KICKOFF MEETING
VACUUM EQUIPMENT PHASE A

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PHASE A INTERACTION

Phase A is a design competition with two contractors working in parallel. All communication by LIGO will be fair and unbiased. Both contractors must be present at all meetings except for the PDR presentations. Any other communication must be in writing and will be copied to both contractors.

PHASE A DELIVERABLES

The "SOW" sets out the tasks and schedules which must be executed by the contractor during Phase A. There are three key deliverables required at the end of this phase:

1. Technical - PDR design material.
2. Management - Project plans for QA, safety, configuration control, etc.
3. Cost proposal.

PHASE A
EVALUATION CRITERIA

At the end of Phase A one contractor will be selected to proceed with Phase B. Selection will be based on (in order of importance):

- Cost proposal - realism and completeness as well as price.
- Technical - PDR design material. Factors to be considered are: maturity of the design, completeness of drawings and schematics, suitability of processes and procedures.
- Management - Project plans for QA, safety, configuration control, cost control; through design, fabrication, installation and testing.

VACUUM SYSTEM

The LIGO Vacuum *System* (Vacuum Equipment + Beam Tubes) provides:

- A clear aperture for the interferometers.
- A clean environment for the precision optics.
- A low pressure in order to minimize diffraction and acoustic coupling.

The LIGO Vacuum *System* will be the world's largest high performance vacuum system with a pumped volume of roughly 20,000 m^3.

VACUUM EQUIPMENT

The LIGO Vacuum Equipment will be a robust, conservative design in order to operate reliably 24 hours per day, year round.

- Designed for operation until 2001 without modification.
  - 2 interferometers in WA and 1 in LA.
- Advanced interferometers may required improved vacuum performance:
  - Obtained by adding getter pumps to existing ports.
- Future interferometers will require:
  - Additional chambers, tubes, pumps, valves.

VACUUM EQUIPMENT

The LIGO Vacuum Equipment (located in the corner, mid, and end stations) consists of six subsystems:

- Vacuum envelope (all stainless steel)- large chambers, 72 inch, 48 inch, 30 inch vacuum pipe, large diameter bellows and flange connections, many smaller flanged connections.
- Pumping subsystem - Roots pumping carts, turbomolecular pump carts, ion pumps, large cryogenic pumps.
- Valve subsystem - 60 inch, 48 inch, roughing gate valves, many small valves.
- Monitor and control subsystem - gauges, valve controllers, cryogenic pump controllers, ion pump controllers...etc.
- Vent and purge subsystem - High purity air distribution system with dry air compressors, soft wall clean rooms (class 100)
- Bakeout subsystem - thousands of square feet of heating and insulating blanket, cabling, temperature controllers.

VACUUM ENVELOPE

Three types of chambers:

- Beam Splitter Chamber (BSC) - two functions - houses beam splitter mirrors and test masses.
- Test Mass Chamber (TMC) - houses retractable test masses.
- Horizontal Access Module (HAM) - houses input and output optics like mode cleaners.

Various tubes and bellows:

- 3 Diameters - 72 inch, 48 inch and 30 inch, for connecting chambers together into contiguous volumes.
- Many large bellows to allow expansion/contraction of connections.

PUMPING SUBSYSTEM

Different types:

- First stage Roughing - from atmosphere to < 1 torr.
  - Roots blower pumps.
- Second stage Roughing - from < 1 torr to 10^{-6} torr.
  - Turbomolecular pumps. Look at new maglev pumps to be released soon.
- Steady state - Ion/getter pumps - 10^{-6} torr and lower.
- Steady state - 80K pumps - cryo-pumps specifically for water vapor.
- Other - Annulus pump system, auxiliary turbo pumps.

