

Purchase Order No. PC266884  
LIGO-C980968-00-D

**Exhibit II**  
**LIGO Seismic Isolation System**  
**Air-Bearing Specification**  
**LIGO-E980080-00-D**

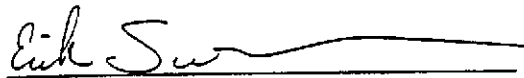
# LIGO Seismic Isolation System Air Bearing Specification

October 24, 1997

## Abstract

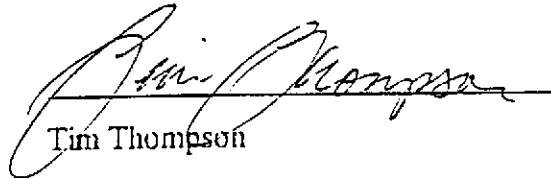
This specification encompasses the air bearing specifications for the LIGO SEI program for which HYTEC is responsible.

PREPARED BY:



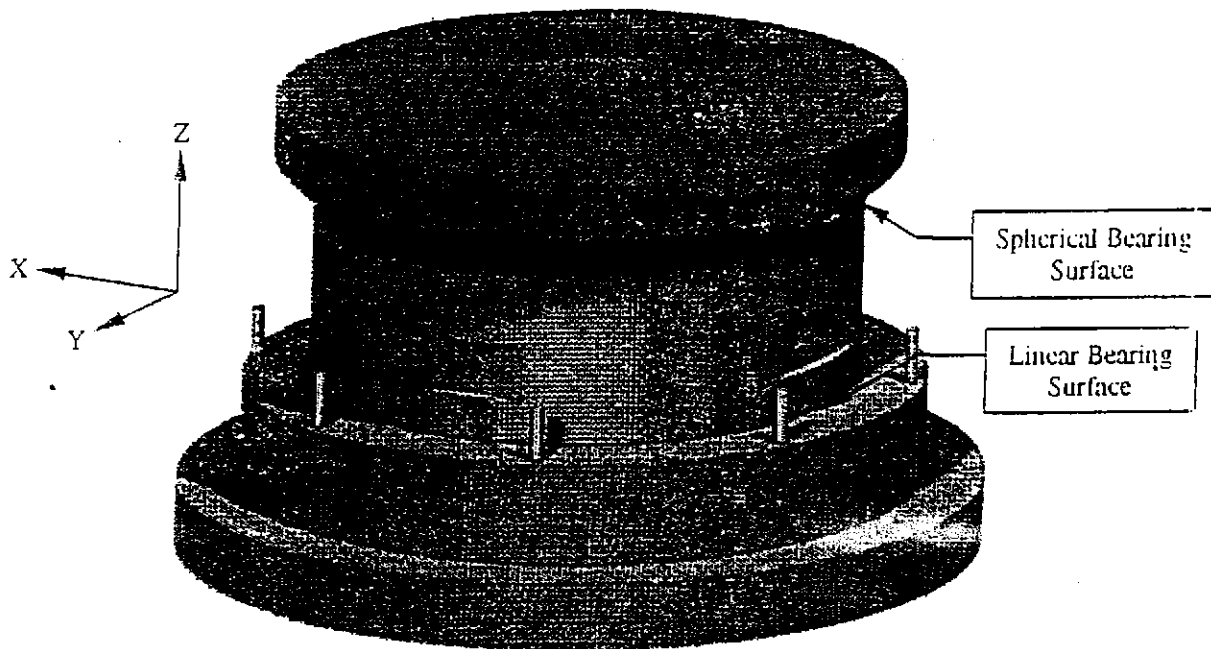
Erik Swensen

PROJECT MANAGER



Tim Thompson

## DESIGN REQUIREMENTS FOR THE LIGO AIR BEARINGS



## 1. Loads (total for each Air Bearing)

X- Direction (along beam path)

Bellows - 106 lb., 4 bellows 14.78 mm excursion

Y- Direction\*

Bellows - 275 lb., 4 bellows 16.53 mm excursion

Z - Direction\*

Bellows - 233 lb., 4 bellows 12.65 mm excursion

Applied - BSC weight = ~ 3,000 lb. (weight supported by the air bearing)

- HAM weight = ~ 1,500 lb.

