contracts sponsored by any Federal agency. It is further the policy of the United States, that contractors establish procedures to ensure timely payment of amounts pursuant to the terms of their subcontracts with such small businesses. The Contractor agrees to implement and support this policy to the maximum practicable extent in the performance of this Contract.

The substance of this Article shall be included in all subcontracts issued under this Contract exceeding $10,000.

✓ ARTICLE 9 - Acknowledgment of Support

The Contractor and their subcontractors, as appropriate, shall acknowledge NSF support in any publication of any material based on or developed under this Contract, in the following terms:

> "This material is based upon work supported by the National Science Foundation under the Cooperative Agreement with the California Institute of Technology. No. PHY-9210038. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the view of the National Science Foundation."

✓ARTICLE 10 - Metric System

All reports and publications resulting from this Contract shall use metric system of weights and measures, unless its use is impractical or is likely to cause significant inefficiencies.

✓ ARTICLE 11 - Assignment of Rights and Delegation of Duties

(a) The Contractor may assign monies due or to become due under this Contract, subject to the following conditions:

1. Any assignment, or subsequent reassignment, shall cover all amounts payable under this Contract and not paid as of (i) the effective date of assignment, or (ii) the date Caltech receives written notice of assignment, whichever is later.

2. No assignment may be made to more than one party.

3. Two copies of the notice of assignment, signed by the assignor, shall be furnished to Caltech.

4. No assignment may be made which includes, either specifically or by implication, any delegation of Contractor's duty to perform the work or provide the items required by this Contract without the prior written consent of Caltech, provided however. that nothing contained herein shall be deemed to prohibit the Contractor from placing subcontracts.

✓ARTICLE 12 - Liability and Indemnification / Land Holders

In addition to provisions in Article 32, Insurance and Indemnification, the following protection is assured to the "land holders" for the LIGO Hanford, WA and Livingston, LA sites:

1. Although the Louisiana State University (LSU) is the beneficial owner of the land on which the LIGO facility in the State of Louisiana is to be constructed and operated, the real party in interest obtaining the benefit of this contract performance is the California Institute of Technology (Caltech/LIGO Project), acting as the awardee of the National Science Foundation (NSF). LSU is not associated with, nor represented by, either NSF or the LIGO Project, and as such, neither NSF nor the LIGO Project may bind LSU to any action of the subcontract responsibility with respect to the subject Contract. Therefore. neither LSU nor the State of Louisiana, shall be liable, directly or indirectly, for the payment of any sums, or the performance of any obligations which are the subject of this Contract.

2. The Contractor agrees to indemnify and save harmless DOE, the contractors of DOE and the officers, employees, authorized representatives and subcontractors of DOE from any claims, costs (including, but not limited to attorney fees, consultant fees and/or expert witness fees) or liabilities (including, but not limited to sums paid in settlement of claims). arising during the term of this Contract or thereafter form the injury or death of any person

or persons or the damage of any property directly attributable to the performance under the subject Contract and not otherwise attributable to any preexisting conditions. This provision shall not apply if injury, death or damage to any property is attributable to the negligence or willful misconduct on the part of DOE, the contractors of DOE or the officers, employees, authorized representatives or subcontractors of DOE.

3. The substance of this Article shall be included in all subcontracts issued under this contract.

✓ ARTICLE 13 - Audit Rights

The Comptroller General of the United States, NSF and Caltech, and any of their duly authorized government representatives, shall have access to any books, documents, papers and records of the Contractor and their subcontractors, as appropriate, and their subcontractors, as which are directly pertinent to the subject Contract for the purpose of making audits, examinations, excerpts and transcripts. The subject access to books, documents, papers and records shall be available until three (3) years after the final payment under this Contract.

✓ ARTICLE 14 - Audit / Negotiations

If, pursuant to law, the Contractor has been required to submit cost or pricing data in connection with pricing this Contract or any modifications of this Contract, the authorized representatives of the Government shall have the right to examine and audit all books, records, documents and other data of the Contractor (including computations and projections) related to negotiating, pricing, or performing the Contract or Contract modification, in order to evaluate the accuracy, completeness and currency of the submitted cost or pricing data.

The substance of this Article shall be included in all negotiated subcontracts issued under this Contract exceeding $100,000.

✓ ARTICLE 15 - Authorization and Consent / Government Patents

The Government authorizes and consents to all use and manufacture of any Government owned inventions and licensing rights in the performance of the Contract or any subcontract issued under this Contract regardless of tier.

✓ ARTICLE 16 - Rights to Inventions and Materials

Matters regarding rights to inventions and materials generated under this Contract are subject to the NSF Grant policy, contained in the NSF Grant Policy Manual, Section 750, Intellectual Property, Exhibit V.

✓ ARTICLE 17 - Rights in Data

(a) Allocation of Rights

1. Except as provided in paragraph (b) of this Article regarding copyright, the Government and in support and furtherance of its Government contract obligations, Caltech, shall have unlimited rights in:

   A. Data first produced in the performance of this Contract;

   B. Form, fit, and function data delivered under this Contract;

   C. Data delivered under this Contract that constitute manuals or instructional and training material for installation, operation, or routine maintenance and repair of items, components, or processes delivered or furnished for use under this Contract; and

   D. All other data delivered under this Contract unless provided otherwise in this Contract.

2. The Contractor shall have the right to:

   A. Use, release to others, reproduce, distribute, or publish any data first produced or specifically used in the performance of this Contract;

   B. Protect from unauthorized disclosure and use those data which are limited rights data to the extent provided in this Contract;

   C. Substantiate use of, add or correct limited rights, restricted rights, or copyright notices and to take other appropriate action, in accordance with paragraphs (d) and (e) of this Article; and

   D. Establish claim to copyright subsisting in data first produced in the performance of this Contract to the extent provided in Article 16, Rights to Inventions and Materials and subparagraph (b) below.

(b) Copyright

1. Data first produced in the performance of this Contract. When claim to copyright is made, the Contractor shall affix an acknowledgment of Government sponsorship as indicated in Article 9, Acknowledgment of Support. The Contractor grants to the Government, and in support and furtherance of its Government contract obligations, Caltech, and others acting on their behalf, a paid-up, nonexclusive, irrevocable worldwide license in such copyrighted data to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly by or on behalf of the Government.

2. Data not first produced in the performance of this Contract. The Contractor shall not, without prior written permission of Caltech, incorporate in data delivered under this Contract any data not first produced in the performance of this Contract, unless the Contractor identifies such data and grants to the Government, and in support and furtherance of its Government contract obligations, Caltech, or acquires on their behalf, a license of the same scope as set forth in subparagraph above.

(c) Release, Publication and Use of Data

1. The Contractor shall have the right to use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Contractor in the performance of this Contract, except to the extent such data may be subject to the Federal export control or national security laws or regulations, or unless otherwise provided in this Contract.

2. The Contractor agrees that to the extent it receives or is given access to data necessary for the performance of this Contract which contain restrictive markings, the Contractor shall treat the data in accordance with such markings unless otherwise specifically authorized in writing by Caltech.

(d) Subcontracting. The Contractor has the responsibility to obtain from its subcontractors all data and rights therein necessary to fulfill the Contractor's obligation to the Government and Caltech under this Contract. If a subcontractor refuses to accept terms affording the Government or Caltech such rights, the Contractor shall promptly bring such refusal to the attention of Caltech and not proceed with subcontract award without further authorization.

(e) Relationship to Patents. Nothing contained in this Article shall imply a license to the Government or Caltech under any patent or be construed as affecting the scope of any license or other right otherwise granted to the Government or the Institute.

✓ ARTICLE 18 - Notice and Assistance Regarding Patent and Copyright Infringement

(a) The Contractor shall report to Caltech promptly, and in reasonable written detail, each notice or claim of patent or copyright infringement based on the performance of this Contract.

(b) In the event of any claim or suit against the Government and/or Caltech on account of any alleged patent or copyright infringement arising out of the performance of this Contract or out of the use of any supplies furnished or work or services performed under this Contract, the Contractor shall furnish to Caltech, when so requested, all evidence and information in possession of the Contractor pertaining to such suit or claim. Such evidence and information shall be furnished at the expense of Caltech except where the Contractor has agreed to indemnify Caltech.

✓ ARTICLE 19 - Equal Employment Opportunity

By acceptance of this Contract, the Contractor assures Caltech that it and its subcontractors will comply with and implement the following Acts:

(a) Title VI of the Civil Rights Act of 1964 (PL 88-352), the regulations issued pursuant to this Act by the NSF (45 CFR 611), and the Assurance of Compliance the Contractor has filed with Caltech.

(b) Section 504 of the Rehabilitation Act of 1973 (29 U.S.C. 794) and NSF's implementing regulations (45 CFR 605, as amended at 55 Federal Register 52142).

(c) Age Discrimination Act of 1975 as implemented by the Department of Health and Human Service regulations at 45 CFR 90 and the regulations of NSF at 45 CFR 617.

(d) Vietnam Era Veterans Readjustment Assistance Act of 1972, as amended, and

(e) Americans with Disabilities Act 42 U.S.C. Section 12101 et. seq. and all implementing regulations.

✓ ARTICLE 20 - Notice of Labor Disputes

The Contractor shall give prompt notice to Caltech of any actual or potential labor disputes which delay or may delay timely performance of this Contract.

✓ ARTICLE 21 - Labor Regulations

It is anticipated that this Contract will involve employment of mechanics and laborers as defined within the scope of the below Acts.

> Davis Bacon Act, Contract Work Hours and Safety Standards Act-Overtime Compensation, Apprentices and Trainees, Payrolls and Basic Records, Compliance with Copeland Regulations, Withholding of Funds, Subcontracts, Contract Termination-Debarment, Buy American Act-Construction, and Disputes Concerning Labor Standards.

All Contracts in excess of $2,500 involving employment of mechanics and laborers shall include a provision for compliance with Sections 103 and 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 327-330) as supplemented by the Department of Labor regulations (29 CFR, Part 5) and as indicated in the Additional General Provisions, Article 2, Contract Work Hours and Safety Standards Act-Overtime Compensation.

The substance of this Article shall be included in all subcontracts issued under this Contract in excess of $2,500 involving employment of mechanics and laborers and in excess of $2,000 for construction, alteration or repair that are within the scope of the above Acts, regardless of tier.

✓ ARTICLE 22 - Safety and Health

The Contractor shall take all reasonable safety and health measures in performing under this Contract, and shall comply with all applicable Federal, state and local laws relating to safety and health in effect on the date of this Contract.

✓ ARTICLE 23 - Hazardous Materials

The Contractor shall comply with all applicable Federal, State, and local laws, codes, ordinances, and regulations (including the obtaining of licenses and permits) in connection with hazardous material. Neither the requirements of this Article nor any act or failure to act by the Government or Caltech shall relieve the Contractor of any responsibility or liability for the safety of Government, Caltech, Contractor, or subcontractor personnel or property.

The Contractor agrees to submit to Caltech material safety information and a plan for handling of any and all hazardous materials delivered under this Contract which will involve exposure to hazardous materials or items containing these materials. The handling including disposition of hazardous materials shall be in accordance with the plan and as approved by Caltech.

The substance of this Article shall be included all in subcontracts issued under this Contract involving hazardous material.

✓ ARTICLE 24 - Drug Free Workplace

The Contractor agrees to inform all Contractor and subcontractors personnel, prior to their first entrance upon Caltech-controlled premises, of Caltech's compliance with the Drug-Free Workplace Act and of requirements for that Contractor and subcontractor personnel to comply with this policy of maintaining a drug-free workplace in all Caltech-controlled premises.

✓ ARTICLE 25 - Convict Labor

The Contractor including its subcontractors agree not to employ any person undergoing sentence of imprisonment in performing this Contract except as provided by 18 U.S.C. 4082(c)(2) and Executive Order 11755, December 29, 1973.

✓ ARTICLE 26 - Buy American Act

The Buy American Act (41 U.S.C. 10) provides that the Government give preference to domestic supplies and construction materials. Accordingly, the Contractor agrees to deliver only domestic end products, as defined by the Buy American Act including exceptions therein. in the performance of this Contract.

The substance of this Article shall be included in all subcontracts issued under this Contract for procurement of significant supplies and/or materials subject to the Buy American Act.

✓ ARTICLE 27 - Preference for Privately owned U.S.-Flag Air Carriers and Commercial Vessels

The Contractor and their subcontractors, as appropriate, shall use privately owned U.S. Air Carriers and U.S.-flag commercial vessels and no others, in the air and/or ocean and river transportation of any personnel, supplies and materials, to be furnished under this Contract.

✓ ARTICLE 28 - Anti-Kickback

The Contractor and their subcontractors shall comply with the Anti-Kickback Act of 1986 (41 U.S.C. 51-58) (the Act).

✓ ARTICLE 29 - Restrictions on Subcontractor Sales

Except as provided below, the Contractor nor any subcontractor, shall not enter into any agreement with an actual or prospective subcontractor, nor otherwise act in any manner, which has or may have the effect of restricting sales by such subcontractors directly to Caltech or the Government of any item or process made or furnished by the subcontractor under this Contract.

The prohibition above does not preclude the Contractor from asserting rights that are otherwise authorized by law or regulation.

✓ ARTICLE 30 - Clean Air and Water

The Contractor shall comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act of 1970 (42 U.S.C. 1857 et seq.) and the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.) as amended. Violations shall be reported to NSF and the Regional Office of the Environmental Protection Agency.

The substance of this Article shall be included in any nonexempt subcontract exceeding $100,000.

ARTICLE 31 - Prohibition of Contractor Use of Privately Owned Aircraft

The Contractor, its employees, agents and subcontractors shall not use privately owned (non-commercial) aircraft in the performance of this Contract without having in effect Aircraft Liability Insurance coverage of not less than $5,000,000 for all deaths, injuries and property damage arising from one accident or occurrence.

The substance of this Article shall be included in any subcontract issued under this Contract involving air transportation travel regardless of tier.

✓ ARTICLE 32 - Insurance and Indemnification

The Contractor shall take such steps as may be deemed necessary to insure or protect itself, its employees and its property. Accordingly, the Contractor shall provide appropriate insurance coverage for all supplies, equipment and personnel involved with the Contract effort. Neither

Caltech, NSF, Department of Energy (DOE) or Louisiana State University (LSU), shall assume any liability for accidents, illnesses, or claims arising out of any work supported by this Contract.

(a) Insurance. The Contractor shall, at its own expense, provide and maintain during the entire performance period of this Contract, following kinds and minimum amounts of insurance:

1. Workers' Compensation and Employer's Liability Insurance, as required by applicable Federal and state workers' compensation and occupational disease statutes. If occupational diseases are not compensable under those statutes, they shall be covered under the Employer' Liability section of the insurance policy, except when Contract operations are so commingled with the Contractor's commercial operations that this would not be practical. The employer's Liability coverage shall be $500,000 per accident, except in states with exclusive or monopolistic funds that do not permit worker's compensation to be written by private carriers. However, the Contractor in fulfillment of its obligation to provide Workers' Compensation Insurance may maintain a self-insurance program if the Contractor is qualified pursuant to statutory authority to do so.

2. Comprehensive Liability Insurance, including automobiles (owned, non-owned, or leased), completed operations, products, and contractual liability, for a combined single limit of $1,000,000 for all deaths, injuries, and property damage arising from one accident or occurrence.

(b) The Contractor shall include as additional insureds, Caltech, NSF, Department of Energy (DOE) and LSU, which are third parties of interest, and as indicated in the Attachment to this General Provisions.

(c) Insurance Certificates. Before commencing work under this Contract, the Contractor shall furnish certificates of insurance for the coverages required hereunder. Such certificates shall provide that any cancellation or material change in the insurance policies shall not be effective (i) for such period as the laws of the State in which this Contract is to be performed prescribe, or (ii) until 30 days after the insurer or the Contractor gives written notice to Caltech, whichever period is longer. Also, such certificates shall (i) cover contractual liability assumed under this Contract, and (ii) be primary and non-contributing to any insurance procured by Caltech.

(d) Indemnification. The Contractor agrees to indemnify and hold harmless the Government and Caltech, its trustees, officers, and employees, from any third party loss, cost, damage, expense or liability, or any suit therefore, by reason of actual or alleged property damage or personal injury of whatsoever kind or character arising out of or in connection and occurring during the performance of work hereunder by the Contractor or any of its subcontractors, howsoever the same may be caused, excepting only such loss, cost, damage, expense or liability attributable to and to the extent of the negligence or fault of the Government or of Caltech, its trustees, officers or employees.

(e) The substance of this Article, including this paragraph (d), shall be included in all subcontracts issued under this Contract regardless of tier on LIGO remote sites. At least five days before entry of each such subcontractor's personnel on the Caltech-controlled premises, the Contractor shall furnish (or ensure that there has been furnished) to Caltech a current certificate of insurance, meeting the requirements of paragraph (b) above, for each such subcontractor.

✓ ARTICLE 33 - Permits and Responsibilities

The Contractor shall, without additional expense to Caltech, be responsible for obtaining any necessary licenses and permits, and for complying with any Federal, State, and municipal laws, codes, and regulations applicable to the performance of the work. The Contractor shall also be responsible for all damages to persons or property that occur as a result of the Contractor's fault, or negligence, and shall take proper safety and health precautions to protect the work, the workers, the public, and the property of others. The Contractor agrees to indemnify Caltech and the Government against any loss, cost, liability or damage by reason of the Contractor's violation of or failure to comply with any applicable laws, executive orders or regulations. Caltech will obtain the necessary project permits, including but not limited to, building occupancy and operating permits for each site as required. No special permits will be required by Caltech, DoE or NSF.

✓ ARTICLE 34 - Other Contracts

(a) Caltech may undertake or award other contracts for additional work at or near the site of the work under this Contract. The Contractor shall fully cooperate with the other contractors and with Caltech employees and shall carefully adapt scheduling and performing the work under this Contract to accommodate the additional work, heeding any direction that may be provided by Caltech. The Contractor shall not commit or permit any act that will interfere with the performance of work by any other contractor or by Caltech employees.