VALVE SUBSYSTEM

Valves allow for the isolation and pumping of different volumes. Several sizes and types are needed:

- 60 inch gate valves - used in the TMC chamber.
- 48 inch gate valves - used to isolate interferometers from each other and to isolate the stations from the beam tube - for repair and maintenance of both interferometer and vacuum components.
- roughing gate valves - used to allow connection of roughing pumps.
- smaller valves - used for venting, purging, gauge mounting, annuli connections, etc.

MONITOR AND CONTROL SUBSYSTEM

The monitor and control subsystem provides:

- trend monitoring with pirani and cold cathode gauges.
- user interfaces for local control and an interface to the LIGO Control and Data Systems (CDS).
- safety - interlocks for safe operation of pumps, valves, and gauges.

OTHER SUBSYSTEMS

VENT AND PURGE SUBSYSTEM

Vent and purge gas (very dry, clean air) is used to:

- maintain low water vapor content of the system - allows speedier pumpdowns, easier ion pump starting, lessened contamination risk.
- provide a class 100 air shower to maintain optics cleanliness.

BAKEOUT SUBSYSTEM

The bakeout system is used for the initial and periodic pumpdowns of the vacuum equipment. This system is needed to:

- Reduce the water vapor in the vacuum equipment after the installation and periodically afterwards.

VACUUM EQUIPMENT SPECIFICATION

Clarifications: ION PUMP SYSTEM

Paragraph 5.2.2 Main Ion Pumps:

- One possible configuration is described using 2500 l/s (N_2) ion pumps.
- Other configurations are possible (and encouraged), such as:
  - combined ion/getter pumps.
  - larger number of smaller pumps.

VACUUM EQUIPMENT SPECIFICATION

Clarifications: 80K PUMP SYSTEM

Paragraph 5.2.3 80K Pumps:

- Possible configurations:
  - combined storage with pump.
  - remote storage with gravity or pressure feed with level control.
  - active system with circulation pumps, recoolers.

LIGO requires a complete system:

- specify lease or purchase storage tanks if used.
- storage capacity > 3 months

VACUUM EQUIPMENT SPECIFICATION

Clarifications: Vacuum Seals

Paragraph 5.1.9 Flanges and Ports:

- Dual o-ring seals used only where "frequent" access is required - chamber ports. Other large diameter seals should be metal.
- Large diameter gates should be designed for dual o-ring seal.

VACUUM EQUIPMENT SPECIFICATION

Clarifications: Valves

Paragraph 5.3.1 Gate Valves:

- In some cases it may make sense to provide large valves with weld necks rather than flanges.
- Actuation may be pneumatic, electric or manual. Shock considerations are important.

INTERFACES
A&E

- **LIGO needs early definition of the interfaces with the buildings:**
  - Chamber anchoring scheme - do we need to cast in place? What are the loads?
  - Wall penetrations.
  - Exterior pads for equipment mounting.
  - Utilities - power, water. exhaust.
  - Storage requirements (bakeout equipment).
- Crane requirements, building access required:
  - current plans call for 10T cranes
  - 16x24 rollup door - the Phase B contractor must provide a temporary air lock to allow movement of equipment through this entrance.

BEAM TUBE INTERFACE

- **LIGO needs early delivery of beam tube valves and pumps:**
  - Valves required in late spring of 1996. Pumps soon after.

PHASE A

During Phase A both contractors shall attend:

- Kickoff meeting - joint attendance
- Two requirements update meetings - joint attendance
- Preliminary Design Review - Individual meetings

At the end of Phase A each contractor shall:

1. Submit a Preliminary design.
2. Submit a project management plan.
3. Submit a detailed Fixed Price Proposal for the Phase B task.

PHASE B

One contractor proceeds with Phase B.

- An updated PDR will allow action items from the Phase A PDR to be addressed.

PHASE B ADDITIONS

Additions to the Phase B task:

- Add a separate FDR for the beam tube deliverables (gate valves and pumps) to allow early procurement of these components.
- Assume electronic data as well as paper for deliverables such as drawings and cost/schedule data.