\*Note: The combined motion in the Y-Z plane is 20.81 mm excursion.

## 2. Motion Capability:

Translations:

X- Direction = +/- 22.23 mm (0.875 in)

Y- Direction = +/- 22.23 mm (0.875 in)

Z- Direction = None

Rotations:

X-X = +/- 2.5 Degrees

Y-Y = +/- 2.5 Degrees

Z-Z = +/- 2.5 Degrees

\*Note: The Air Bearing motion capabilities are greater than the excursions given in #1 above to allow ample motion for initial positioning. Initial positioning is required to account for tolerance, loads and other external factors.

## 3. Motion:

Velocity:

X, Y, Z = 0.01 cm/s (*maximum*)

Acceleration:

X, Y, Z = 0.001 cm/ s<sup>2</sup> (*maximum*)

## 4. Duty Cycle = &lt; 1%

## 5. Life expectancy = 20 years

## 6. Nominal Operating Environment:

Temperature = 22 +/- 2 °C

Humidity = 20 - 70 %

Contaminants (cleanliness) = clean environment

Radiation = none

Earthquakes = Designed to withstand a 0.4 g static equivalent lateral and vertical load (total weight) without catastrophic failure - the part must remain structurally sound. Applying a 0.4 g load in all three directions simultaneously can be conservative, therefore the 100-40-40 rule\* can be used to account for phase differences between the X, Y and Z motions.

\*Note: The 100-40-40 rule is used by civil engineers to account for phase differences between the three axes. The rule is applied to the seismic problem by using 100% of the static equivalent load in one direction and 40% of the static equivalent load in the two orthogonal directions. The worst case is dependent on the problem.

## 7. Interfaces:

Mechanical = Cross Beam (Top) and Mounting Plate (Bottom)

Pneumatic = Air supplied by LIGO and air quality Requirements supplied by vendor.

Utility = All utilities/cabling will not create or result in loads greater than 10 lbs.

## 8. Air Supply:

Source = Supplied by HYTEC and LIGO.

Quality = Requirements will be supplied by the air bearing manufacturer.

Pressure = Requirements will be supplied by the air bearing manufacturer.

## 9. Smoothness:

The system must provide smooth/stable rigid body motions during air bearing motions. Flutter or an instability of any sort is not permissible at any time.

Air Bearing Pressurized:

Stiction = none

Friction = none

Air Bearing Unpressurized:

Creak\* = none

Friction = frictional forces will be greater than operational loads

\*Note: *Creak is a micro-burst of energy released into the system.*

10. System Stiffness:

The overall stiffness of the air bearing components must meet stack attenuation goals when unpressurized, > 25 Hz.

11. Safety Stops:

The air bearing will incorporate mechanical safety-stops to prevent any damage to the system caused by an errant actuator system and earthquake type movements. The stops will be configured to allow for the full range of mobility.

12. Material:

Materials selected for construction of the bearing must meet the requirements shown above. In particular the infrequent use of the hardware will not effect the expected performance.

Purchase Order No. PC266884  
LIGO-C980968-00-D

**Exhibit III**  
**Hytec, Inc. Purchase Order**  
**LIGO PO Number 1112**



DESIGN ENGINEERING  
ADVANCED COMPOSITE APPLICATIONS  
ULTRA-STABLE PLATFORMS

110 EASTGATE DR., STE. 100  
LOS ALAMOS, NM 87544

PHONE 505 661-3000  
FAX 505 662-5179  
WWW.HYTECINC.COM

January 28, 1998

Marc Hadarik  
Specialty Components  
27A Village Lane  
Wallingford, CT 06492

Subject: LIGO-PO-1112

Dear Marc:

Enclosed are two copies of the drawings (Drawing #D972106) on the referenced purchase order.

This letter is confirmation of LIGO-PO-1112 that was verbally issued on January 12, 1998 that requested you to begin ordering materials and preparing the design. Deliveries of the 1<sup>st</sup> Article bearings are critical to the LIGO program.