(b) Where the Contractor's work is associated with that of another contractor, the Contractor shall examine the adjacent work and report in writing to Caltech any defect or condition preventing the proper performance of this Contract. If the Contractor proceeds without giving such notice, the Contractor shall not be relieved of the obligation of any warranty because of any such condition or imperfection.

(c) The Contractor's work at the site will be performed on a joint occupancy non-interference basis as defined in Article 1 and as specified in the Contract.

✓ ARTICLE 35 - Temporary Utilities and Utility Tie-Ins

(a) Electricity

1. All reasonable electric current required by the Contractor shall be furnished by Caltech. All temporary connections for electricity shall be accomplished by the Contractor subject to the approval of Caltech.

2. All temporary lines will be furnished, installed, connected and maintained by the Contractor in a workman like manner satisfactory to Caltech and shall be removed by the Contractor in like manner prior to completion of the construction, or as directed by Caltech.

(b) Telephone Service. Unless otherwise provided in this Contract, telephone service shall be provided by the Contractor.

(c) Utility Tie-Ins. All tie-ins, modifications, or moving of utilities such as air, power, water, etc., must be coordinated with Caltech.

✓ ARTICLE 36 - Inspection

(a) "Work," as used in this Article, includes, but is not limited to, materials, workmanship, and manufacture fabrication, installation/integration and acceptance testing of LIGO Vacuum Equipment components.

(b) The Contractor shall maintain an adequate inspection system and perform such inspections as will ensure that the work called for by this Contract conforms to Contract requirements. The Contractor shall maintain complete inspection records and make them available to Caltech. The inspection records shall be maintained for three (3) years after Contract completion.

(c) All work shall be subject to Caltech inspection and test at all places and at all reasonable times before acceptance to ensure strict compliance with the terms of this Contract. Caltech inspections and tests are for the sole benefit to Caltech and do not:

1. Relieve the Contractor of responsibility for providing adequate quality control measures;

2. Relieve the Contractor of responsibility for damage to or loss of equipment before acceptance;

3. Constitute or imply acceptance; or

4. Affect the continuing rights of Caltech after acceptance of the completed work under paragraph (i) below.

(d) The presence or absence of Caltech's authorized representative (representative) does not relieve the Contractor from any Contract requirement, nor is the representative authorized to change any contract term or condition, or specification, unless such representative has been authorized to make such changes in accordance with the Article 3, Authority of Caltech's Representatives.

(e) The Contractor shall promptly furnish, without additional charge, all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required under the Contract.

(f) The Contractor shall, without charge, replace or correct work found by Caltech not to conform to Contract requirements, unless Caltech consents to accept the work in "as is" condition with an appropriate adjustment in Contract price.

(g) If the Contractor does not promptly replace or correct rejected work, Caltech may (i) by Contract or otherwise, replace or correct the work and charge the cost to the Contractor or (ii) terminate for default the Contractor's right to proceed.

(h) NSF through its authorized representatives has the right to inspect and evaluate the work performed or being performed under the Contract, and the premises where the work is being performed, at all reasonable times. The Contractor shall furnish and shall require subcontractors to furnish all reasonable facilities and assistance for the safe and convenient performance of these duties.

ARTICLE 37 - Acceptance

Unless otherwise specified in the Contract, Caltech shall accept, as promptly as practicable after completion and inspection all work that can be accepted separately. Acceptance of the work at each site will occur upon successful completion of system or component acceptance tests, or eight (8) months after system delivery to the site, whichever occurs first, should system acceptance tests be delayed through no fault of the Contractor.

ARTICLE 38 - Caltech-Furnished Property

(a) Caltech shall deliver to the Contractor, at the time stated in the Schedule or, if not so stated, in sufficient time to enable the Contractor to meet the delivery or performance schedule, Caltech and/or Government owned property described as Caltech-furnished property in the Schedule or specifications. If that property, suitable for its intended use, is not delivered to the Contractor, Caltech shall equitably adjust this Contract in accordance with Article 4, Changes conditional upon submission of a timely written request for an equitable adjustment and the facts warrant an equitable adjustment.

Attachment to General Provisions
Document LIGO-C950323-00-P

Additional Insureds

- California Institute of Technology
  General Insurance Office, 2-42B
  Pasadena, CA 91125

- National Science Foundation
  Divisions of Grants and Agreements
  4201 Wilson Blvd.
  Arlington, VA 22230

- Department of Energy
  Richland Field Office
  Site Infrastructure Division
  P. O. Box 550
  Richland, WA 99352

- Board of Supervisors
  Louisiana State University
  and Agricultural & Mechanical College
  P. O. Box 25317
  Baton Rouge, LA 70894-5317

EXHIBIT V

NATIONAL SCIENCE FOUNDATION GRANT POLICY MANUAL SECTION 750, INTELLECTUAL PROPERTY LIGO-C950365-A-P

750 INTELLECTUAL PROPERTY

751 Patents and Inventions

751.1 Background

a. The disposition of rights to inventions made by small business firms and nonprofit organizations, including universities and other institutions of higher education, during NSF-assisted research is governed by chapter 18 of title 35 of the United States Code, commonly called the Bayh-Dole Act. In accordance with a Presidential Memorandum entitled "Government Patent Policy" issued February 18, 1983 and under the authority of section 12 of the National Science Foundation Act of 1950, as amended (42 U.S.C. Section 1871), NSF applies the policies of that Act of all its grantees. The Department of Commerce is the lead agency for implementing the Bayh-Dole Act and has published guidance to Federal agencies as part 401 of title 37 of the Code of Federal Regulations. The Foundation's implementing rules are published as part 650 of title 45 of the Code of Federal Regulations.

b. NSF's standard Patent Rights clause, published at 45 CFR Section 650.4(a) and below at GPM 751.3, is identical to that prescribed in the DOC guidelines (37 CFR Section 401.14(a)) except that:

1. NSF has tailored the clause to apply to grants and to identify NSF;
2. pursuant to section 401.5(d) of the DOC guidance (37 CFR Section 401.5(d). NSF has added to paragraph (b) of the clause a stipulation that the Foundation reserves the right to direct a grantee to transfer to a foreign government or research performer such rights to any subject invention as are required to comply with any international treaty or agreement identified when the grant is made as being applicable to the assisted research;
3. as permitted by sections 401.5(f) of the DOC guidance (37 CFR Section 401.5(f)), NSF has added two subparagraphs to the end of paragraph (f) of the clause to require grantees or their representatives to send to the Foundation confirmations of the Government licenses for and copies of any United States patents on subject inventions; and
4. since NSF normally uses the same clause for all subcontractors, the first two subparagraphs of paragraph (g) of the clause specified in the DOC guidance have been reduced to one.

751.2 National Science Foundation Patent Policy

As authorized by the National Science Board at its 230th meeting, October 15-16, 1981, the Director of the National Science Foundation has adopted the following statement of NSF patent policy.

(a) In accordance with, by the Bayh-Dole Act and the Presidential Memorandum entitled "Government Patent Policy" issued February 18, 1983, the Foundation will use the Patent Rights clause prescribed by the Department of Commerce in all its funding agreements for the performance of experimental, developmental, or research work, including awards made to foreign entities, unless the Foundation determines that some other provision would better serve the purposes of that Act or the interests of the United States and the general public.

(b) In funding agreements covered by a treaty or agreement that provides that an international organization or foreign government, research institute, or inventor will own or share patent rights, the Foundation will acquire such patent rights as are necessary to comply with the applicable treaty or agreement.

(c) If an awardee elects not to retain rights to an invention, the Foundation will allow the inventor to retain the principal patent rights unless the awardee, or the inventor's employer if other than the awardee, shows that it would be harmed by that action.

(d) The Foundation will normally allow any patent rights not wanted by the awardee or inventor to be dedicated to the public through publication in scientific journals or as a statutory invention registration. However, if another Federal agency is known to be interested in the relevant technology, the Foundation may give it an opportunity to review and patent the invention so long as that does not inhibit the dissemination of the research results to the scientific community.

751.3 Standard Patent Rights Clause

The following Patent Rights clause will be used in every funding agreement awarded by the Foundation that relates to scientific or engineering research unless a special patent clause has been negotiated (see GPM 753.1). When the clause is used in a funding agreement other than a grant, "grant" and "grantee" may be replaced by "contract" and "contractor" or other appropriate terms.

PATENT RIGHTS (APRIL, 1992)

(a) Definitions

(1) "Invention" means any invention or discovery which is or may be patentable or otherwise protectable under title 35 of the United States Code, to any novel variety of plant which is or may be protected under the Plant Variety Protection Act (7 USC 2321 et seq.).

(2) "Subject Invention" means any invention of the grantee conceived or first actually reduced to practice in the performance of work under this grant, provided that in the case of a variety of plant, the date of determination (as defined in section 41(d) of the Plant Variety Protection Act (7 USC 2401(d)) must also occur during the period of grant performance.

(3 "Principal application" means to manufacture in the case of a composition or product, to practice in the case of a process or method, or to operate in the case of a machine or system; and, in each case, under such conditions as to establish that the Invention is being utilized and that its benefits are to the extent permitted by law or Government regulations available to the public on reasonable terms.

(4) "Made" when used in relation to any Invention means the conception or first actual reduction to practice of such invention.

(5) "Small business firm" means a domestic small business concern as defined act section 2 of Pub. L. 85-536 (15 USC 632) and implementing regulations of the Administrator of the Small Business Administration. For the purpose of this Patent Rights clause, the size standard for small business concerns involved in Government procurement and subcontracting at 13 CFR 121.3-8 and 13 CFR 121.3 -12, respectively, will be used.

(6)"Nonprofit organization" means a domestic university or other institution of higher education or an organization of the type described in section 501(c)(3) of the Internal Revenue Code of 1954 (26 USC 501(c)) and exempt from taxation under section 501(a) of the Internal Revenue Code (28 USC 501(a)) or any domestic nonprofit scientific or educational organization qualified under a State nonprofit organization statute.

(b) Allocation of Principal Rights

The grantee may retain the entire right, title, and interest throughout the world to each subject Invention subject to the provisions of this Patents Rights clause and 35 USC 203. With respect to any subject Invention in such the grantee retains title, the Federal Government shall have a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States the subject Invention throughout the world. If the award indicates it is subject to an identified International agreement or treaty, the National Science Foundation (NSF) also has the right to direct the grantee to convey to any foreign participant such patent rights to subject inventions as are required to comply with that agreement or treaty.

(c) Invention Disclosure, Election of Title and Filing of Patent Applications by Grantee

(1) The grantee will disclose each subject Invention to NSF within two months after the Inventor discloses it in writing to grantee personnel responsible for the administration of patent matters. The disclosure to NSF shall be in the form of a written report and shall identify the grant under which the invention was made and the Inventor(s). It shall be sufficiently complete in technical detail to convey a clear understanding of the nature, purpose, operation, and, to the extent known, the physical, chemical, biological or electrical characteristics of the invention. The disclosure shall also identify any publication, on sale or public use of the Invention and whether a manuscript describing the invention has been submitted for publication and, if so, whether it has been accepted for publication at the time of disclosure. In addition, after disclosure to NSF, the grantee will promptly notify NSF of the acceptance of any manuscript describing the invention for publication or of any on sale or public use planned by the grantee.

(2) The grantee will elect in writing whether or not to retain title to any such inventory by notifying NSF within two years of disclosure to NSF. However, in any case where publication, on sale, or public use has initiated the one year statutory period wherein valid patent protection can still be obtained in the United States, the period for election of the title may be shortened by NSF to a data that is no more than 60 days prior to the end of the statutory period.

(3) The grantee will file its initial patent application on an invention to which it elects to retain title within one year after election of title or, if earlier, prior to the end of any statutory period wherein valid patent protection can be obtained in the United States after a publication, or sale, or public use. The

grantee will file patent applications in additional countries or international patent offices within either ten months of the corresponding initial patent application, or six months from the date when permission is granted by the Commissioner of Patents and Trademarks to file foreign patent applications when such filing has been prohibited by a Secrecy Order.

(4) Requests for extension of the time for disclosure to NSF, election, and filing under subparagraphs (1), (2), and (3) may, at the discretion of NSF, be granted.

(d) Conditions When the Government May Obtain Title

The grantee will convey to NSF, upon written request, title to any subject invention:

(1) If the grantee fails to disclose or elect the subject invention within the times specified in paragraph (c) above, or elects not to retain title; provided that NSF may only request title within 60 days after learning of the failure of the grantee to disclose or elect within the specified times.

(2) In those countries in which the grantee fails to file patent applications within the times specified in paragraph (c) above; provided, however, that if the grantee has filed a patent application in a country after the times specified in paragraph (c) above, but prior to its receipt of the written request of NSF, the grantee shall continue to retain title in that country.

(3) In any country in which the grantee decides not to continue the prosecution of any application for, to pay the maintenance fees on, or defend in a reexamination or opposition proceeding on, a patent on a subject invention.

(e) Minimum Rights to Grantee

(1) The grantee will retain a nonexclusive royalty-free license throughout the world in each subject invention to which the Government obtains title, except if the grantee fails to disclose the subject invention within the times specified in paragraph (c) above. The grantee's license extends to its domestic subsidiaries and affiliates, if any, within the corporate structure of which the grantee is a party and includes the right to grant sublicenses of the same scope to the extent the grantee was legally obligated to do so at the time the grant was awarded. The license is transferable only with the approval of NSF except when transferred to the successor of that part of the grantee's business to which the invention pertains.

(2) The grantee's domestic license may be revoked or modified by NSF to the extent necessary to achieve expeditious practical application of the subject invention pursuant to an application for an exclusive license submitted in accordance with applicable provisions at 37 CFR Part 404. This license will not be revoked in that field of use or the geographical areas in which the grantee has achieved practical application and continues to make the benefits of the invention reasonably accessible to the public. The license in any foreign country may be revoked or modified at the discretion of NSF to the extent the grantee, its licensees, or its domestic subsidiaries or affiliates have failed to achieve practical application in that foreign country.

(3) Before revocation or modification of the license, NSF will furnish the grantee a written notice of its intention to revoke or modify the license, and the grantee will be allowed thirty days (or such other time as may be authorized by NSF for good cause shown by the grantee) after the notice to show cause why the license should not be revoked or modified. The grantee has the right to appeal, in accordance with applicable regulations in 37 CFR Part 404 concerning the licensing of Government-owned inventions, any decision concerning the revocation or modification of its license.

(f) Grantee Action to Protect Government's Interest

(1) The grantee agrees to execute or to have executed and promptly deliver to NSF all instruments necessary to: (i) establish or confirm the rights the Government has throughout the world in those subject inventions for which the grantee retains title, and (ii) convey title to NSF when requested under paragraph (d) above, and to enable the Government to obtain patent protection throughout the world in that subject invention.

(2) The grantee agrees to require, by written agreement, its employees, other than clerical and non-technical employees, to disclose promptly in writing to personnel identified as responsible for the administration of patent matters and in a format suggested by the grantee each subject invention made under this grant in order that the grantee comply with the disclosure provisions of paragraph (c) above, and to execute all papers necessary to file patent applications on subject inventions and to establish the Government's rights in the subject inventions. The disclosure format should require, as a minimum, the information requested by paragraph (c)(1) above. The grantee shall instruct such employees through the employee agreements or other suitable educational programs on the importance of reporting inventions in sufficient time to permit the filing of patent applications prior to U.S. or foreign statutory bars.

(3) The grantee will notify NSF of any decision not to continue prosecution of a patent application, pay maintenance fees, or defend in a reexamination or opposition proceeding on a patent, in any country, not less than thirty days before the expiration of the response period required by the relevant patent office.

(4) The grantee agrees to include, within the specification of any United States patent application and any patent issuing thereon covering a subject invention, the following statement: "This invention was made with Government support under (identify the grant) awarded by the National Science Foundation. The Government has certain rights in this invention."

(5) The grantee or its representative will complete, execute, and forward to NSF a confirmation of a License to the United States Government within two months of filing any domestic or foreign patent application.

(6) The grantee or its representative will forward to NSF a copy of any United States patent covering a subject invention within two months after it is issued.

(g) Subcontracts

(1) The grantee will include this Patents Rights clause, suitably modified to identify the parties, in all subcontracts, regardless of tier, for experimental, developmental, or research work. The subcontractor will retain all rights provided for the grantee in this Patents Rights clause, and the grantee will not, as part of the consideration for awarding the subcontract, obtain rights in the subcontractor's subject Inventions.

(2) In the case of subcontracts, at any tier, when the prime award by the Foundation was a contract (but not a grant or cooperative agreement), NSF, subcontractor, and contractor agree that the mutual obligations of the parties created by this Patents Rights clause constitute a contract between the subcontractor and the Foundation with respect to those matters covered by this Patents Rights clause.

(h) Reporting on Utilization of Subject Inventions

The grantee agrees to submit on request periodic reports no more frequently than annually on the utilization of a subject Invention or on efforts at obtaining such utilization that are being made by the grantee or its licensees or assignees. Such reports shall include information regarding the status of development, date of first commercial sale or use, gross royalties received by the grantee, and such other data and information as NSF may reasonably specify. The grantee also agrees to provide additional reports in connection with any march-in proceeding undertaken by NSF in accordance with paragraph (j) of this Patents Rights clause. As required by 35 USC 202(c)(5), NSF agrees it will not disclose such information to persons outside the Government without the permission of the grantee.

(i) Preference for United States Industry

Notwithstanding any other provision of this Patents Rights clause, the grantee agrees that neither it nor any assignee will grant to any person the exclusive right to use or sell any subject Invention in the United States unless such person agrees that any products embodying the subject Invention or produced through the use of the subject Invention will be manufactured substantially in the United States. However, in individual cases, the requirement for such an agreement may be waived by NSF upon a showing by the grantee or its assignee that reasonable but unsuccessful efforts have been made to grant licenses on similar terms to potential licensees that would be likely to manufacture substantially in the United States or that under the circumstances domestic manufacture is not commercially feasible.