This procurement is in support of the LIGO Project, collaboration between the California Institute of Technology (Caltech) and Massachusetts Institute of Technology (MIT), managed by Caltech and sponsored by the National Science Foundation (NSF). LIGO is intended for detection and study of gravitational waves from astrophysical sources.

This procurement is structured as a two phased effort, namely the 1<sup>st</sup> Article Phase (the first 20 Air Bearings) and a Production Phase (88 Air Bearings with an option for 2 spares). HYTEC is currently responsible for procurement of the 1<sup>st</sup> Article hardware and Caltech will be responsible for the procurement of the production hardware. This is reflected in LIGO-PO-1112 with a request to purchase the first 20 air bearing, 1<sup>st</sup> Article Phase, and a priced option (Page 2) for the procurement of the remaining 90 air bearings by Caltech.

Specialty Components shall perform acceptance testing of each air bearing prior to being delivered to the appropriate facility. It shall be required that the acceptance testing of the first 1<sup>st</sup> Article bearing must be witnessed and signed off by a HYTEC or Caltech representative to ensure that the air bearing design meets or exceeds the requirements outlined in LIGO-TS-AB (Attached), prior to completing the 1<sup>st</sup> Article Phase. Please notify the appropriate HYTEC representative two weeks prior to the actual testing date. This will allow ample time to make the appropriate travel arrangements and minimize the impact on the air bearing schedule.

Delivery Schedule:

Time is of the essence on this procurement. The first bearing should be delivered 16 weeks ARO. Since you have been issued a P.O. number, this should in effect be 16 weeks from 1/14/98, which would be 5/6/98. The first 4 bearings will in turn be delivered to HYTEC on or before 5/13/98. The remaining 16 bearings of the 1<sup>st</sup> Article Phase shall be delivered to the Hanford Observatory during the next 6 weeks, shipped in lots of 4. The 1<sup>st</sup> Article Phase is expected to be complete on or before 6/17/98. Please note that we anticipate a 2-month hiatus between the shipment of the 1<sup>st</sup> Article and the beginning of the production article phase. This will allow us time to evaluate the hardware and to incorporate any changes into the production hardware.

Note: Delivery of the production phase hardware will begin within 1 month after notification, verbal or written, from Caltech to begin the production phase. Partial shipments will be required to meet facility deadlines. The LIGO facility will require that a minimum of 20 bearings be shipped each month in order to meet schedule deadlines. However, all of the remaining bearings (88 total) are expected to arrive at the appropriate LIGO facility by the end of December 1998. The two remaining spare bearings shall be shipped anytime during this time period.

Erik Swensen will act as the technical point of contact for this order. If you have any questions, please don't hesitate to call me at (505) 661-3000. You may also call Erik Swensen at (505) 661-4021.

Sincerely,



Tim Thompson  
Vice President

Attachments:

- LIGO-PO-1112
- Drawing #D972106
- LIGO Seismic Isolation System Air Bearing Specification - LIGO-TS-AB

CC:

Mike Fine	LIGO
Erik Swensen	HYTEC
Marilyn Johnson	HYTEC





DESIGN ENGINEERING  
 ADVANCED COMPOSITE APPLICATIONS  
 ULTRA-STABLE PLATFORMS  
 110 EASTGATE DR., STE. 100  
 LOS ALAMOS, NM 87544  
 PHONE 505 661-3000  
 FAX 505 662-5179  
 WWW.HYTECINC.COM

# PURCHASE ORDER

P.O. NUMBER: LIGO-PO-1112

The PO number shown above must appear on all related correspondence, shipping papers, and invoices

To: Specialty Components  
 27A Village Lane  
 Wallingford, CT 06492  
 Phone: (203) 284-9112  
 Fax: (203) 265-9804

Ship to: See Notes Below

Your Reference:

P.O. DATE	REQUISITIONER	SHIP VIA	F.O.B. POINT	TERMS
January 19, 1998	Erik A. Swensen	Fastest Ground	To LIGO Facilities	Net 30

QTY	UNIT	DESCRIPTION	UNIT PRICE	TOTAL
16	each	HAM Air Bearing <sup>2,6</sup> - 1 <sup>st</sup> Article (Includes the Following Parts)	\$8,270.00	\$132,320.00
		a. Spherical Air Bearing - Drawing #D972106		
		b. Linear Air Bearing - Drawing #D972106		
		c. Air Bearing Base - Drawing #D972106		
4	each	BSC Air Bearing <sup>1,8</sup> - 1 <sup>st</sup> Article	8,270.00	33,080.00
20	each	Packaging and Shipping <sup>7</sup>	0	0

SUBTOTAL	\$165,400.00
(TAX EXEMPTION CERTIFICATE WILL BE PROVIDED) SALES TAX	0
(See Above) SHIPPING & HANDLING	0
OTHER	0
TOTAL	\$165,400.00

Note 1: Deliver to: HYTEC Inc.  
 110 Eastgate Dr, Suite 100  
 Los Alamos, NM 87544  
 Ph: (505) 661-4021  
 Fax: (505) 662-5179

Note 2: Deliver to: LIGO Hanford Observatory  
 Route 10, Mile Marker #2  
 Richland, WA 99352  
 C/o Dr. Fred Raab/Jill Berry  
 Ph: (509) 372-2325

Note 6: It is critical that Specialty Components adheres to the schedule outlined in their quote dated December 12, 1997.

Note 7: The Packaging and Shipping costs have been included in the purchase price as part of the bearing costs. The actual costs are: Packaging - \$70 and Shipping - \$120.

Note 8: The air bearings shall meet or exceed the requirements outlined in the technical specification - "LIGO Seismic Isolation System Air Bearing Specification", LIGO-TS-AB.

- Please send two copies of your invoice.
- Enter this order in accordance with the prices, terms, delivery method, and specifications listed above.
- Please notify us immediately if you are unable to ship as specified.
- Send all correspondence to:  
 HYTEC Inc.  
 110 Eastgate Dr, Suite 100, Los Alamos, NM 87544  
 (505) 661-3000; Fax (505) 662-5179

Authorized by: *John Thompson* Date: January 28, 1998

# Priced Option



DESIGN ENGINEERING  
ADVANCED COMPOSITE APPLICATIONS  
ULTRA-STABLE PLATFORMS

110 EASTGATE DR., STE. 100  
LOS ALAMOS, NM 87544

PHONE 505 661-3000  
FAX 505 662-5179  
WWW.HYTECINC.COM

## PURCHASE ORDER

P.O. NUMBER: LIGO-FD-1112

(Part 2)

The PO number shown above must appear on all related correspondence, shipping papers, and invoices

To: Specialty Components  
27A Village Lane  
Wallingford, CT 06492  
Phone: (203) 284-9112  
Fax: (203) 265-9804

Ship to: See Notes Below

### Your Reference:

P.O. DATE	REQUISITIONER	SHIP VIA	F.O.B. POINT	TERMS
January 28, 1998	Erik A. Swensen	Fastest Ground	To LIGO Facilities	Net 30

QTY	UNIT	DESCRIPTION	UNIT PRICE	TOTAL
16	each	HAM Air Bearing <sup>2,8</sup> - Production Phase (Includes the Following Parts)	\$3,843.00	\$61,488.00
		a. Spherical Air Bearing - Drawing #D972106		
		b. Linear Air Bearing - Drawing #D972106		
		c. Air Bearing Base - Drawing #D972106		
16	each	HAM Air Bearing <sup>3,8</sup> - Production Phase	3,843.00	61,488.00
36	each	BSC Air Bearing <sup>2,8</sup> - Production Phase	3,843.00	138,348.00
20	each	BSC Air Bearing <sup>3,8</sup> - Production Phase	3,843.00	76,860.00
2	each	Spare BSC/HAM Air Bearing <sup>4,8</sup>	3,843.00	7,686.00
90	each	Packaging and Shipping <sup>7</sup>	0	0
SUBTOTAL				\$345,870.00
(TAX EXEMPTION CERTIFICATE WILL BE PROVIDED) SALES TAX				0
(See Above) SHIPPING & HANDLING				0
OTHER				0
TOTAL				\$345,870.00

Note 2: Deliver to: LIGO Hanford Observatory  
Route 10, Mile Marker #2  
Richland, WA 99352  
C/o Dr. Fred Raab/Jill Berry  
Ph: (509) 372-2325

Note 3: Deliver to: LIGO Livingston Observatory  
P.O. Box 940  
Livingston, LA 70754  
C/o Dr. Mark Coles/Bonnie Wascom  
Ph: (504) 686-2709

Note 4: The LIGO Collaboration shall have the option to purchase these two spares at the purchase price provided above, anytime during the contract period.