(j) March-in Rights

The grantee agrees that with respect to any subject invention in which it has acquired title, NSF has the right in accordance with procedures at 37 CFR 401.6 and NSF regulations at 45 CFR 650.13 to require the grantee, an assignee or exclusive licensee of a subject invention to grant a nonexclusive, partially exclusive, or exclusive license in any field of use to a responsible applicant or applicants, upon terms that are reasonable under the circumstances, and if the grantee, assignee, or exclusive licensee refuses such a request, NSF has the right to grant such a license itself if NSF determines that:

(1) Such action is necessary because the grantee or assignee has not taken, or is not expected to take within a reasonable time, effective steps to achieve practical application of the subject invention in such field of use;

(2) Such action is necessary to alleviate health or safety needs which are not reasonably satisfied by the grantee, assignee, or their licensees;

(3) Such action is necessary to meet requirements for public use specified by Federal regulations and such requirements are not reasonably satisfied by the grantee, assignees, or licensee; or

(4) Such action is necessary because the agreement required by paragraph (i) of this Patents Rights clause has not been obtained or waived or because a licensee of the exclusive right to use or sell any subject invention in the United States is in breach of such agreement.

(k) Special Provisions for Grants with Nonprofit Organizations

If the grantee if a nonprofit organization, it agrees that:

(1) Rights to a subject invention in the United States may not be assigned without the approval of NSF, except where such assignment is made to an organization which has as one of its primary functions the management of inventions, provided that such assignee will be subject to the same provisions as the grantee;

(2) The grantee will share royalties collected on a subject invention with the inventor, including Federal employee co-inventors (when NSF deems it appropriate) when the subject invention is assigned in accordance with 35 USC 202(e) and 37 CFR 401.10;

(3) The balance of any royalties or income earned by the grantee with respect to subject inventions, after payment of expenses (including payments to inventors) incidental to the administration of subject inventions, will be utilized for the support of scientific research or education; and

(4) It will make efforts that are reasonable under the circumstances to attract licensees of subject inventions that are small business firms and that it will give preference to a small business firm if the grantee determines that the small business firm has a plan or proposal for marketing the invention which, if executed, is equally likely to bring the invention to practical application as any plans or proposals from applicants that are not small business firms; provided that the grantee is also satisfied that the small business firm has the capability and resources to carry out its plan or proposal. The decision whether to give a preference in any specific case will be at the discretion of the grantee. However, the grantee agrees that the Secretary of Commerce may review the grantee's licensing program and decisions regarding small business applicants, and the grantee will negotiate changes to its licensing policies, procedures, or practices with the Secretary when the Secretary's review discloses that the grantee could take reasonable steps to implement more effectively the requirements of this paragraph (k)(4).

(l) Communications

All communications required by this Patents Rights clause should be sent to:

Patent Assistant
Officer of the General Counsel
National Science Foundation
Washington, DC 20550

[END OF CLAUSE]

752 Copyright

752.1 Rights to Copyrightable Material

The following principles governing the treatment of copyrightable material produced under NSP awards were adopted by the National Science Board on March 26, 1984.

a. The Foundation normally will acquire only such rights to copyrightable material as are needed to achieve its purposes or to comply with the requirements of any applicable government-wide policy or international agreement.

b. To preserve incentives for private dissemination and development, the Foundation normally will not restrict or take any part of income earned from copyrightable material except as necessary to comply with the requirements of any applicable government-wide policy or international agreement.

c. In exceptional circumstances, the Foundation may restrict or eliminate an awardee's control of NSF-supported copyrightable material and of income earned from it, if the Foundation determines that this would best serve the purposes of a particular program or award.

752.2 Standard Copyrightable Material Clause

The following copyrightable material clause will be used in every funding agreement awarded by the Foundation that relates to scientific or engineering research unless a special copyrightable material clause has been negotiated. (See GPM 753.2) When the clause is used in a funding agreement other than a grant, "grant" and "grantee" may be replaced by "contract" or other appropriate terms.

COPYRIGHTABLE MATERIAL

a. "Subject writing" means any material that:

1. is or may be copyrightable under Title 17 of the United States Code, and
2. is produced by the grantee or its employees in the performance of work under this grant.

"Subject writings include such items as reports, books, journal articles, software, sound recordings, video tapes, and video discs.

b. Copyright Ownership, Government License. Except as otherwise specified in the grant or by this paragraph, the grantee may own or permit others to own copyright in all subject writings. The grantee agrees that if it or anyone else does own copyright in a subject writing, the Federal government will have a nonexclusive, nontransferable, irrevocable, royalty-free license to exercise or have exercised for or on behalf of the United States throughout the world all the exclusive rights provided by copyright. Such license, however, will not include the right to sell copies or phonerecords of the copyrighted works to the public.

c. Grants Affected by International Agreements. If the award indicates it is subject to an identified international agreement or treaty, the Foundation can direct the grantee to convey to any foreign participant or otherwise dispose of such rights to subject writings as are required to comply with that agreement or treaty.

d. Grantee Action to Protect Government Interests. The grantee agrees to acquire, through written agreement or an employee relationship, the ability to comply with the requirements of the preceding paragraphs and, in particular, to acquire the ability to convey rights in a subject writing to a foreign participant if directed by the Foundation under the previous paragraph. The grantee further agrees that any transfer of copyright or any other rights to a subject writing, by it or anyone whom it has allowed to own such rights, will be made subject to the requirements of this article.

[END OF CLAUSE]

753 Special Patent and Copyright Situations

753.1 Special Award Provisions

At the request of the prospective awardee or on recommendation from NSF staff, a Grants or Contracts Officer, with the concurrewnce of the cognizant Program Manager, may negotiate special patent or copyright provisions when he or she determines that exceptional circumstances require restriction or elimination of the right of a prospective awardee to control principal rights to subject inventions or writings in order to better achieve the objectives of the program, the National Science Foundation Act, or (in the case of inventions) Chapter 18 of Title 35 of the United States Code. Unless doing so would be inconsistent with an obligation imposed on the Foundation by statute, internationial agreement, or pact with other participants in or supporters of the research, every special copyright or patent provision will allow the awardee, after an invention has been made or copyrightable material created, to request that it be allowed to retain principal rights to that invention or material.

753.2 Awards Not Primarily for Research

a. Awards not primarily intended to support scientific or enginee3ring research need contain no patent or copyrightable material provision. Examples of such aweards are travel, conference, and equipment grants.

b. NSF Fellowships and Traineeships. In accordance with section 212 of title 35 of the United States Code, the Foundation claims no rights to inventions made by fellows or trainees. The following provision will be included in each fellowship or traineeship program announcement and made part of the award:

INTELLECTUAL PROPERTY RIGHTS

The National Science Foundation claims no rights to any inventions or writings that might result from its fellowship or traineeship awards. However, fellows and trainees should be aware that the NSF, another Federal agency, or some private party may acquire such rights through other support for particular research. Also, fellows and trainees should note their obligation to include an Acknowledgment and Disclaimer in any publication.

[END OF PROVISION]

753.3 Awards Affected by International Agreements

a. Many of the bilateral and multilateral treaties and agreements underlying the Foundation's international cooperative research programs contain provisions on allocation of rights to inventions or writings. These sometimes require an allocation of rights different from that provided by the standard *Copyrightable Material* or *Patent Rights* clauses. In those cases, the standard clauses will be modified through the addition of the following to the award letter:

"This project is supported under the cooperative science program listed below. Your rights in invention, writings, and data may be affected."

The applicable agreement or treaty will be identified immediately beneath that sentence.

b. After an invention is disclosed to the Patent Assistant, the recipient of an award subject to an international agreement will be informed as to what rights, if any, it must transfer to foreign participants. Recipients may also ask the NSF Program Officer for copies of the identified international agreement before or after accepting an award.

754 Dissemination and Sharing of Research Results

a. Investigators are expected to promptly prepare and submit for publication, with authorship that accurately reflects the contributions of those involved, all significant findings from work conducted under NSF grants. Grantees are expected to permit and encourage such publication by those actually performing that work, unless a grantee intends to publish or disseminate such findings itself.

b. Investigators are expected to share with other researchers, at no more than incremental cost and within a reasonable time, the primary data, samples, physical collections, and other supporting materials created or gathered in the course of work under NSF grants. Granters are expected to encourage and facilitate such sharing. Privileged or confidential information should be released only in a form that protects the privacy of individuals and subjects involved. General adjustments and, where essential, exceptions to this sharing expectation may be specified by the funding NSF Program or Division for a particular field or discipline to safeguard the rights of individuals and subjects, the validity of results, or the integrity of collections or to accommodate legitimate interests of investigators. A grantee or investigator may also request a particular adjustment or exception from the cognizant NSF Program Officer.

c. Investigators and grantees are encouraged to share software and inventions created under the grant or otherwise make them or their products widely available and usable.

d. The NSF normally allows grantees to retain principal legal rights to intellectual property developed under NSF grants to provide incentives for development and discrimination of inventions, software, and publications that can enhance their usefulness, accessibility, and upkeep. Such incentives do not, however, reduce the responsibility that investigators and institutions have as members of the scientific and engineering community to make results, data and collections available to other researchers.

A 21

ATTACHMENT B

Additional General Provisions

Davis-Bacon Act (40 U.S.C. 276a276a-7)

Contract Work Hours and Safety Standards Act - Overtime Compensation

Apprentices and Trainees

Payrolls and Basic Records

Compliance with Copeland Act Requirements

Withholding of Funds

Subawards

Agreement Termination - Debarment

Disputes Concerning Labor Standards

Equal Opportunity

Project Labor Agreement for the Laser Interferometer Gravitational-Wave Observatory at Hanford (LIGO-C950331-00-P)

~~General Decision Number LA950006, State of Louisiana; Counties of: Ascension, East Baton Rouge, West Baton Rouge, Livingston~~

Davis-Bacon Act (40 U.S.C. 276A-276A-7)

1. All mechanics and laborers, including apprentices and trainees employed or working directly upon the site of the work shall be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by the Copeland Regulations (29 CFR part 3), the full amounts due at the time of payment computed at wage rates not less than the aggregate of the basic hourly rates and the rates of payments, contributions, or costs for any fringe benefits contained in the wage determination decision of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the Government Prime Awardee or subawardee and such laborers and mechanics. A copy of such wage determination decision shall be kept posted by the subawardee at the site of the work in a prominent place where it can be easily seen by the workers.

2. The subawardee may discharge his obligation under this clause to workers in any classification for which the wage determination decision contains:

(a) Only a basic hourly rate of pay, by making payment at not less than such basic hourly rate, except as otherwise provided in the Copeland Regulations (29 CFR Part 3); or

(b) both a basic hourly rate of pay and fringe benefits payments, by making payment in cash, by irrevocably making contributions pursuant to a fund, plan, or program for, and /or assuming an enforceable commitment to bear the cost of, bona fide fringe benefits contemplated by the Davis-Bacon Act, or by any combination thereof. Contributions made, or cost assumed, on other than a weekly basis shall be considered as having been constructively made or assumed during a weekly period to the extend that they apply to such period. Where a fringe benefit is expressed in a wage determination in any manner other than as an hourly rate and the subawardee pays a cash equivalent or provides an alternative fringe benefit, it shall furnish information with its payrolls showing how it determined that the cost incurred to make the cash payment or to provide the alternative fringe benefit is equal to the cost of the wage determination fringe benefit different from any contained in the wage determinatin, it shall similarly show how it arrived at the hourly rate shown therefore. In the event of disagreement between or among the interested parties as to an equivalent of any fringe benefit, the Grants and Contracts Officer shall submit the question, together with her or his recommendation, to the Secretary of Labor for final determination.

3. The assumption of an enforceable commitment to bear the cost of fringe benefits, or the provision of any fringe benefits not expressly listed in section 1(b)(2) of the Davis-Bacon Act or in the wage determination decision forming a part of the agreement, may be considered as payment of wages only with the approval of the Secretary of Labor pursuant to a written request by the subawardee. The Secretary of Labor may require the subawardee to set aside assets, in a separate account, to meet its obligations under any unfunded plan or program.

4. The Grant and Contracts Officer shall require that any class of laborers or mechanics, including apprentices and trainees, which is not listed in the wage determination decision and which is to be employed under the agreement shall be classified or reclassified conformably to the wage determination decision, and shall report the action taken to the Secretary of Labor. If the interested parties cannot agree on the proper classification or reclassification of a particular class of laborers or mechanics to be used, the Grants and Contracts Officer shall submit the question, together with his or her recommendation, to the Secretary of Labor for final determination. Apprentices and trainees may be added under this clause only where they are employed pursuant to an apprenticeship or trainee program meeting the requirements of the "Apprentices and Trainees" clause below.

5. In the event it is found by the Grants and Contracts Officer that any laborer or mechanic, including apprentices and trainees, employed by any subawardee directly on the site or the work covered by this agreement has been or is being paid at a rate of wages less than the rate of wages required by paragraph 1. of this clause, the Grants and Contracts Officer may (1) request by written notice to the Government Prime Awardee, that it terminate the subawardee's right to proceed with the work, or such part of the work as to which there has been a failure to pay said required wages, and (2) prosecute the work to completion by contract or otherwise, whereupon such subawardee and its sureties shall be liable to the Government for any excess costs occasioned the Government thereby.

6. The Government Prime Awardee shall include the requirements of paragraphs 1. through 5., appropriately modified, if required, in any subawards which are subject to the Davis-Bacon Act.

Contract Work Hours and Safety Standards Act -- Overtime Compensation

This agreement is subject to the Contract Work Hours and Safety Standards Act and to the applicable rules, regulations and interpretations of the Secretary of Labor.

1. Overtime requirements. No subawardee contracting for any part of the contract work which may require or involve the employment of laborers or mechanics (see Federal Acquisition Regulation (FAR 22.300) shall require or permit any such laborers or mechanics in any workweek in which the individual is employed on such work to work in excess of 40 hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than 1-1/2 times the basic rate of pay for all hours worked in excess of 40 hours in such workweek.

2. Violation, liability for unpaid wages, liquidated damages. In the event of any violation of the provisions set forth in paragraph (1) of this clause, the subawardee responsible therefore shall be liable to the United States (in the case of work done under agreement for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanics employed in violation of the provisions set forth in paragraph (1) of this clause in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of 40 hours without payment of the overtime wages required by provisions set forth in paragraph (1) of this clause.

3. Withholding for unpaid wages and liquidated damages. The Grants and Contracts Officer shall upon his or her own action or upon written request of an authorized representative of the Department of Labor shall require that the Government Prime Awardee withhold or cause to be withheld, from any moneys payable on account of work performed by the subawardee under any such agreement or any other Federal agreement with the same Prime Awardee, or any the Federally-assisted agreement subject to the same Prime Awardee, such sums as may be determined to be necessary to satisfy any liabilities of such subawardee for unpaid wages and liquidated damages as provided in the provisions set forth in paragraph (2) of this clause.

4. Payrolls and basic records

(a) The Government Prime Awardee shall require the subawardee to maintain payrolls and basic payroll records during the course of agreement work and to preserve them for a period of three (3) years from the completion of the agreement for all laborers and mechanics working on the agreement. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Nothing in this paragraph shall require the duplication of records required to be maintained for construction work by Department of Labor regulations at 29 CFR 5.5(a)(3) implementing the Davis-Bacon Act.

(b) The records to be maintained under paragraph (4)(a) of this clause shall be made available by the subawardee to the Government Prime Awardee. The original versions of said records shall be made available by the subawardee for inspection, copying, or transcription by authorized representatives of the Grant and Contract Officer or the Department of Labor. The Government Prime Awardee shall require that the subawardee shall permit such representatives to interview employees during working hours on the job.

5. Subcontracts. The Government Prime Awardee shall insert in any subawards the provisions set forth in paragraphs (1) through (5) of this clause appropriately modified, if required, and also a clause requiring the subawardees to include these provisions in any lower tier subaward. The Government Prime Awardee shall be responsible for compliance by any subawardee or lower tier subawardee with the provisions set forth in paragraphs (1) through (5) of this clause.

Apprentices and Trainees

1. Apprentices shall be permitted to work at less than the predetermined rate for the work they performed (1) when they are employed and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Manpower Administration, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau, or (2) if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen in any craft classification shall not be grater than the ratio permitted to the Awardee as to its entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not a trainee as defined paragraph 2. of this clause and who is not registered or otherwise employed as stated above, shall be paid the wage rate determined by the Secretary of Labor for the classification of work he or she actually performed. The Government Prime Awardee shall require that the subawardee furnish to the Grants and contracts Officer or a representative of the Wage-Hour Division of the U.S. Department of Labor written evidence of the appropriate ratios allowed and wages (expressed in percentages of the journeyman's hourly rate) for the area of construction, prior to using any apprentices on the agreement work. The wage rate paid apprentices shall be not less than the appropriate percentage of the journeyman's rate contained in the applicable wage determination.

2. Except as provided in 29 CFR 5.16, trainees shall not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to an individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Manpower Administration, Bureau of Apprenticeship and Training. The term "trainee" means a person registered and receiving on-the-job training in a construction occupation under a program which has been approved in advance by the U.S. Department of Labor, Manpower Administration Bureau of Apprenticeship and Training, as meeting its standards for on-the-job training programs and which has been so certified by the Bureau. The ratio of trainees to journeymen shall not be greater than ratio permitted under the plan approved by the Bureau of Apprenticeship and Training. Every trainee must be paid at not less than the rate specified in the approved program for his or her level of progress. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Bureau of Apprenticeship and Training shall be paid not less than the wage rate determined by the Secretary of Labor for the classification of work she or he actually performed. The Government Prime Awardee shall require that the subawardee furnish the Grants and Contracts Officer or a representative of the Wage-Hour Division of the U.S. Department of Labor written evidence of the certification of its program, the registration of the trainees, and the ratios and wage rates prescribed in the program. In the event the Bureau of Apprenticeship and Training withdraws approval of a training program, the subawardee shall no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

3. The utilization of apprentices, trainees, and journeymen under this clause shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, and 29 CFR Part 30.

4. If at any time the Bureau of Apprenticeship and Training determines, after opportunity for a hearing, that the standards of a training program have not been complied with, or that such a program fails to provide adequate training for participants, the subawardee shall not utilize trainees at less than the predetermined rate for the classification of work actually performed until an acceptable program is approved. If the subawardee brings an appeal pursuant to 29 CFR 5.17 within thirty (30) days of his or her receipt of a certified letter withdrawing the Bureau of Apprenticeship and Training's approval, the effect of the withdrawal of approval of the program will be delayed until a decision is rendered on the appeal pursuant to 29 CFR 5.17.

Payrolls and Basic Records

1. The subawardee shall maintain payrolls and basic records relating thereto during the course of the work and shall preserve them for a period of three (3) years thereafter for all laborers and mechanics, including apprentices, trainees, watchmen, and guards, working at the site of the work. Such records shall contain the name, and address of each employee, his or her correct classification, rate of pay (including rates or contributions or costs assumed to provide fringe benefits) daily and weekly number of hours worked, deductions made, and actual wages paid. Whenever the subawardee obtained approval from the Secretary of Labor as provided in paragraph 3. of the clause entitled "Davis-Bacon Act," it shall maintain records which show the commitment, its approval, written communication of the plan or program to the laborers or mechanics affected, including apprentices, trainees, watchmen, and guards, and the costs anticipated or incurred under the plan or program.

2. The Government Prime Awardee shall require that the subawardee submit a weekly copy of all payrolls to its designated representative. The Government Prime Awardee shall be responsible for the collection of copies of payrolls of all subawardees. The copy shall be accompanied by a statement signed by the subawardee indicating that the payrolls are correct and complete, that the wage rates contained therein are not less than those determined by the Secretary of Labor, and the classifications set forth for each laborer or mechanic, including apprentices, trainees, watchmen, and guards, conform with the work he or she performed. Submission of the "Weekly Statement of Compliance" required under this agreement and the Copeland Regulations of the Secretary of Labor (29 CFR part 3) shall satisfy the requirement for submission of the above statement. The subawardee shall submit also a copy of any approval by the Secretary of Labor with respect to fringe benefits which is required by paragraph 3. of the clause entitled "Davis-Bacon Act."

3. The Government Prime Awardee shall make copies of the records required under this clause available to the Grants and Contracts Officer, upon request. The subawardee shall make original versions of these records available for inspection by authorized representatives of the Grants and Contracts officer and the Department of Labor and shall permit such representatives to interview employees during working hours.

4. The requirement for submission of weekly payroll records in paragraph 2 above is hereby waived. However, the Contractor must provide such records when and if requested by Caltech.

Compliance With Copeland Act Requirements

The Government Prime Awardee shall require that the subawardee comply with the Copeland Regulations of the Secretary of Labor (29 CFR Part 3) which are incorporated herein by reference.

Withholding of Funds

1. The Grants and Contracts Officer may require that the Government Prime Awardee withhold or cause to be withheld from any subawardee so much of the accrued payments or advances as may be considered necessary (1) to pay laborers and mechanics, including apprentices, trainees, watchmen, and guards, employed by the subawardee on the work the full amount of wages required by the agreement, and (2) to satisfy any liability of the subawardee for liquidated damages under paragraph 2. of the clause entitled "Contract Work Hours and Safety Standards Act–Overtime Compensation."

2. If any subawardee fails to pay any laborer, mechanic, apprentice, trainee, watchman, or guard, employed or working on the site of the work, all or part of the wages required by the agreement, either the Government Prime Awardee or the Grants and Contracts Officer upon written notice to the Government Prime Awardee, take such action as may be necessary to cause the suspension of any further payments, or advances until such violations have ceased.

Subawards

The Government Prime Awardee agrees to require that any subawardee insert the clauses hereof entitled "David-Bacon Act," "Contract Work Hours and Safety Standards Act--Overtime Compensation," "Apprentices and Trainees," "Payrolls and Basic Records," "Compliance with Copeland Regulations," "Subawards," "Contract Termination--Debarment," and "Equal Opportunity" in all lower tier subawards. The term "Government Prime Awardee" as used in such clause in any lower tier subaward shall be deemed to refer to the subawardee and the term "subawardee" shall refer to the lower tier subawardee.

Agreement Termination -- Debarment

A breach of the clauses hereof entitled "Davis-Bacon Act," "Contract Work Hours and Safety Standards Act--Overtime Compensation," "Apprentices and Trainees," "Payrolls and Basic Records," "Compliance with the Copeland Regulations," "Withholding of Funds," and "Subawards," may be grounds for termination of the agreement and for debarment as provided in 29 CFR5.6.

Disputes Concerning Labor Standards

Disputes arising out of the labor standards provision of this agreement shall be subject to the "Resolution of Disagreements and Disputes" clause except to the extent such disputes involve the meaning of classifications or wage rates contained in the wage determination decision of the Secretary of Labor or the applicability of the labor provisions of the agreement which questions shall be referred to the Secretary of Labor in accordance with the procedures of the Department of Labor.

Equal Opportunity

1. If, during any 12-month period (including the 12 months preceding the award of this agreement), the Awardee has been or is awarded nonexempt Federal contracts/awards and/or subcontracts/subawards that have an aggregate value in excess of $10,000, the Awardee shall comply with subparagraphs 2.1 through k. below. Upon request, the Awardee shall provide information necessary to determine the applicability of this clause.

2. During performing this agreement, the Awardee agrees as follows:

(a) The Awardee shall not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

(b) The Awardee shall take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, or national origin. This shall include, but not be limited to, (1) employment, (2) upgrading, (3) demotion, (4) transfer, (5) recruitment or recruitment advertising, (6) layoff or termination, (7) rates of pay or other forms of compensation, and (8) selection for training, including apprenticeship.

(c) The Awardee shall post in conspicuous places available to employees and applicants for employment the notices to be provided by the Grants and Contracts Officer that explain this clause.

(d) The Awardee shall, in all solicitations or advertisement for employees placed by or on behalf of the Awardee, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, or national origin.

(e) The Awardee shall send, to each labor union or representative or workers with which it has a collective bargaining agreement or other contract or understanding, the notice to be provided by the Grants and Contracts Officer advising the labor union or workers' representative to the Awardee's commitments under this clause, and post copies of the notice in conspicuous places available to employees and applicants for employment.

(f) The Awardee shall comply with Executive Order 11246, as amended, and the rules, regulations, and orders of the Secretary of Labor.

(g) The Awardee shall furnish to the National Science Foundation all information required by Executive Order 11246, as amended, and by the rules, regulations, and orders of the Secretary of Labor. Standard Form 100 (EEO-1), or any successor form, is the prescribed form to be filed within 30 days following the award, unless filed within 12 months preceding the date of award.

(h) The Awardee shall permit access to its books, records, and accounts by the award-

ing agency or the office of Federal Contract Compliance Programs (OFCCP) for the purposes of investigation to ascertain the Awardee's compliance with the applicable rules, regulations, and orders.

(i) If the OFCCP determines that the Awardee is not in compliance with this clause or any rule, regulation, or order of the Secretary of Labor, this agreement may be cancelled, terminated, or suspended in whole or in part and the Awardee may be declared ineligible for further Government awards, under the procedures authorized in Executive Order 11246, as amended. In addition, sanctions may be imposed and remedies invoked against the Awardee as provided in Executive Order 11246, as amended, the rules, regulations, and orders of the Secretary of Labor, or as otherwise provided by law.

(j) The Awardee shall include the terms and conditions of subparagraph 2.a through k. of this clause in every subaward or purchase order that is not exempted by the rules, regulations, or orders of the Secretary of Labor issued under Executive Order 11246, as amended, so that these terms and conditions will be binding upon each subawardee or vendor.

(k) The Awardee shall take such action with respect to any subaward or purchase order as the National Science Foundation may direct as a means of enforcing these terms and conditions, including sanctions for noncompliance; provided, that if the Awardee becomes involved in, or is threatened with, litigation with a subawardee or vendor as a result of any direction, the Awardee may request the United States to enter into the litigation to protect the interests of the United. States.

3. Notwithstanding any other clause in this agreement, disputes relative to this clause will be governed by the procedures in 41 CFR 60-1.1.

PROJECT LABOR AGREEMENT
for the
LASER INTERFEROMETER GRAVITATIONAL-WAVE OBSERVATORY AT HANFORD

ARTICLE I
SCOPE

Section 1: This AGREEMENT shall only apply to all construction performed for the California Institute of Technology (CIT), hereinafter, the OWNER, by employers and all subcontractors for the Laser Interferometer Gravitational Wave Observatory (LIGO) at the Hanford Site near Richland, Washington.

Section 2: This AGREEMENT shall NOT apply to the following:

(A) Executives, engineers, superintendents, assistant superintendents, timekeepers, messengers, clerical office workers, guards or any employees above general foremen.

(B) Testing or inspection of equipment apparatus or systems of the OWNER, after such OWNER'S acceptance of and physical possession of such equipment apparatus, system, facility or component.

(C) The deliveries of equipment, apparatus, machinery and construction material to the site of construction.

ARTICLE II
RECOGNITION

Section 1: The EMPLOYERS recognize and acknowledge the UNIONS affiliated and in good standing with the Central Washington Building and Construction Trades Council as the exclusive bargaining representatives of all construction craft employees performing work covered by this AGREEMENT with respect to wages, hours and all other terms and conditions of employment.

Section 2: The EMPLOYERS are the principals and do not act as the agent of or bind the OWNER for any purpose relating to or arising out of the terms and conditions hereof.

ARTICLE III
EMPLOYMENT

The following employment provisions shall apply:

(A) EMPLOYERS and all subcontractors performing construction work on the Site described in this AGREEMENT shall, in filling craft job vacancies, utilize and be bound by the registration facilities and referral systems established or authorized by the UNIONS signatory hereto when such procedures are not in violation of Federal law. The EMPLOYER shall have the right to reject any applicant referred by the UNION.

(B) The EMPLOYER shall have the unqualified right to select and hire key personnel such as foremen and general foremen and those possessing special skills and the UNIONS agree to refer the requested individuals subject to legal hiring hall provisions.

(C) In the event referral facilities maintained by the UNIONS are unable to fill the requisition of an EMPLOYER for employees within a forty-eight (48) hour period after such requisition is made by the EMPLOYER (Saturday, Sunday and holidays excepted): the EMPLOYER shall be free to obtain workmen from any source.

(D) All employees covered by this AGREEMENT and coming under the jurisdiction of the UNIONS, shall, as a condition of employment, become members of appropriate UNION within eight (8) days following the date of their employment, and shall remain members in good standing during the term of this AGREEMENT. "Good Standing" for the purpose of this AGREEMENT is interpreted to mean the payment or tender of initiation fees and periodic union dues uniformly required as a condition of acquiring or retaining membership.

(E) The UNION represents that its local UNIONS administer and control their referrals, and it is agreed these referrals will be made in a nondiscriminatory manner and in full compliance with federal, state and local laws and regulations.

(F) The UNIONS agree to hold the EMPLOYERS harmless for any liability arising out of the improper administration by the UNION of the referral procedure.

(G) Each of the UNIONS signatory hereto shall have the right to designate a working journeyman as steward for each EMPLOYER and the steward shall be recognized as the UNION'S representative. Such designated steward shall be a qualified workman assigned to a crew and shall be the last journeyman on the project. The steward shall not perform supervisory duties of that craft. Under no circumstances shall there be a nonworking steward.

ARTICLE IV
SUBCONTRACTING

Section 1: A subcontractor is any person, firm or corporation who takes over or performs any portion of the construction work to be done at the site of the construction, alternation, painting or repair of a building, structure or other OWNER contract or subcontract work for a signatory contractor at the site of construction under contract with a signatory contractor.

Section 2: A signatory EMPLOYER shall not subcontract or otherwise transfer in whole or in part any construction work covered by this AGREEMENT to be done at the site of the construction, alteration, painting or repair of a building, structure or other work, unless the person, firm, corporation or other business entity is signatory to this AGREEMENT.

Section 3: The furnishing of materials, supplies or equipment and the delivery thereof shall in no case be considered subcontracting.

Section 4: The EMPLOYER and each subcontractor shall be required to hold a pre-job conference with the UNIONS before commencement of any work on the site.

ARTICLE V
HOURS OF WORK, SHIFTS AND OVERTIME

Section 1: The standard work day shall consist of eight (8) hours of work between 7:00 am. and 5:30 pm. with one half hour designated as an unpaid period for lunch, which may be taken between the hours of 11:00 a.m. and 1:30 p.m. but not to exceed five (5) hours from the start of the shift. In the event an employee goes beyond five (5) hours without a lunch, he shall receive one half hour's pay at the overtime rate in addition to regular shift pay.

The standard work week shall be five (5) consecutive days commencing with the day shift on Monday. Nothing herein shall be construed as guaranteeing any employee eight (8) hours of work per day, or forty (40) hours of work per week.

The EMPLOYER may adjust the scheduled start time as per this AGREEMENT one (1) hour *in either direction.*

Section 2: Shift Work

Shifts may be established when considered necessary by the EMPLOYER.

(A) Shift hours and rates will be as follows:

First shift (day shift): Eight (8) hours pay for eight (8) hours work, plus one half (1/2) hour unpaid lunch period. The first shift shall be worked between the hours of 7:00 a.m. and 5:30 p.m.

Second shift (swing shift): Eight (8) hours pay for seven and one half (7 1/2) hours work, plus one half (1/2) hour unpaid lunch period. The second shift shall be worked between the hours of 3:30 p.m. and 1:30 a.m.

Third shift (graveyard shift): Eight (8) hours pay for seven (7) hours work, plus one half (1/2) hour unpaid lunch period. The third shift shall be worked between the hours of 10:30 p.m. and 8:30 a.m.

(B) Shifts shall be established and continue for a minimum of five (5) consecutive work days. If Saturday and/or Sunday are worked, they shall be included in the five (5) day minimum period. It is understood the third shift on Friday must end on a calendar Saturday morning.

(C) The interval between shifts worked in the same day shall not exceed the reasonable time necessary to change shifts and in no event shall such interval exceed one (1) hour.

(D) If only two shifts are to be worked, the EMPLOYER may regulate starting times of the two shift operations to permit maximum utilization of daylight hours.

(E) When special conditions warrant, swing and/or graveyard shifts may be worked even though no day and/or swing shift is worked. Normal shift premiums apply.

Section 3: Overtime

All work performed in excess of the standard work day, Monday through Friday, and all work performed on Saturday shall be at the rate of time and one-half the basic straight time hourly wage rate. All work performed on Sundays and holidays shall be paid at twice the basic straight time hourly wage rate. There shall be no duplication or pyramiding of overtime and/or premium pay.

Section 4: Reporting Pay

When an employee reports for work at the time and place specified by the EMPLOYER and he is not put to work or he works less than two hours, he shall be paid for two hours at the applicable straight-time rate of pay. If, after working two hours, he is prevented from working a full eight hours, he shall be paid for actual hours worked. It is the intent of this section that an employee who shows up for work shall be paid at least two hours of a shift, except when he has been notified, at the EMPLOYER'S expense, not to report by direct contact, from the EMPLOYER. When the proper notice is given and the employee reports, he shall not be entitled to reporting pay.

If an employee leaves the job on his own accord, he will be paid for actual hours worked. If an employee reports to work in a condition unable to work, he will not be eligible for reporting pay.

Section 5: Option for 10-Hour Shift

The EMPLOYER may, at his option, establish a first and/or a second shift consisting of ten (10) hours of work, exclusive of a one-half (1/2) hour non-paid lunch period per day. The first eight (8) hours of work on these shifts shall be paid for at the basic straight-time hourly wage rate. The last two (2) hours of work shall be paid for at the rate of time and one half (1-1/2) the basic straight-time hourly wage rate.

ARTICLE VI
HOLIDAYS

Holidays recognized under this AGREEMENT shall be as follows:

New Years Day	Thanksgiving Day
Memorial Day	Friday following Thanksgiving
July Fourth	Christmas Day
Labor Day	

Should any of these holidays fall on a Saturday, the previous Friday shall be a holiday and should any of these holidays fall on a Sunday, the following Monday shall be considered a legal holiday and observed as such. A holiday shall be the twenty-four hour period, commencing with the starting time of the first shift on the day of the holiday. No work shall be performed on Labor Day except to save life or property.

ARTICLE VII
WAGE SCALES AND FRINGE BENEFITS

Section 1: All wages, fringe benefits and travel provisions shall be paid equal to, and in accordance with the applicable provisions of the Hanford Site Stabilization Agreement (HSSA) that are in effect at the time they are earned.

Section 2: All employees covered by this AGREEMENT shall be paid weekly, by check on company time before the end of their regular shift, on Friday, unless failure to pay on such day is mutually considered beyond the reasonable control of the EMPLOYER. When an employee cannot be paid accordingly because of a holiday, he shall be paid on his last shift before the holiday.

Section 3: Employees on the swing and graveyard shifts or on a special shift extending beyond the quitting time for the day shift shall be paid by not later than quitting time Thursday's shift. If an employee is discharged or laid off, he/she shall be paid in full provided he/she is present at the job or place where he/she is employed. Employees who voluntarily terminate their employment shall be paid in full provided they give adequate, timely notice.

Section 4: If an employee is not paid as herein provided, said employee must be paid an additional four (4) hour's straight-time pay for each twenty-four (24) hour period or portion thereof prior to actual payment. When mailing checks, the postmark on the envelope will determine if the check was mailed timely and will serve as the cutoff for any penalty.