Note 5: This priced option shall be transferable to the California Institute of Technology after the 1<sup>st</sup> Article Phase of this Purchase Order without modifications to the agreed upon pricing information provided above.

Note 6: It is critical that Specialty Components adheres to the schedule outlined in their quote dated December 12, 1997.

Note 7: The Packaging and Shipping costs have been included in the purchase price as part of the bearing costs. The actual costs are: Packaging - \$70 and Shipping - \$120.

Note 8: The air bearings shall meet or exceed the requirements outlined in the technical specification - "LIGO Seismic Isolation System Air Bearing Specification". LIGO-TS-AB.

### 1. PACKING AND SHIPPING

Each container and accompanying packing lists must show this Order number. The Order price includes all charges for packaging, packing and shipping, and no additional charge for such will be paid unless authorized by Buyer. All goods shall be packaged to assure safe delivery, to meet the carrier's requirements, and to obtain the most favorable transportation and insurance rates. Routing, shipping and delivery instructions shown on the face of this Order must be followed, and Seller shall be liable for any excess charges or damage resulting from deviation therefrom. Seller shall not declare excess value on shipments unless authorized by Buyer or done for his own account.

### 2. VARIATION IN QUANTITY - EXTRAS

No variation in quantity will be accepted unless caused by conditions of loading, shipping, packing or allowances in manufacturing process. No payment for extras will be made unless such extras and the price thereof are authorized in writing by the Buyer.

### 3. INSPECTION

- a) All goods (which term includes without limitation raw materials, components, intermediate assemblies, and end products, identified to this Order) to be delivered hereunder, may be inspected by Buyer, or Buyer's authorized representative, at any reasonable time and place, including Seller's plant, and in any reasonable manner, before payment or acceptance and without regard to the manner of shipment or any shipping or price terms contained in this Order. All goods tendered are subject to count and inspection for a reasonable period of time after receipt. Payment shall not terminate Buyer's right to inspect, and no inspection shall be deemed to constitute acceptance. Non-conforming goods may be rejected at any time prior to final acceptance, and without limiting any other rights Buyer may have. Seller shall be liable for all expenses of inspection, re-packing and packaging, handling, shipping and storing, attributable to such non-conforming goods.
- b) All services (which term includes without limitation services performed, material furnished or utilized in the performance of the services, and workmanship) may be inspected by Buyer, or Buyer's authorized representatives at any reasonable time and place, including Seller's plant and in any reasonable manner, before payment or acceptance. If any services do not conform with the requirements of this order, or do not conform with generally recognized standards of the trade applicable to such services, the Buyer may require the Seller to perform the services again in conformity with such requirements or standards at no cost to the Buyer. When the non-conforming services are of such a nature that the defect cannot be corrected by re-performance, the Buyer may (i) demand adequate assurance of due performance as to future services, and (ii) reduce the Order price to reflect the reduced value of the services performed. If the Seller fails to perform the services again or to provide adequate assurances, the Buyer may cancel this Order forthwith.

### 4. PAYMENTS

The Seller will be paid, upon the submission of a proper invoice, the prices stipulated for goods delivered and accepted or services rendered and accepted, less deductions and discounts, if any, as herein provided. Unless otherwise specified, payment will be made for any portion of the work delivered or rendered and accepted for which a separate or unit price is stated in the Order. Discount periods shall be computed from the date a proper invoice is received by the Buyer, or from the date of delivery, whichever is later. For the purpose of earning any discount, payment shall be deemed made on the date Buyer's check is mailed.

### 5. TAXES

Except as may be otherwise provided in this Order, the Order price includes all applicable Federal, State and local taxes and duties. With respect to transactions for which the Buyer may be exempt from any tax or duty, the Buyer will provide, upon request, evidence to support its claim to such exemption.