Section 5:

(A) When the EMPLOYER contributes fringe benefit payments into local, regional or national trust funds, the EMPLOYER agrees to be bound to all lawful terms and conditions of such trust agreements, and all amendments thereto. The EMPLOYER further agrees to accept as its representatives in the administration of such funds, the employer trustees serving such funds. Furthermore, the EMPLOYER and UNION may establish other trust funds by mutual agreement when necessary.

(B) Fringe benefit payments shall be paid only on the basis of hours worked, not hours paid for, except where this is in violation of the applicable trust agreement, in which case the provisions of the trust agreement will prevail. In the case of shift work, compensable hours shall apply.

Section 6: Dues Check-off

Upon presentation of a proper authorization form executed by the individual employee, the EMPLOYER agrees to deduct UNION dues and remit same to the UNION in accordance with applicable laws. The authorization forms shall be supplied by the UNION.

ARTICLE VIII
CERTIFICATION

If the job to be performed requires additional certification of any kind, the EMPLOYER shall pay for all expenses involved in such testing, including wages and cost of testing, and shall (after 30 days of employment or completion of the job) provide the employee and the UNION with a copy of the certification.

ARTICLE IX
GENERAL WORKING CONDITIONS

Section 1: Employment begins and ends at the job site.

Section 2: The selection of craft foremen and general foremen including the number of foremen required shall be entirely the responsibility of the EMPLOYER, it being understood that in the selection of such foremen the EMPLOYER will give primary consideration to the qualified individuals available in the local area. After giving such consideration, the EMPLOYER may select such craft individuals from other areas. Foremen and general foremen shall take orders from the designated EMPLOYER representatives.

Section 3: There shall be no limit on production by workmen nor restrictions on the full use of tools or equipment. Craftsmen using tools shall perform any of the work of the trade and shall work under the direction of the craft foremen. There shall be no restrictions on efficient use of manpower other than as may be required by safety regulations.

Section 4: The parties reaffirm their policy of a fair day's work for a fair day's pay. Any violation of work starting and stopping times will be grounds for termination. Employees shall be at the place of work designated by the EMPLOYER at the starting time and shall remain at their place of work until quitting time except where the OWNER'S security and/or job requirements require employees to report to work or quit their work at different locations. The EMPLOYER agrees to provide adequate time at the end of each shift for picking up tools.

Section 5: There shall be no limit to the number of work classifications or pieces of equipment employees can work within their craft when qualified to perform the work.

Section 6: The EMPLOYER shall determine the need for overtime and will have the specific right to assign employees to work overtime, including the use of partial crews. The EMPLOYER will designate when employees will work and all overtime. If overtime is worked, the EMPLOYER will make a reasonable effort to distribute overtime on an equitable basis wherever practicable.

Section 7: The EMPLOYER shall establish such reasonable project rules as the EMPLOYER deems appropriate. These rules will be reviewed a the pre-job conference and posted at the project site by the EMPLOYER, and may be amended thereafter as necessary. EMPLOYERS and the UNIONS agree to conform to all security regulations and requirements of the OWNER.

Section 8: Adequate facilities will be provided for employees in which to dry their clothes and eat their lunches. These facilities shall be adequately heated and shall not be used for storing supplies, tools or equipment to the extent that the facilities are rendered unsuitable for the intended use.

ARTICLE X
SAFETY AND HEALTH

Section 1: The EMPLOYER acknowledges responsibility to comply with all applicable laws, ordinances and regulations relating to safety and health. No employee will be required to perform any work in an unsafe manner or unsafe condition.

Section 2: The employees covered by the terms of this AGREEMENT shall at all times be bound by the safety rules and regulations as established by the EMPLOYER in accordance with WISHA and OSHA safety rules and regulations. Any employee's failure to comply with the safety requirements heretofore referred to, or failure to participate and cooperate in such program shall be cause for discharge.

Section 3: The UNIONS agree that all employees will be required to use all required safety equipment and all required protective clothing supplied by the EMPLOYER. Failure or refusal to use such protective equipment is cause for discharge.

Section 4: It will not be a violation of this AGREEMENT, when the EMPLOYER considers it is necessary to shut down to avoid the possible loss of human life because of an emergency situation that could endanger the life and safety of an employee. In such cases,

employees will be compensated only for the actual time worked. In the case of a situation described above whereby the EMPLOYER requests employees to stand by, the employees will be compensated for the "standby" time. Employees shall not be discharged for refusing to work in the above-described situations.

ARTICLE XI
SECURITY OF EQUIPMENT AND TOOLS

Security procedures for the control of tools, equipment and materials shall be solely the responsibility of the EMPLOYER. The EMPLOYER will be responsible to cover the costs of the full, priorly agreed to inventory of employee tools lost because of fire, flood or theft. Tools broken or damaged in the course of employment will be replaced or reimbursement will be made by the EMPLOYER upon the presentation of satisfactory evidence.

ARTICLE XII
WORK ASSIGNMENTS

The EMPLOYER and subcontractor shall make assignments of work to the respective crafts at the mark-up meeting, or in writing within forty-eight (48) hours after the mark-up meeting, to all interested parties. The parties may discuss and/or agree upon all other aspects of the contract work at the mark-up meeting.

Jurisdictional disputes will be handled in accordance with the Procedural Rules and Regulations of the Plan for the Settlement of Jurisdictional Disputes in the Construction Industry, effective June 1, 1984, or any successor plan.

ARTICLE XIII
GRIEVANCE PROCEDURE

Section 1: It is specifically agreed that, in the event any disputes arise out of the interpretation or application of this AGREEMENT, excluding questions of jurisdiction of work, which shall be adjusted pursuant to Article XIII, Work Assignments, such disputes shall be settled in accordance with the procedures set out herein. No such grievance shall be recognized unless called to the attention of the EMPLOYER by the UNION or to the attention of the UNION by the EMPLOYER in writing or postmarked within ten (10) working days after the alleged violation was committed.

Employees must notify their UNION within three (3) working days of the alleged violation.

Section 2: Grievances shall be settled according to the following procedure.

Step 1: The written disputes shall be referred to the Representative of the UNION involved or his designated representative and the EMPLOYER'S designated representative.

Step 2: In the event the Representative of the UNION and the EMPLOYER'S designated representative cannot reach agreement within five (5) working days after a meeting is arranged and held, the matter shall be referred to the representative of the International Union and the designated representative of the EMPLOYER.

Step 3: In the event the Representative of the International Union and the EMPLOYER'S Representative are unable to resolve the dispute within ten (10) calendar days after completion of Step 2, it shall be adjusted by arbitration in the manner hereinafter set forth.

The EMPLOYER or his designated representative and the UNION shall then select an arbitrator for final and binding arbitration. The impartial arbitrator shall be selected from a panel of arbitrators submitted by the Federal Mediation and Conciliation Service in accordance with their procedures. The written decision of the Arbitrator shall be binding upon all parties. The Arbitrator shall have no authority to change, amend, add to, or detract from any of the provisions of this AGREEMENT. The expense of the impartial arbitrator shall be borne equally by the EMPLOYER and the UNION.

Step 4: The time limits specified in any step of the Grievance Procedure may be extended by mutual agreement of the parties initiated by the written request of one party to the other, at the appropriate step of the Grievance Procedure. However, failure to process a grievance, or failure to respond in writing, within the time limits provided above, without a request for an extension of time, shall be deemed a waiver of such grievance to the other without prejudice, or without precedent to the processing of and/or resolution of like or similar grievances or disputes.

ARTICLE XIV
SAVINGS CLAUSE

This AGREEMENT is intended to be in conformity with all applicable rules and regulations including, but not limited to, Federal, State and local statutes or a decision by a court of competent jurisdiction. Should any conflict occur between any provision of this AGREEMENT and the terms of any of the above, subject provision shall become null and void and the EMPLOYER and the UNIONS will enter into negotiations to bring such a provision into conformance with the law, rule, or regulation. However, all other provisions of this AGREEMENT not in conflict with any of the above shall not be annulled or superseded and shall remain in full force and effect.

CONTRACTOR/SUBCONTRACTOR:

_____

Date: _____

FOR THE UNIONS:

CENTRAL WASHINGTON BUILDING CONSTRUCTION TRADES COUNCIL, AFL-CIO

Richard A Berglund
President

Secretary

ATTACHMENT C

SPECIAL TERMS AND CONDITIONS

1. **Shipping Terms**

The terms of shipment are F.O.B. Destination. Seller is responsible for providing adequate insurance for repair or replacement of goods lost or damaged when under seller's care, custody, and control, and filing and processing any claim, along with expediting such repair or replacement to minimize impact on schedule and cost.

2. **Warranty**

The warranty period for the goods provided hereunder is for one (1) year after the date of final acceptance by Buyer's Customer at the sites. Seller is responsible for all cost arising out of any warranty defect and will correct such defect on an expedited basis. Final acceptance at Hanford Reservation, WA site is expected to be around May 1998. This warranty shall pass directly to Buyer's Customer and is enforceable by Buyer and/or Buyer's Customer. The warranty conditions are specified in Attachment D, Construction General Provisions, Article 7.

3. **Performance and Payment Bond**

Seller will provide a Performance (Attachment C-1) and Payment (Attachment C-2) Bond at no cost to Buyer within fifteen (15) days of placement of the Purchase Order with Seller. Buyer retains the option to cancel the Purchase Order for default should Seller not provide acceptable bonds in the time period specified. No progress payments will be made under this Purchase Order should the required bonds not be provided by Seller.

4. **Liquidated Damages**

Time is of the essence and Buyer is relying on Seller's representation that it can meet its commitments undertaken in this Purchase Order. In the event that these commitments are not met, Buyer will be materially damaged. In view of the difficulty or estimating such damages, it is agreed upon, fixed, and determined by Seller and Buyer that Seller shall be liable to Buyer, as the proper measure of liquidated damages, the sum of 0.2% per day for each and every day of delay beyond the date(s) specified for completion of the work. The per-day assessment of liquidated damages will be measured against the value of the purchase order. Imposing liquidated damages does not relieve the Seller of its obligations hereunder nor preclude Buyer from its remedies herein or by law.

5. **Payment Terms**

Buyer will pay invoices Net 30 Days from the date of receipt by Buyer of a valid invoice with all required supporting documentation.

Buyer will pay 90 percent of the value of the approved invoice and the final 10 percent upon final acceptance of the work.

6. **Notification of Adverse Conditions**

Seller shall, within twenty-four (24) hours, notify Buyer of any adverse condition(s) that will impact Seller's performance under this Purchase Order. Failure to notify Buyer will have a material impact on Buyer and create a severe hardship. Seller will be liable for all costs resulting from such failure to notify Buyer. This notification does not relieve Seller of its obligations and liabilities hereunder.

7. **License and Permits**

The Seller warrants that it has been duly authorized to operate and do business in the state of Washington and that it will obtain at no cost to the Buyer all necessary licenses and permits required in connection with the Purchase Order; and that it will fully comply with all laws, decree, labor standards and regulations of such state during the performance of this work.

8. **Craft Labor Escalation**

The Seller shall present a proposal for craft labor escalation to Buyer at the time such escalation is incurred. The proposal shall include the baseline costs proposed in Seller's proposal, evidence of the escalated costs to be incurred and the delta to the purchase order. Upon conclusion of fact-finding and negotiations, the purchase order amount will be adjusted accordingly by the issuance of a change order. Profit will not be applied to the escalated amounts.

ATTACHMENT C-1

THE AMERICAN INSTITUTE OF ARCHITECTS

AIA Document A311

Labor and Material Payment Bond

THIS BOND IS ISSUED SIMULTANEOUSLY WITH PERFORMANCE BOND IN FAVOR OF THE OWNER CONDITIONED ON THE FULL AND FAITHFUL PERFORMANCE OF THE CONTRACT

KNOW ALL MEN BY THESE PRESENTS: that

(Here insert full name and address or legal title of Contractor)

as Principal, hereinafter called Principal, and,

(Here insert full name and address or legal title of Surety)

as Surety, hereinafter called Surety, are held and firmly bound unto

(Here insert full name and address or legal title of Owner)

as Obligee, hereinafter called Owner, for the use and benefit of claimants as hereinbelow defined, in the amount of

(Here insert a sum equal to at least one-half of the contract price) Dollars ($),

for the payment whereof Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS,

Principal has by written agreement dated 19 , entered into a contract with Owner for

(Here insert full name, address and description of project)

in accordance with Drawings and Specifications prepared by

(Here insert full name and address or legal title of Architect)

which contract is by reference made a part hereof, and is hereinafter referred to as the Contract.

LABOR AND MATERIAL PAYMENT BOND

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if Principal shall promptly make payment to all claimants as hereinafter defined, for all labor and material used or reasonably required for use in the performance of the Contract, then this obligation shall be void; otherwise it shall remain in full force and effect, subject, however, to the following conditions:

1. A claimant is defined as one having a direct contract with the Principal or with a Subcontractor of the Principal for labor, material, or both, used or reasonably required for use in the performance of the Contract, labor and material being construed to include that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental of equipment directly applicable to the Contract.

2. The above named Principal and Surety hereby jointly and severally agree with the Owner that every claimant as herein defined, who has not been paid in full before the expiration of a period of ninety (90) days after the date on which the last of such claimant's work or labor was done or performed, or materials were furnished by such claimant, may sue on this bond for the use of such claimant, prosecute the suit to final judgment for such sum or sums as may be justly due claimant, and have execution thereon. The Owner shall not be liable for the payment of any costs or expenses of any such suit.

3. No suit or action shall be commenced hereunder by any claimant:

a) Unless claimant, other than one having a direct contract with the Principal, shall have given written notice to any two of the following: the Principal, the Owner, or the Surety above named, within ninety (90) days after such claimant did or performed the last of the work or labor, or furnished the last of the materials for which said claim is made, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were furnished, or for whom the work or labor was done or performed. Such notice shall be served by mailing the same by registered mail or certified mail, postage prepaid, in an envelope addressed to the Principal, Owner or Surety, at any place where an office is regularly maintained for the transaction of business, or served in any manner in which legal process may be served in the state in which the aforesaid project is located, save that such service need not be made by a public officer.

b) After the expiration of one (1) year following the date on which Principal ceased Work on said Contract, it being understood, however, that if any limitation embodied in this bond is prohibited by any law controlling the construction hereof such limitation shall be deemed to be amended so as to be equal to the minimum period of limitation permitted by such law.

c) Other than in a state court of competent jurisdiction in and for the county or other political subdivision of the state in which the Project, or any part thereof, is situated, or in the United States District Court for the district in which the Project, or any part thereof, is situated, and not elsewhere.

4. The amount of this bond shall be reduced by and to the extent of any payment or payments made in good faith hereunder, inclusive of the payment by Surety of mechanics' liens which may be filed of record against said improvement, whether or not claim for the amount of such lien be presented under and against this bond.

Signed and sealed this _____ day of _____ 19

_____ (Witness)

_____ (Principal) (Seal)

_____ (Title)

_____ (Witness)

_____ (Surety) (Seal)

_____ (Title)

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ATTACHMENT C-2

THE AMERICAN INSTITUTE OF ARCHITECTS

AIA Document A311

Performance Bond

KNOW ALL MEN BY THESE PRESENTS: that

(Here insert full name and address or legal title of Contractor)

as Principal, hereinafter called Contractor, and,

(Here insert full name and address or legal title of Surety)

as Surety, hereinafter called Surety, are held and firmly bound unto

(Here insert full name and address or legal title of Owner)

as Obligee, hereinafter called Owner, in the amount of

_____ Dollars ($ _____),

for the payment whereof Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS,

Contractor has by written agreement dated _____ 19 ____, entered into a contract with Owner for

(Here insert full name, address and description of project)

in accordance with Drawings and Specifications prepared by

(Here insert full name and address or legal title of Architect)

which contract is by reference made a part hereof, and is hereinafter referred to as the Contract.

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PERFORMANCE BOND

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if Contractor shall promptly and faithfully perform said Contract, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

The Surety hereby waives notice of any alteration or extension of time made by the Owner.

Whenever Contractor shall be, and declared by Owner to be in default under the Contract, the Owner having performed Owner's obligations thereunder, the Surety may promptly remedy the default, or shall promptly

1) Complete the Contract in accordance with its terms and conditions, or

2) Obtain a bid or bids for completing the Contract in accordance with its terms and conditions, and upon determination by Surety of the lowest responsible bidder, or, if the Owner elects, upon determination by the Owner and the Surety jointly of the lowest responsible bidder, arrange for a contract between such bidder and Owner, and make available as Work progresses (even though there should be a default or a succession of defaults under the contract or contracts of completion arranged under this paragraph) sufficient funds to pay the cost of completion less the balance of the contract price; but not exceeding, including other costs and damages for which the Surety may be liable hereunder, the amount set forth in the first paragraph hereof. The term "balance of the contract price," as used in this paragraph, shall mean the total amount payable by Owner to Contractor under the Contract and any amendments thereto, less the amount properly paid by Owner to Contractor.

Any suit under this bond must be instituted before the expiration of two (2) years from the date on which final payment under the Contract falls due.

No right of action shall accrue on this bond to or for the use of any person or corporation other than the Owner named herein or the heirs, executors, administrators or successors of the Owner.

Signed and sealed this _____ day of _____ 19

_____ (Witness)

_____ (Principal) (Seal)

_____ (Title)

_____ (Witness)

_____ (Surety) (Seal)

_____ (Title)

ATTACHMENT D

CONSTRUCTION

GENERAL PROVISIONS

Process Systems International, Inc.
20 Walkup Drive
Westborough, MA 01581-5003
(508) 366-9111 FAX (508) 870-5930

SECTIONS

1. **APPLICATION**
These General Provisions apply to the Work to be performed under the Contract. Subcontractors, if any, shall be supplied with a copy of these General Provisions and no contracts or arrangements with them shall conflict therewith.

2. **DEFINITION OF TERMS**
A. The term "BUYER" as used herein, shall mean "Process Systems, Inc. and its duly authorized representative
B. The term "Contractor," as used herein, shall mean the company awarded this Work by Process Systems, Inc. and its duly authorized representative.
C. The term "Subcontractor," shall mean any individual, firm, or corporation, other than an employee of the Contractor, who contracts with the Contractor or any other Subcontractor to furnish labor and/or materials for the Plant. Nothing herein, however, shall be construed as establishing any contractual relationship between BUYER and any Subcontractor

3. **LIENS AND CHARGES; PAYMENT FOR MATERIALS AND LABOR**
Before the Contractor shall become entitled to any payment of retained monies under the terms of this Contract, a completed Release and Affidavit form shall be furnished on the form supplied by BUYER certifying that all of the labor, services, materials, equipment or supplies used or furnished for or in connection with the Work covered by this Contract, have been fully and completely paid, prior to the date of the Contractor's application for payment. If any such person shall notify BUYER of any unpaid claim for work, labor and services performed, or materials, equipment, tools or supplies furnished, BUYER in addition to all of the rights granted by the terms and provisions of this Contract, shall have the right to withhold the amount of such claim out of any monies due or to become due to the Contractor. Contractor agrees to keep the property to which this Contract relates free and clear of all liens, claims and encumbrances arising out of the performance of this Contract, and shall, at its own cost and expense take immediate action to remove any liens or encumbrances filed against the property by any of its Subcontractors, materialmen, suppliers or laborers.

4. **CHANGES**
(1) BUYER shall have the right, by giving notice in writing to Contractor via an Addendum or Construction Change Order from time to time prior to completion of the Work, to make changes in the Work. Field changes amounting to less than $5,000 will be authorized via Construction Change Order. All other changes will be authorized via an Addendum. Contractor shall comply with such changes provided, however, that if any such change increases or decreases the cost of the Work to Contractor and/or the time required to complete the Work, an adjustment will be made in the Contract price as hereinafter provided and/or an equitable adjustment will be made in the time within which the Work is to be completed
(2) Adjustment in the Contract Price necessitated by any such change shall be made by any one, or by any combination, of the following methods, as designated by BUYER:
(a) by adding or deducting a lump sum determined by mutual agreement of the parties.
(b) by adding or deducting a sum computed on the basis of applicable unit prices or time and material rates, or, in the absence of any such unit prices or time and material rates on the basis of unit prices, or time and material rates mutually agreed to
(c) By adding or deducting the amount or amounts determined under the applicable provisions of a cost formula.
Under methods (a) and (c) above, allowances for overhead and profit combined, included in total cost to BUYER, shall be based upon the following schedule:
a. To Contractor, for work which he performs with his own forces, not to exceed 15% of his net additional cost.
b. To Subcontractor, for work which he performs with his own forces, not to exceed 15% of his net additional cost.
c. To the Contractor for work performed by his Subcontractor not to exceed 7 ½% of the amount due to the Subcontractor
Net additional cost shall include direct labor employed, net invoice cost of materials used and a fair rental for machinery used upon the Work. Among items to be considered as overhead are rental of small tools, superintendents, timekeepers, clerks, watchmen, insurance, bond premiums, or any job or office overhead not previously mentioned. Payroll taxes and insurance shall be added to cost after overhead and profit have been applied
In method (b) where extra work or changes are covered by unit prices or time and material rates which have been accepted by BUYER, value of such extra work or changes shall be determined only upon basis of such unit prices or time and material rates
Contractor's itemized estimate for charges or credits for additions to or deductions from Work required by Contract shall be submitted to BUYER when requested.
(3) In the event Contractor is required under this Contract to submit to BUYER for approval any shop, fabrication or erection drawings and/or specifications, any change in said drawings and/or specifications made by BUYER, prior to his approval, in order to cause said drawings and specifications to conform to the provisions of this Contract shall not be construed as a change under the provisions of this Section
(4) It is understood and agreed that unit prices and time and material rates set forth for changes shall apply throughout the life of this Contract irrespective of (a) the time a change is ordered, (b) the state of completion of the Work, or (c) the sequence of Contractor's performance of the Work
(5) Any claim by the Contractor for an adjustment under this Section must be asserted in writing within ten (10) calendar days from the date a change is ordered. Even though the Parties may fail to agree upon the extent or amount of adjustment hereunder, the Contractor shall nevertheless proceed promptly and diligently with the prosecution of the Work as so changed, provided, however, that Contractor shall not be deemed to prejudice its claims to an adjustment by so proceeding
(6) If any extra, additional or different Work is performed by the Contractor without a previous written order signed by BUYER, no addition to the consideration provided in this Contract shall be made
(7) Work performed on the basis of time and material shall not be performed either in whole or in part on a premium time basis (including overtime, Saturdays, Sundays, and Holidays) unless the Contractor obtains the prior written consent of BUYER
(8) For each and every item of Work performed on a time and material basis, Contractor shall submit daily reports which shall list the time and trades used, materials consumed, and hours and types of rental equipment used. Said reports shall be submitted no later than the following workday to BUYER for approval. Invoices submitted for Work performed on a time and material basis must be supported by duly approved copies of said daily reports and material invoices. BUYER shall be under no obligation to pay invoices which are not supported.
(9) Contractor shall take and afford BUYER the advantage of all reasonably available cash and trade discounts, rebates, allowances, credits, salvage and commissions.

5. **FORCE MAJEURE**
Time is of the essence with respect to this Contract; provided, however, that neither Party shall be liable for default or delay caused by any occurrence beyond its reasonable control, including but not limited to unusual weather conditions, fire, strikes, accidents acts of God and delays of common carriers. In the event Contractor should be delayed in the completion of the Work by reason of any such occurrence, the time within which the Work is to be completed shall be extended up to the period of such delay, but no such extension shall be made unless written notice thereof is given within five (5) working days after the occurrence of such delay, and no payment shall be made by BUYER to Contractor for any expenses incurred by reason of any such delay.

6. **SUSPENSION OF WORK**
(a) BUYER may, at any time, by written order to Contractor, require Contractor to stop all, or any part, of the Work called for by the Contract for a period of ninety (90) days after the order is delivered to the Contractor, and for any further period to which the Parties may agree. Any such order shall be specifically identified as a Suspension of Work Order issued pursuant to this Section. Upon receipt of such an order, Contractor shall forthwith comply with its terms and take all reasonable steps to minimize the incurrence of costs allocable to the Work covered by the order during the period of work stoppage. Within a period of ninety (90) days after a Suspension of Work Order is delivered to Contractor, or within any extension of that period to which the Parties shall have agreed, BUYER shall either:
(i) Cancel the Suspension of Work Order, or
(ii) Terminate the Work covered by such order as provided in the "Termination" Sections of this Contract.
(b) If a Suspension of Work Order issued under this Section is cancelled or the period of the order or any extension thereof expires, the Contractor shall resume work. An equitable adjustment shall be made in the schedule or the Contract Price, or a combination thereof, and in any provisions of this Contract that may be affected and the Contract shall be modified in writing accordingly, if:
(i) The Suspension of Work Order results in an increase in the time required for or in the Contractor's cost properly allocable to the performance of any part of this Contract, and
(ii) Contractor asserts a claim for such adjustment within thirty (30) days after the end of the period of work stoppage; provided that, if BUYER decides the facts justify such action, he may receive and act upon any such claim asserted at any time prior to final payment under this Contract.
(c) If a Suspension of Work Order is not cancelled and the work covered by such order is terminated for the convenience of BUYER, the reasonable costs resulting from the Suspension of Work Order shall be allowed in arriving at the termination settlement.
(d) If a Suspension of Work Order is not cancelled and the Work covered by such order is terminated for default, the reasonable costs resulting from the Suspension of Work Order shall be allowed by equitable adjustment or otherwise.

7. **WARRANTIES AS TO MATERIALS, EQUIPMENT AND WORKMANSHIP**
Contractor hereby warrants that all materials, equipment, workmanship and articles incorporated in the Work:
(a) Shall conform to the Contract specifications and the drawings.
(b) Except to the extent otherwise specifically provided in Contract documents, shall be new and unused, of first-class quality and of the best grade of the respective kinds for the purposes intended. Where workmanship, material, equipment or articles are referred to in the Contract as "equal to" any particular kind or standard, BUYER shall decide any question of equality.
(c) Shall be fit for the particular purposes for which they are required.
(d) Shall be free from all defects in material and workmanship. The Contractor shall immediately upon demand of BUYER and at the entire cost and expense of the Contractor, repair and/or replace in a manner satisfactory to BUYER any and all defective Work and/or material furnished by the Contractor appearing within one (1) year from acceptance of the Work hereunder, and in connection with such repair and/or replacement Contractor shall make good all damage caused to other Work or materials due to such required replacement and/or repair.

8. **PROTECTION OF WORK AND THE PLANT**
The Contractor shall, at all times, and at its own expense, protect its labor, materials, appliances, supplies, tools, plant, equipment, work in progress and completed Work against any damage, injury, destruction, theft or loss. BUYER shall not be liable or responsible for any damage, injury, loss, theft or destruction howsoever or by whomsoever caused unless the same shall have been caused by the sole negligence of BUYER or its employees. The foregoing provisions shall likewise apply to the property and work of Subcontractors of the Contractor and to the tools, equipment and supplies of any of its or their mechanics, laborers, or workmen. Contractor shall supply, install, and maintain all necessary protection and security, for its work and for materials and supplies not incorporated or already incorporated in the Work to insure against damage including damage by weather conditions.

9. **INDEMNITY, PHYSICAL DAMAGE RESPONSIBILITY**
Contractor shall indemnify and save harmless BUYER and its employees and agents, against all claims, liabilities, losses, damages and expenses of every character whatsoever, for bodily injury, sickness, and/or disease, including death resulting from such bodily injury, sickness and/or disease sustained by any person (including but not limited to employees of BUYER or Contractor or of a Subcontractor of Contractor), if or where such injury, sickness, disease and/or death arose out of or was in any way connected with the Work or with the performance of or failure to perform the Work.
It is specifically understood that the Contractor hereby accepts and assumes exclusive liability for, and shall save and hold BUYER harmless against, the payment of all contributions, taxes or premiums payable under any federal or state unemployment insurance law or any federal or state social security act measured by or upon the payroll of employees, by whomsoever employed, engaged in the performance of Work undertaken by the Contractor in this Contract, and any and all other taxes which may be levied or assessed because of the Contractor's employment of persons or the Contractor's purchase of services or supplies for the performance of its undertakings in this Contract. Contractor shall obtain from each of its Subcontractors an indemnification agreement identical to this Section 9

10. **SURETY BONDS**
Contractor shall furnish a performance bond in the amount of the current Contract Price to secure its performance under this Contract and the satisfactory completion of the Work, and a labor and material payment bond in the amount of the current Contract Price to insure the prompt payment of all persons furnishing labor or materials to Contractor in the performance of the Work on forms provided by BUYER. The premiums shall be for the account of Contractor. The Surety shall be acceptable to BUYER

11. **INSPECTION; TESTING**
(1) Contractor shall provide and maintain safe access and proper facilities for the inspection by BUYER of all portions of the Work, including access to the shops in which any portion of the Work is in preparation.
(2) If laws, ordinances, governmental rules and/or regulations require any portion of the Work to be inspected and/or tested, Contractor shall promptly perform the inspection and/or tests so required
(3) Where Contractor is required, under the specifications and/or the drawings or pursuant to this Section, to perform tests and/or inspections, Contractor shall give timely notice to BUYER of the readiness of Contractor to perform each such test or inspection. Should Contractor fail to give such timely notice and/or should Contractor cover up, without the consent of BUYER, the portion of the Work to be so tested and/or inspected, Contractor shall, upon request of BUYER, uncover such portion and/or perform a retest and/or a reinspection of such portion, all at the sole expense of Contractor.
(4) The BUYER shall have the right to order special tests not required by the Contract specifications and/or the drawings, whereupon Contractor shall promptly perform such tests. If the portion of the Work so tested proves to be in accordance with the specifications and the drawings, all costs involved in such testing shall be for the account of BUYER and if such testing delays the Work, the time within which the Work is to be completed shall be extended by a mutually agreed to period of time. If the portion of the Work so tested, however, proves to be not in accordance with the specifications and the drawings, all costs involved in such testing shall be for the account of Contractor
(5) BUYER shall have the right to reject or require the correction of materials and workmanship which are defective or which are not in strict accordance with the Contract documents. Rejected workmanship shall be satisfactorily corrected and rejected material, equipment and other articles shall be promptly replaced at no cost to BUYER
(6) Should it be considered necessary or advisable by BUYER at any time before final acceptance of all of the Work hereunder, to make an examination of Work already

completed, by removing or tearing out the same, the Contractor shall, upon request, promptly furnish all necessary facilities, labor and materials therefore. If such Work is found to be defective in any respect due to the fault of the Contractor or any of its Subcontractors, the Contractor shall bear all the costs and expenses of such examination and of satisfactory reconstruction. If, however, such Work is found to meet the requirements of the Contract documents, the Contractor shall be reimbursed for actual costs of such examination and reconstruction on a time and material basis in accordance with the Contract documents.

(7) No failure of BUYER to discover or reject materials or work not in strict accordance with the Contract documents shall be deemed an acceptance thereof or a waiver of defects therein.

12. PURCHASE OF MATERIALS

BUYER shall have the right, upon giving notice in writing to Contractor to have the Contractor purchase from such vendors as BUYER may designate any or all of the materials which are to be used in performing the Work, or which are to be incorporated into the Work. If any materials so designated by BUYER for purchase by Contractor are purchased at prices which exceed, or are less than, the prices which Contractor would be required to pay to reputable vendors at that time for similar materials of like grade and quality which would have complied with the specifications and the drawings, then BUYER shall pay to Contractor the amount of such excess, or the Contract price shall be reduced by the amount of the difference, as the case may be.

13. TITLE

Except as otherwise provided in this Contract, title to Work not already owned by BUYER, the value of which has been included in any payment made by BUYER under this Contract, shall pass to BUYER upon such payment.

14. BUYER'S REPRESENTATIVE

(1) BUYER'S representative is hereby given authority, on behalf of BUYER, to give approvals and to take action to the extent necessary for the orderly and expeditious prosecution of the Work, but BUYER's representative shall not have authority to amend or modify this Contract.

(2) In addition to his duties and authorities specified in this Section and elsewhere in the Contract, BUYER'S representative shall have authority to suspend the Work whenever he deems such action necessary to secure the proper performance of the Work.

(3) Neither BUYER nor any representative of BUYER shall have authority to direct or control any employee of Contractor or any Subcontractor with respect to the method of performing the Work.

(4) BUYER shall have the right, by giving written notice to Contractor from time to time, to delegate responsibilities to other respresentatives of BUYER in connection with specific portions of the Work.

15. CONTRACTOR'S EXAMINATION

(1) The Contractor hereby expressly warrants, covenants and agrees that, prior to the execution of this Contract, it has made a complete and careful examination of all of the Contract documents applicable to the Contractor's work hereunder and of all the conditions and features of the Work site which might be important in the prosecution of its work, and has fully apprised itself of all obstructions, difficulties or conditions which it will or might encounter in the prosecution of the Work including, but not limited to, subsurface conditions, road conditions, and the availability of labor, materials and utilities. The BUYER assumes no responsibility for any understanding or representation made by any of its officers, employees or agents prior to the execution of this Contract, unless such understanding or representations is expressly stated in the Contract.

(2) Contractor shall be solely responsible for all locations, dimensions and elevations and shall take its own measurements at the site, verifying same with the drawings and will be held responsible for the proper fit of completed work in position.

16. PERMITS AND LICENSES, LAWS, ORDINANCES, GOVERNMENTAL RULES AND REGULATIONS

(1) The Contractor shall, at its own cost and expense, comply with, and procure the compliance of all of its Subcontractors and suppliers with all applicable laws, regulations, court decrees, ordinances and other rules of the United States Government (or other government having jurisdiction thereof) and of the state, territory, municipality, or other political subdivision having or exercising jurisdiction in connection with any of the Work hereunder. Such compliance shall include among other things, the procuring of all necessary permits and licenses in connection with the Work, the compliance with all applicable wage and hour laws and regulations and all other laws, regulations and court decrees dealing with or relating to the employment of persons and to employment practices.

(2) Contractor shall give all necessary notices, shall pay all fees required by law and shall comply with all laws, ordinances, governmental rules and regulations applicable to the Work, to labor employed on the Work and to the preservation of the public health and safety. Contractor shall indemnify and save harmless BUYER from and against all liability with respect to penalties and/or interest that may result from non-compliance with any such laws, ordinances, governmental rules or regulations.

(3) Should the specifications and/or the drawings be at variance with any of such permits, licenses, laws, ordinances, governmental rules or regulations, Contractor shall promptly notify BUYER in writing, whereupon BUYER shall make all necessary changes in the specifications and or the drawings. If Contractor performs any portion of the Work which is contrary to any of such permits, licenses, laws, ordinances, governmental rules or regulations, Contractor shall correct such portion of the Work, and Contractor shall bear the cost of all damages arising therefrom.

17. OVERTIME WORK

(1) Overtime work requested or authorized by BUYER in writing shall be performed by Contractor and BUYER shall, except in the case of changes performed under Section 4, reimburse Contractor for only (a) the premium portion of the payments made for performing such overtime work and (b) with respect to such premium portion only, any other required payments to or for the benefit of employees and any applicable insurance premiums and payroll taxes.

(2) Overtime work performed at Contractor's election but without the written authorization of BUYER and overtime work, if any, required under other provisions of this Contract shall be performed at Contractor's sole expense. Casual overtime work required by the nature of the Work shall be performed at Contractor's sole expense.