### 6. WARRANTY

Seller warrants that all goods furnished hereunder, whether manufactured by Seller or by others, are free from defects in materials and workmanship, conform to applicable specifications, drawings, samples, and descriptions, and if of Seller's design, are free from design defects. Seller warrants that the goods may be shipped, sold, and used in a customary manner without violation of any law, ordinance, rule, or regulation of any government or administrative body. Seller agrees to assign to Buyer, at Buyer's request, all rights Seller may have against manufacturers or distributors for breach of warranties relating to the goods and Seller agrees to execute any documents of assignment that Buyer may request. Notwithstanding any usage of trade or course of dealing between the parties, Seller's liability for breach of any warranty, express or implied, shall include: (i) replacement or repair of defective goods or, at Buyer's option, refund of the purchase price, and (ii) any general, special, or consequential damages proximately caused by the breach of warranty. There are no exclusions, limitations, or disclaimers of warranty other than those expressly recited in this Order.

### 7. CHANGES

Buyer may at any time by written notice, and without notice to sureties or designees, make changes within the general scope of this Order, in any one or more of the following: (i) drawings, designs, or specifications, where the items are to be specially manufactured for the Buyer in accordance herewith, (ii) method of shipment or packing, (iii) the time of delivery, and (iv) the place of

delivery. If any such change causes an increase or decrease in the cost of, or the time required for performance of this Order, an equitable adjustment shall be made in the price, or delivery schedule, or both, and the Order modified in writing accordingly. Any claim of the Seller for adjustment under this clause must be received by the Buyer within thirty (30) days after receipt of the notification of change, or such longer period as may be authorized by the Buyer. Nothing in this clause shall excuse the Seller from proceeding with performance of work as changed.

### 8. ASSIGNMENT OF RIGHTS - DELEGATION OF DUTIES

- a) The Seller may assign monies due or to become due under this Order, subject to the following conditions:
- (1) Any assignment, or subsequent reassignment, shall cover all amounts payable under this Order and not paid as of (i) the effective date of assignment, or (ii) the date Buyer 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 Buyer.
  - (4) No assignment may be made which includes, either specifically or by implication any delegation of Seller's duty to perform the services or provide the items required by this Order without the prior written consent of Buyer in accordance with paragraph (b) below.
- b) The Seller agrees to delegate no part of the duties required of Seller by this Order without the prior written consent of Buyer, provided however, that nothing contained herein shall be deemed to prohibit Seller from placing subcontracts subject to any requirement herein for approval of subcontracts, and where applicable, assigning appropriate terms and conditions of this order to the subcontractor.

### 9. TERMINATION - CANCELLATION

- a) Buyer may terminate this Order, either in whole or in part, by the giving of notice to Seller that the Order will be so terminated on a stated date. Such notice shall:
- (1) be in writing, transmitted by telegraphic means or certified mail with return receipt requested.
  - (2) state that the termination is either total or partial, and if partial, specify what items or services are terminated;
  - (3) state the date such termination is effective, which date shall be no sooner than five (5) days after the notice is received.
- In the event of a total termination, Seller shall be paid in accordance with the terms of this Order for all items delivered and accepted and all services performed and accepted prior to the effective date of termination.
- b) TIME IS OF THE ESSENCE IN THE PERFORMANCE OF THIS ORDER. If for any reason (including without limitation any failure of the Seller to undertake performance in a timely manner, or to make satisfactory progress in the performance of work), the Buyer has reasonable grounds for insecurity with respect to Seller's performance, the Buyer may demand adequate assurance of due performance. If such assurance is not provided within the time specified in such demand, or if no time is specified, within ten days after the Seller receives the demand, the Buyer may cancel this Order forthwith.

### 10. INDEMNIFICATION AND INSURANCE

In the event the Seller, its employees, agents, or subcontractors, either premises occupied by or under the control of the Buyer in the performance of this Order, the Seller agrees that it will be responsible to, and indemnify and hold harmless, the Buyer, its trustees, officers, and employees, from any loss, cost, damage, expense or liability by reason of property damages or personal injury of whatsoever kind or character, arising out of, as a result of, or in connection with such performance occasioned by the negligence or other fault, by act or omission, of the Seller, its agents, employees, or subcontractors; and the Seller agrees that it and its subcontractors will maintain public liability and property damage insurance in reasonable limits covering the obligations set forth above, and will maintain work's compensation coverage (either by insurance or, if qualified pursuant to law, through a self-insurance program) covering all employees performing this Order on premises occupied by or under the control of the Buyer.