18. LABOR

Contractor shall employ, or cause to be employed, on or in connection with the performance of the Work only persons who are fit and skilled in the work assigned. Contractor shall at all times enforce, or cause to be enforced, strict discipline and good order among the workmen employed on the Work. Should any disorderly, incompetent, or objectionable person be employed by Contractor, or by any Subcontractor upon or about the Work site, Contractor shall, upon request of BUYER, cause such person to be removed from the work.

19. FIELD ORGANIZATION

Contractor shall provide and maintain during the the performance of the Work an organization of competent and qualified field personnel necessary for the proper performance of the Work, such organization and personnel to be subject at all times to the approval of BUYER. Contractor shall not remove from the Work key field personnel approved by BUYER without the BUYER'S consent. The Contractor shall provide full-time supervision throughout the entire contract period. Superintendents shall be empowered with the Contractor's full authority to act on all matters related to the Work.

20. SUBCONTRACTS

Contractor shall not enter into any subcontract except with Subcontractors approved by BUYER, unless otherwise agreed to in writing; such approval, however, shall not relieve Contractor from responsibility for the conduct and work of all Subcontractors. Contractor agrees to include in each subcontract (a) termination provisions similar to those contained in this Contract and (b) all provisions specifically required, under this Section or under any other provision of this Contract, to be so included and (c), a provision permitting the assignment of the Subcontract to the BUYER.

21. OTHER CONTRACTORS

(1) BUYER reserves the right to enter into contracts with other contractors for work relating to, but not included in, the Work. Contractor agrees at all times to cooperate fully with such other contractors and to give them reasonable opportunity for the introduction and storage of their materials, and equipment and for the performance of their work. Contractor shall properly connect and correlate the Work with the work of such other contractors.

(2) If any part of the Work depends, for its proper performance, upon the work of any such other contractor, Contractor shall inspect such other contractor's work at the point of its connection to the Work and shall promptly report to BUYER any defects in such other contractor's work that render it unsuitable for the proper performance of the Work. If Contractor should fail to so inspect such other contractor's work and/or to report any such defects, Contractor shall be deemed to have accepted such other contractor's work as being fit and proper for its connection to the Work, except as to defects which may develop in such other contractor's work after Contractor's performance of the Work.

(3) Should Contractor cause damage to the work of any such other contractor, Contractor agrees to repair, or to remove from the Work site and replace, such work or to cause such work to be repaired, or to be removed and replaced, all at Contractor's sole expense.

22. SAFETY AND SECURITY

A. Contractor agrees to comply with all safety and health standards promulgated under the Occupational Safety and Health Act of 1970 as amended. The Contractor shall take all reasonable precautions for the safety of, and shall provide all reasonable protection to prevent injury to, all persons employed on, or who may be affected by, the Work. During the performance of his Work, Contractor, its employees, Subcontractors, agents and invitees shall strictly comply with all safety, fire, health and other applicable rules and regulations of BUYER or BUYER'S customer. Contractor agrees to indemnify and hold harmless BUYER from any expense, claim, penalty or fine resulting directly or indirectly from Contractor's failure to comply with the aforementioned safety and health standards.

B. The Contractor shall, at its own expense, comply with all requirements of BUYER or any other party having an interest in the Work, concerning the secrecy of any part or aspect of the Work or of the Project and shall not permit any person to enter upon the premises at the Work site or elsewhere, except in accordance with the safety and security requirements of the BUYER or such other party having an interest in the Work.

23. USE OF WORK SITE

Contractor shall cause all materials to be stored on, all temporary structures to be erected on, and the operations of its workmen, and those of all its Subcontractors employed on the Work, to be confined to only such portions of the Work site as may be designated by BUYER.

24. REMOVAL OF WASTE MATERIAL AND RUBBISH

While the Work is in progress, Contractor shall not allow waste materials or rubbish to accumulate in or about the Work or the Work site and shall comply with all housekeeping standards in effect at the Work site. Contractor shall remove or dispose of such waste materials and rubbish in a manner approved by BUYER.

25. TREATMENT OF DOCUMENTS

Any information, data, specifications, drawings, documents, blueprints or instructions submitted to the Contractor by BUYER, it's representatives or agents, or prepared by the Contractor, its employees, agents or Subcontractors, in connection with any work performed or to be performed hereunder, shall be regarded as confidential, and the Contractor shall not reveal their contents to any third party. All drawings, specifications, documents and other memoranda or writings relating to the Work and services hereunder, shall remain or become the property of BUYER and all such documents and copies thereof shall be returned or transmitted to BUYER forthwith upon termination or completion of the Work under this Contract, whichever may first occur. All subcontracts which may be executed by the Contractor shall provide for rigid adherence to terms similar to those contained in this Section. The obligations of the Contractor under the terms and provisions of this Section shall continue even though any or all the Work under the Contract documents may have been terminated or completed.

26. PATENTS AND INVENTIONS

It is agreed that the Contractor shall be obligated to transfer to BUYER or its representatives, assigns, designees or successors, the benefits of all inventions, improvements, technical information and data resulting from or connected with the Contractor's work under the Contract documents and the Contractor agrees to execute or cause to be executed, any assignment or other documents necessary to assure to or vest in BUYER or its representatives, assigns, designees or successors, all the benefits of as well as the entire right, title and interest in and to any such inventions, improvements, technical information or data, including the execution of any and all applications for United States or foreign patents as BUYER or any of its representatives, assigns, designees or successors may request. It is understood that all costs and expenses of the Contractor previously approved by BUYER in taking any of the steps required by BUYER hereunder shall be reimbursed to the Contractor by BUYER.

27. PATENT INDEMNITY

(1) Contractor shall defend at its sole expense, any and all suits, proceedings and claims for infringement of any patent of the country in which the Work is located arising out of the use by BUYER, in connection with the Work (whether or not modified or expanded), of any materials, equipment or combination which is designed by Contractor or is a standard article of sale of Contractor, and shall indemnify and save harmless BUYER from and against all claims, damages, loss and expense on account of such infringement, provided that Contractor is notified promptly in writing of such claim or of the commencement of such suit or proceeding, as the case may be, and is given authority, information and reasonable assistance for the defense or settlement thereof. Furthermore, in the event BUYER should be enjoined in such suit or proceeding from use of such materials, equipment or combination, Contractor, at its option, shall promptly either (a) secure termination of the injunction and procure for BUYER the right to use such materials, equipment or combination, without any obligation or liability or (b) replace such materials, equipment or combination with a noninfringing material, equipment or combination or modify same to become noninfringing, all at Contractor's expense and to BUYER's satisfaction.

(2) BUYER shall defend at its sole expense, any and all suits, proceedings and claims for infringement of any patent of the country in which the Work is located arising solely by reason of Contractor's use in accordance with BUYER's written instructions, of a particular combination or process, or of materials or equipment of a particular manufacturer specified in writing by BUYER, which combination, process, materials or equipment is not customarily so used by Contractor, and BUYER shall indemnify and save harmless Contractor from and against all claims, damages, loss and expense on account of such infringement provided the BUYER is notified in writing of such claim or of the commencement of such suit or proceeding, as the case may be, and is given authority, information and reasonable assistance for the defense or settlement thereof and provided further that Contractor shall not settle such claim, suit or proceeding without the prior written consent of BUYER.

28. TERMINATION FOR CONVENIENCE OF BUYER

(1) BUYER may terminate this Contract at any time upon written notice to Contractor whether or not Contractor is in default, whereupon BUYER'S only liability shall be to pay to Contractor (a) all costs (including payroll taxes and benefits) incurred by Contractor for field office personnel and labor used in performing the Work and for materials incorporated in the Work in accordance with the terms of this Contract up to the date of termination, (b) all costs incurred by Contractor for materials ordered by Contractor for the Work up to the date of termination and not incorporated therein, provided such materials conform to the specifications of this Contract, (c) all costs incurred by Contractor in settling or discharging outstanding obligations of Contractor at the request of BUYER, (d) sales and use taxes paid by Contractor on materials, (e) all accrued bond premiums paid by Contractor up to the date of termination required by this Contract, and (f) a reasonable overhead and profit, (g) less all payments theretofore made by BUYER to Contractor hereunder and the amount of all claims of BUYER against Contractor. If it appears that Contractor would have sustained a loss on the entire Work had it been completed, no profit shall be included. Contractor shall transfer and assign to BUYER all materials and orders for which payment is made by BUYER hereunder.

(2) In no event shall the total of all amounts due and paid to the Contractor exceed the total price specified in this Contract or the individual cost element as the case may be.

(3) BUYER shall pay to Contractor, within Sixty (60) days of receipt of an invoice and submission of a termination claim the total amount due under the provisions of this Section less ten percent (10%). The remaining ten percent (10%) shall be retained by BUYER pending an audit by BUYER of Contractor's records and complete evaluation of Contractor's claim. BUYER shall give Contractor prompt written notice of the completion date, which completion date shall be not later than ninety (90) days following the date of BUYER's receipt of a final invoice from Contractor properly itemized to show the cost of each item for which payment is requested under this Section. Such audit shall determine the final amount to be paid by BUYER to Contractor or the amount to be paid by Contractor to BUYER, as the case may be, and the amount to be paid by Contractor to BUYER as the case may be, and the amount so determined shall be paid within thirty (30) days after completion of such audit and receipt of the appropriate Release and Affidavit in accordance with Section 3.

(4) The Contractor and the BUYER hereby agree that, in the event of such termination, compliance by the other Party with the provisions of this Section shall be in full settlement of all claims of every character whatsoever which such Party, its successors and assigns may have against the other Party, its successors and assigns, arising out of or in connection with or resulting from this Contract and or the Work, excepting only such claims as may arise after the termination date out of duties or obligations which survive such termination.

Process Systems International, Inc.
20 Walkup Drive
Westborough, MA 01581-5003
(508) 366-9111 FAX (508) 870-5930

29. TERMINATION FOR DEFAULT OF CONTRACTOR

(1) If the Contractor is adjudged bankrupt, or if he makes a general assignment for the benefit of his creditors, or if a receiver is appointed on account of his insolvency, or if he persistently or repeatedly refuses or fails, except in cases for which extension of time is provided, to supply enough properly skilled workmen or proper materials, or if he fails to make prompt payment to Subcontractors for materials or labor, or persistently disregards laws, ordinances, rules, regulations or orders of any public authority having jurisdiction, or otherwise is guilty of a substantial violation of a provision of the Contract documents, then the BUYER may, without prejudice to any right or remedy and after giving the Contractor and his surety, if any, seven days' written notice, terminate the Contract and take possession of the Work and all materials, equipment, tools, construction equipment and machinery on the Work site owned by the Contractor and may finish the Work by whatever method deemed expedient. In such case, the Contractor shall not be entitled to receive any further payment until the Work is finished.

(2) If the unpaid balance of the Contract Price exceeds the costs of finishing the Work, including compensation for the BUYER'S additional services, such excess shall be paid to the Contractor. If such costs exceed such unpaid balance, the Contractor shall pay the difference to the BUYER.

30. DRAWINGS; PARTS LISTS; INSTRUCTIONS

The Contractor shall furnish, at its own expense, all drawings, parts lists, catalogs, instructions and the like which are required by those provisions of the Contract documents applicable to the work of the Contractor hereunder, or which, in the opinion of BUYER, are required in connection with the Work hereunder. All drawings shall show the title and location of the work and shall clearly show the relation of the various parts to the main members and lines of the structure or facility to which the work relates. Where fabrication of the work depends upon field measurements, the Contractor shall make the same and note them upon the drawings before submitting such drawings for BUYER'S approval, in the order in which materials are needed at the Work site. Items of work requiring drawings shall not be commenced until drawings covering the work are approved by BUYER. Approval of drawings by BUYER, regardless of whether such drawings have been changed in order to obtain such approval, shall not relieve the Contractor from responsibility for defects, insufficiencies, errors or omissions therein and any and all additional and corrective work and material required by any such defects, insufficiencies or omissions shall be performed by the Contractor at its own expense.

31. INDEPENDENT CONTRACTOR

It is understood and agreed that the Contractor shall be and remain an independent contractor.

32. DISPUTES

The Parties expressly covenant and agree that any and all disputes, issues and controversies between the Parties under this Contract shall be submitted for determination to the BUYER and that the written decision of BUYER shall be final, binding and conclusive upon the parties hereto. Pending such final, binding and conclusive decision of any such dispute, which shall be rendered within ninety (90) days after the submission of a dispute in writing to the BUYER, the Contractor shall, except to the extent that its right to proceed with the Work has been terminated, diligently proceed with the performance of any uncompleted work under this Contract.

33. LABOR DISPUTES

Whenever an actual or potential labor dispute is delaying or threatens to delay the performance of the Work, the Contractor shall immediately notify the BUYER in writing. Such notice shall include all relevant information concerning the dispute and its background.

34. PAYMENT AND TERMS THEREOF

A. The amount of any monthly invoice shall be based upon the percentage satisfactorily completed of the various parts of the Work, which shall include only the materials actually and physically incorporated into the Work during the period, as set forth in the cost breakdown approved by BUYER, plus additional and/or extra work incorporated into this contract via amendment during the month for which the invoice is submitted, less amounts previously billed and less the retained percentage as set forth in Clause B of this Section and subject to the provisions of Section 3 Construction Change Orders shall be invoiced only once upon satisfactory completion of the Construction Change Order work. Partial billings of Construction Change Orders shall not be allowed.

(1) Additional or extra work added to the original Contract price by means of addendum shall be subject to the retained percentage as set forth in Clause B of this Section. Additional or extra work added to the original Contract by Construction Change Order shall not be subject to retained percentage.

(2) Contractor shall submit separate invoices for

(a) Progress Payments

(b) Construction Change Orders

(c) Retainage

B. Ninety (90) percent of the value of the Work actually completed and invoiced by the Contractor and approved by BUYER will be paid thirty (30) days after receipt of invoice. The balance of ten (10) percent thereof will be retained by BUYER to insure the Contractor's full and complete performance of its obligations hereunder and shall become due and payable upon the acceptance by BUYER of all material and Work as being completed in accordance with the Contract documents.

C. If at any time there shall be evidence of any lien or any other claims of any kind or description for which BUYER may become liable, and which is chargeable to the failure of the Contractor to pay its Subcontractors, materialmen, suppliers or laborers, and/or when damage shall be caused by the Contractor to another Subcontractor's work then BUYER shall have the right to retain out of any payment then due or thereafter to become due an amount sufficient, in the opinion of BUYER, to completely indemnify BUYER against any such lien or claim. If there shall prove to be any such lien or claim after all payments are made, the Contractor shall refund to BUYER all monies that the latter may be compelled to pay in discharging or disposing thereof and of any other claim made in consequence of the Contractor's default.

35. PUBLICITY

No information relative to the Work shall be released by Contractor, either before or after completion of the Work, for publication or for advertising purposes without the prior written consent of BUYER.

36. NOTICES

Unless otherwise specified in this Contract, any notice, request or other communication to be given in writing under this Contract shall be deemed to have been given by either Party to the other Party.

(1) Upon the date of the mailing thereof, as shown by the Post Office receipt, if mailed to the other Party by registered or certified mail at the applicable address set forth in this Contract or at the latest address specified by the other Party in writing, or

(2) Upon the date of the receipt thereof by the other Party, if not so mailed by registered or certified mail.

37. MODIFICATION; WAIVER

No change in, addition to, or waiver of any of the provisions of this Contract shall be binding upon either Party unless in writing signed by each Party. No waiver by either Party of any breach by the other Party of any of the provisions of this Contract shall be construed as a waiver of any subsequent breach, whether of the same or of a different provision of this Contract.

38. ASSIGNMENT

No assignment by Contractor of this Contract, or of any monies due or to become due to Contractor under this Contract, shall be made without the prior written consent of BUYER.

39. RIGHTS AND REMEDIES

The rights and remedies of the Parties set forth in this Contract shall not be exclusive and are in addition to all other rights and remedies of the Parties.

40. CONFLICT

In case of conflict between any provision of any of the documents incorporated herein, the provision, term or requirement which is more stringent will apply.

41. TAXES

The Contractor shall pay all sales, consumer, use and other similar taxes required by law. He shall pay any and all taxes imposed by local, city, state or federal government, including such expenses in Contract Price.

42. INSURANCE

Contractor shall at its expense provide and maintain, until the Work is completed and accepted by BUYER minimum insurance coverage as follows:

TYPE OF COVERAGE	LIMITS	
WORKMEN'S COMPENSATION	Sufficient limits to discharge obligations under all applicable state workmen's compensation laws, the United States Longshoremen's and Harbor Worker's Act, the Jones Act and Admiralty or Maritime Law.	
EMPLOYER'S LIABILITY, including occupational disease.	$1,000,000 ea. occurrence	
COMPREHENSIVE GENERAL LIABILITY	$1,000,000	$3,000,000
PERSONAL INJURY, including death.	ea. person	ea. occurrence.
PROPERTY DAMAGE, including coverage for damage caused by blasting, collapse or structural injury, and/or damage to underground property, broad form property damage, products and completed operations.	$1,000,000 ea. person	$3,000,000 ea. occurrence.
CONTRACTUAL PERSONAL INJURY	$3,000,000 ea occurrence	
CONTRACTUAL PROPERTY DAMAGE	$3,000,000 ea. occurrence	
AUTOMOBILE BODILY INJURY, covering all automobiles, trucks, tractors, trailers, motorcycles, or other automotive equipment whether owned or rented by the Contractor, or by employees of the Contractor.	$1,000,000 ea. person	$1,000,000 ea. occurrance
AUTOMOBILE PROPERTY DAMAGE, covering all automobiles, trucks, tractors, trailers, motorcycles, or other automotive equipment whether owned or rented by the Contractor, or by employees of the Contractor.	$1,000,000 ea. occurrance	

BUYER shall be made an additional insured on all of the above policies except Workmen's Compensation and Employers' Liability and shall be given thirty (30) days notice in the event of cancellation or non-renewal of any policy. Certificates evidencing this coverage shall be forwarded to BUYER prior to commencing work under the Contract. A waiver of subrogation in favor of BUYER shall be obtained on each policy. Contractor shall cause its Subcontractors at the Work site to procure and maintain insurance policies to protect BUYER in accordance with the requirements stated above and shall furnish BUYER evidence of such insurance.

All insurance provided by Contractor and its Subcontractors shall be primary and any insurance maintained by BUYER shall be excess and not contributing with Contractor's or Subcontractors insurance.

All insurance coverage provided by Contractor shall extend through acceptance of the Work by BUYER except for Comprehensive General Liability, which shall be extended for the entire period of the guaranty unless otherwise specified.

The policies shall be endorsed to provide that there will be no recourse against BUYER for payment of any premiums.

43. PROGRESS SCHEDULE AND PROGRESS REPORTING

1. As required in the Proposal, the Contractor shall submit a Proposed Construction Schedule showing the order in which he proposes to carry on the Work, the date on which he will start the several salient features and contemplated dates for completing same. The schedule shall indicate the percentage of work scheduled for completion at any time. The schedule shall also show the proposed weekly manpower loading of the Work by individual activity from start to completion. This schedule shall be broken down by individual activities on a format similar to the bid breakdown.

2. Prior to the contract award, the Proposed Construction Schedule will be reviewed by the BUYER with the Contractor and confirmed or revised as mutually agreed upon. The resulting Construction Schedule will then become a part of this Contract. The Contractor will review with the BUYER the percentage of actual completion of each scheduled activity at the end of each week.

3. After moving on-site, the Contractor shall submit to the BUYER'S representative a daily report describing the work performed and indicating the number of men employed, by each trade, in the same breakdown as in the Construction Schedule. This daily report shall also indicate all major construction equipment on-site, materials received, the diameter inches of weld for each type of material, and any problems the contractor may have. On the last day of each week the Contractor shall submit a summary of the total manhours expended in each breakdown area of the schedule and on each Construction Change Order or Addendum.

4. The Contractor and his Subcontractors will be required to meet with BUYER'S representative weekly to review planning, safety requirements, material procurement, and any other pertinent items.

5. Progress on the above reports will be closely monitored in relation to the schedule. If, in the judgement of the BUYER'S Representative, it becomes evident that actual progress of the Contractor is not in keeping with the approved schedule due to slow progress in purchasing materials, undermanning, unqualified manning, incompetent supervision or any other cause within the Contractor's responsibility, the BUYER'S representative shall notify the Contractor of this condition, for prompt and adequate action or correction of the problem slowing down the job.

6. The BUYER'S representative shall have the right to require the Contractor to take measures or adopt such methods as may be necessary to bring the Work in line with the schedule and eliminate any interference with the progress of other contractors. The Contractor shall not be entitled to any additional compensation for effecting this improvement, should additional labor, equipment, materials, overtime, or other methods be required.

7. The Contractor shall, within two weeks after award, supply to the BUYER'S Representative a comprehensive list of all materials which the Contractor is supplying. This list shall indicate the delivery dates for every item.

8. The Contractor shall furnish sufficient labor and equipment, and shall work such hours, including overtime, Saturday, Sunday and holiday work as may be necessary to assure the prosecution of the Work in accordance with the approved progress schedule.

44. "AS BUILT" DRAWINGS

Upon completion of construction, the Contractor shall prepare a set of reproducible Mylar Drawings with all corrections made to "As Built" conditions. Submittal of these drawings shall be made before final payment to the Contractor. These shall become the property of the BUYER.

45. ENTIRE AGREEMENT

This Contract sets forth the entire agreement between BUYER and Contractor with respect to the subject matter of this Contract and supersedes all prior negotiations, understandings and dealings between the Parties.

ATTACHMENT E

CERTIFICATIONS

Certification of Nonsegregated Facilities, Clean Air and Water and Anti-Kickback Compliance

Certification Regarding Lobbying

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transaction

Assurance of Compliance and National Foundation Regulation Under Title VI of the Civil Right Act of 1964

Americans With Disabilities Certification

Public Law 95-507 Certification

I. NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES

A Certification of Nonsegregated Facilities, as required by the May 9, 1967, order on Elimination of Segregated Facilities, by the Secretary of Labor (32 Fed. Reg. 7439, May 19, 1967), must be submitted prior to the award of a subcontract exceeding $10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semi-annually, or annually).

CERTIFICATION OF NONSEGREGATED FACILITIES

By the submission of this proposal, the proposer certifies that he does not maintain or provide for his employees any segregated facilities at any of his establishments, and that he does not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. He certifies further that he will not maintain or provide for his employees any segregated facilities at any of his establishments, and that he will not permit his employees to perform their services at any location, under his control, where segregated facilities are maintained. The proposer agrees that a breach of this certification is a violation of the Equal Opportunity clause in this contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom or otherwise. He further agrees that (except where he has obtained identical certifications from proposed subcontractors for specific time periods) he will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding $10,000 which are not exempt from the provisions of the Equal Opportunity clause; that he will retain such certifications in his files; and that he will forward the above notice titled "NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CER-

TIFICATIONS OF NONSEGREGATED FACILITIES," to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods).

II. CLEAN AIR AND WATER

A Clean Air and Water Certification is required for the award of any nonexempt subcontract. A "nonexempt subcontract" is defined as:

(A) A subcontract for supplies and nonpersonal services in excess of $10,000, or a subcontract for construction in excess of $2,000, if any facility to be used in performance of the work has been the subject of a conviction under the Clean Air Act [42 U.S.C. 1857c-8(c)(1)] or the Federal Water Pollution Control Act [33 U.S.C. 1319(c)] and is listed, on the date of award of the subcontract, on the Environmental Protection Agency "List of Violating Facilities";

(B) any other subcontract in excess of $100,000;

(C) any indefinite quantity subcontract if the offeror has reason to believe the amount to be ordered in any contract year may exceed $100,000.

Proposers are advised that the Additional General Provision entitled "Clean Air and Water" must be included in any nonexempt subcontract entered into as the result of this solicitation.

III. CLEAN AIR AND WATER CERTIFICATION

By the submission of this proposal, the proposer certifies as follows:

(A) No facility to be utilized in the performance of the proposed contract is listed on the Environmental Protection Agency "List of Violating Facilities".

(B) He will promptly notify the Institute, prior to award, of the receipt of any communication from the Director, Office of Federal Activities, U.S. Environmental Protection Agency, indicating that any facility which he proposes to use for the performance of the contract is under

consideration to be listed on the EPA "List of Violating Facilities".

IV. ANTI-KICKBACK COMPLIANCE

A Certification of Anti-Kickback Compliance must be submitted prior to award.

CERTIFICATION OF ANTI-KICKBACK COMPLIANCE

By submission of a proposal in response to this solicitation incorporating this form, the offeror certifies that it has read the General Provision entitled "Anti-Kickback Procedures", contained in the solicitation and that neither it nor any of its employees have performed or participated in any prohibited actions, as defined in that provision, relating to the award of the Contract. By commencing performance of the Contract work, the selected contractor certifies to Anti-Kickback Compliance.

(NOTE: The penalty for making false statements in offers is prescribed in 18 U.S.C. 10001.)

CERTIFICATION REGARDING LOBBYING

Certification for Contracts, Grants, Loans and Cooperative Agreements

The undersigned certifies, to the best of his or her knowledge and belief, that:

(1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying" in accordance with its instructions.

(3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Certified by:

Proposal or Award Identification Information:

_____ _____

Signature Date

_____

Name

_____

Title

_____

Institution

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

ASSURANCE OF COMPLIANCE WITH NATIONAL SCIENCE FOUNDATION REGULATION UNDER TITLE VI OF THE CIVIL RIGHTS ACT OF 1964

_____ (hereinafter called the "Applicant") HEREBY AGREES THAT it will comply with Title VI of the Civil Rights Act of 1964 (P.L. 88-362) and all requirements imposed by or pursuant to the Regulation of the National Science Foundation (45 CFR Part 611) issued pursuant to that title, to the end that, in accordance with Title VI of that Act and Regulation, no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be otherwise subjected to discrimination under any program or activity for which the Applicant receives Federal financial assistance from the Foundation; and HEREBY GIVES ASSURANCE THAT it will immediately take any measures necessary to effectuate this agreement.

If any real property or structure thereon is provided or improved with the aid of Federal financial assistance extended to the Applicant by the Foundation this Assurance shall obligate the Applicant, or in the case of any transfer of such property, any transferee, for the period during which the real property or structure is used for a purpose for which the Federal financial assistance is extended or for another purpose involving the provision of similar services or benefits. If any personal property is so provided, this Assurance shall obligate the Applicant for the period during which it retains ownership or possession of the property. In all other cases, this Assurance shall obligate the Applicant for the period during which the Federal financial assistance is extended to it by the Foundation.

THIS ASSURANCE is given in consideration of and for the purpose of obtaining any and all Federal grants, cooperative agreements, loans, contracts, property, discounts or other Federal financial assistance extended after the date hereof to the Applicant by the Foundation including installment payments after such date on account of applications for Federal financial assistance which were approved before such date. The applicant recognizes and agrees that such Federal financial assistance will be extended in reliance on the representations and agreements made in this Assurance, and that the United States shall have the right to seek judicial enforcement of this Assurance. This Assurance is binding on the Applicant, its successors, transferees, and assignees.

PLEASE TYPE OR PRINT	
NAME OF APPLICANT, STREET ADDRESS OR P.O. BOX, CITY, STATE, ZIP CODE	
I CERTIFY THAT THE ABOVE INFORMATION IS COMPLETE AND CORRECT TO THE BEST OF MY KNOWLEDGE	
SIGNATURE AND TITLE OF AUTHORIZED OFFICIAL	DATE

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION - LOWER TIER COVERED TRANSACTION

(a) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.

(b) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

_____

Name and Title of Authorized Representative

_____

Signature and Date

AMERICANS WITH DISABILITIES ACT CERTIFICATION

(a) The Contractor agrees to comply with the provisions of the Americans with Disabilities Act 42 U.S.C. section 12101 et. seq. and all implementing regulations.

(b) The Contractor agrees that it will be responsible to the Institute and will indemnify and hold harmless the Institute, its trustees, officers, and employees from any loss, cost, damage, expense or liability or suit therefore, by reason of actual or alleged property damage or personal injury of whatever kind or character, arising out of, or in connection with performance of the requirements of paragraph (a) above by the contractor or any of its Subcontractors, howsoever the same may be caused, excepting only such loss, cost, damage, expense or liability attributable to the sole or contributory active negligence of the Institute, its trustees, officers or employees.

(c) The Contractor agrees to insert the provision of this Article, including this (c), in all subcontracts and purchase orders hereunder.

The Contractor represents and certifies as part of its offer that:

The Contractor certifies compliance with the Americans with Disabilities Act, 42 U.S.C. 12101 et. seq.

_____

Company Name

_____ _____

Signature of Authorized Representative | Date

_____ _____

Name (typed) | Title

PSI PROCESS SYSTEMS INTERNATIONAL, INC.

ATTENTION: Sales Manager

SUBJECT: Public Law 95-507

As the result of Public Law 95-507 amending the Small Business Act of 1958, our company is required to obtain certain information from its current or prospective suppliers concerning their status as a small or small disadvantaged business. Additionally, we are required to report on the volume of subcontracted work being performed or to be performed in areas of persistent or substantial labor surplus.

Therefore, would you please complete each of the certifications indicated below as defined on the reverse side of this letter, sign, date and return to me at your earliest convenience.

Very truly yours,

PROCESS SYSTEMS INTERNATIONAL, INC.

Ronald B. Bento
Purchasing Manager

BUSINESS TYPE CERTIFICATION

1. CHECK ONE (Mandatory)
   - Small Business _____
   - Large Business _____
   - Non-Profit Concern _____
   - Foreign Owned Business _____

2. CHECK ONE (If Applicable)
   - Disadvantage Business _____
   - Women-Owned Business _____

3. Also, indication if your location is in labor surplus area. _____ Yes

Business Name _____

Address _____

City _____ State _____ Zip Code _____

Authorized Signature _____ Phone _____

Name/Title _____ Date _____

Fax Number _____

PLEASE RESPOND AS SOON AS POSSIBLE. FAX: 508-898-0351

BUSINESS TYPE CERTIFICATION DEFINITIONS

1. **Small Business.** A concern that meets the pertinent criteria established by the Small Business Administration. ASPR 1-701.1-5.

If you are not certain concerning your status, please contact the nearest office of the Small Business Administration for assistance.

2. **Socially and Economically Disadvantage Small Business Concern.** A small business concern:

   (a) Which is at least 51 per centum owned by one or more socially and economically disadvantaged individuals; or, in the case of any publicly owned business, at least 51 per centum of the stock of which is owned by one or more socially and economically disadvantaged individuals, and

   (b) Whose management and daily business operations are controlled by one or more of such individuals.

   (c) The contractor shall presume that socially and economically disadvantaged individuals include Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans and other minorities, or any other individual found to be disadvantaged by the Small Business Administration pursuant to Section 9(a) of the Small Business Act.

3. **Women-Owned Business.** A business that is at least 51 per centum owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

4. **Non-Profit Concern.** A concern that is legally incorporated and not conducted or maintained for the purpose of making a profit.

5. **Large Business.** A concern that is not small business or non-profit.

6. **Labor Surplus area.** A county location designated by the Department of Labor. If the county location of your business is identified currently as such, indicate Yes. Also, please indicate the county in which your business is located.

7. **Foreign Supplier.** A concern that is located and owned in a country outside the United States of America.

We would appreciate being informed of future changes occurring after you submit the requested information.

Please address any questions to Ron Bento, telephone number 508-366-9111.

ATTACHMENT F

CALIFORNIA INSTITUTE OF TECHNOLOGY
LIGO Project, MS 51-33, Pasadena, California 91125
818-395-2129, Fax 818-304-9834

Process Systems International
20 Walkup Drive
Westborough, MA 01581-5003
Attn: W.J. Murphy

Date: June 5, 1996
Refer to: LIGO-L960403-00-P

Subject: Washington Sales Tax Exemption, State Senate Bill 6511

Dear Sir:

On March 20, 1996, the Governor of the State of Washington signed into law State Senate Bill 6511. This bill granted an exemption from sales and use taxes for materials used in the construction of a laser interferometer gravitational-wave observatory.

Specifically, this Act provided that these taxes shall not apply to that tangible personal property that is incorporated into, installed in, or attached to a building or other structure that is an integral part of a laser interferometer gravitational wave observatory. Therefore, those goods and services used in the construction of LIGO, but which do not ultimately become part of LIGO, are subject to the sales and use tax, as applicable.

For example, cranes, trucks, tractors, compressors, etc., used in construction are generally taxable, unless the contractor has previously paid Washington sales tax on this equipment. Also, lease payments for such equipment are taxable, as are professional services and consumables such as fuel.

It is requested that invoices which include taxable items show the applicable tax amount on a separate line, clearly identified as tax paid and chargeable to Caltech, Account Number 5A523.

Information regarding taxes in the State of Louisiana shall be transmitted as soon as determinations are finalized.

As a result of this legislation, every opportunity should be taken to minimize the tax liability to LIGO wherever possible. If there are questions regarding tax exemptions or liabilities under State Senate Bill 6511, please contact Mr. Richard Fischer at (818) 395-2968, or the undersigned at (818) 395-3044.

Very truly yours,

Edward J. Jaskow
Subcontracts Manager, LIGO Project

EJJ:rt

enclosure: Copy of Senate Bill 6511

cc: Document Control Center
Chronological File

CERTIFICATION OF ENROLLMENT

SENATE BILL 6511

Chapter 113, Laws of 1996

54th Legislature
1996 Regular Session

EFFECTIVE DATE: March 20, 1996

Passed by the Senate March 7, 1996
YEAS 47 NAYS 0

President of the Senate

Passed by the House March 7, 1996
YEAS 97 NAYS 0

Speaker of the
House of Representatives

Approved March 20, 1996

Governor of the State of Washington

CERTIFICATE

I, Marty Brown, Secretary of the Senate of the State of Washington, do hereby certify that the attached is **SENATE BILL 6511** as passed by the Senate and the House of Representatives on the dates hereon set forth.

Secretary

FILED

MAR 20 1996

Time 10:09 a.m.

Secretary of State
State of Washington

F 3

SENATE BILL 6511

Passed Legislature - 1996 Regular Session

State of Washington 54th Legislature 1996 Regular Session

By Senators Loveland and Hale; by request of Governor Lowry

Read first time 01/16/96. Referred to Committee on Ways & Means.

AN ACT Relating to sales and use tax exemptions for materials used in the construction of a laser interferometer gravitational wave observatory; adding a new section to chapter 82.08 RCW; adding a new section to chapter 82.12 RCW; and declaring an emergency.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF WASHINGTON:

NEW SECTION. Sec. 1. A new section is added to chapter 82.08 RCW to read as follows:

The tax levied by RCW 82.08.020 shall not apply to sales of tangible personal property to a consumer as defined in RCW 82.04.190(6) if the tangible personal property is incorporated into, installed in, or attached to a building or other structure that is an integral part of a laser interferometer gravitational wave observatory on which construction is commenced before December 1, 1996.

NEW SECTION. Sec. 2. A new section is added to chapter 82.12 RCW to read as follows:

The provisions of this chapter shall not apply in respect to the use of tangible personal property by a consumer as defined in RCW 82.04.190(6) if the tangible personal property is incorporated into,

F 4

installed in, or attached to a building or other structure that is an integral part of a laser interferometer gravitational wave observatory on which construction is commenced before December 1, 1996.

NEW SECTION. Sec. 3. This act is necessary for the immediate preservation of the public peace, health, or safety, or support of the state government and its existing public institutions, and shall take effect immediately.

--- END ---