### 11. DRUG-FREE WORKPLACE

Seller agrees to inform all Seller personnel, prior to their first entrance upon Buyer's premises, that Buyer's policy is to fully comply with the requirements of the Drug-Free Workplace Act and that Seller personnel are required to comply with Buyer's policy of maintaining a drug-free workplace.

### 12. LABOR DISPUTES

Seller shall give prompt notice to Buyer of any or potential labor dispute which delays or may delay timely performance of this Order.

### 13. ADVERTISING OR PUBLICITY

Seller shall not use the Buyer's name in any advertising or publicity releases, or publicize the fact that Buyer has placed this order with Seller, without the prior written consent of Buyer.

14. This order shall be deemed to be a contract made in the State of New Mexico, and shall be construed in accordance with the New Mexico Uniform Commercial Code in existence on the date of this Order.


# LIGO Seismic Isolation System Air Bearing Specification

October 24, 1997

## Abstract

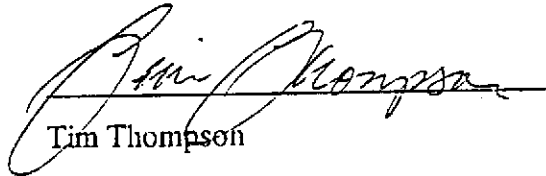
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PREPARED BY:



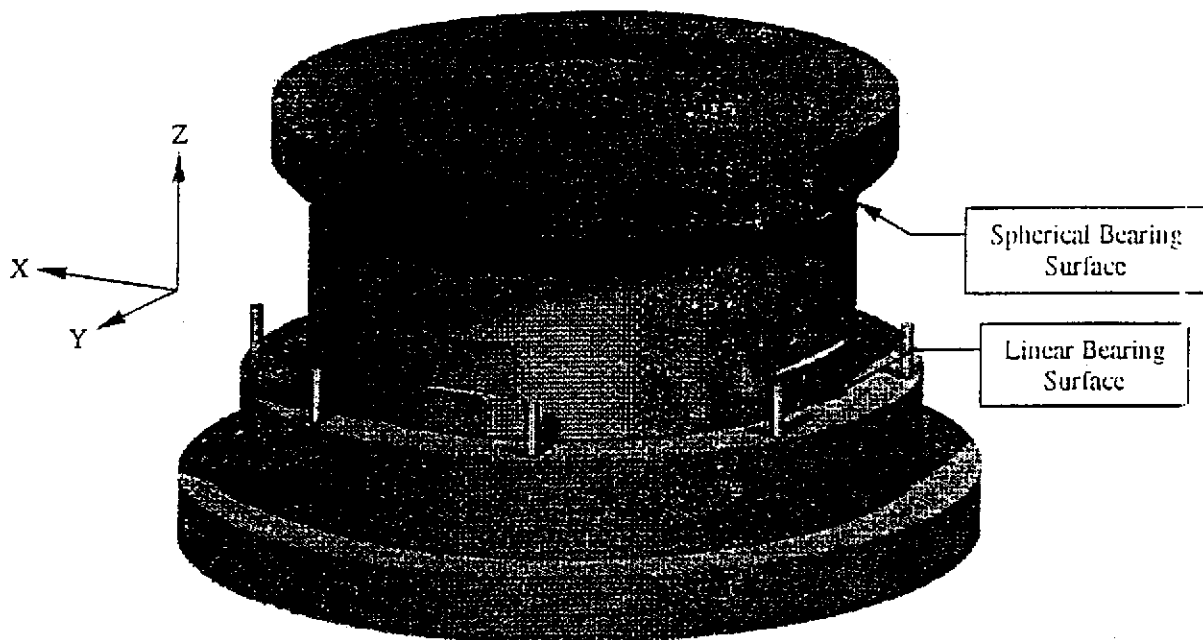
Erik Swensen

PROJECT MANAGER



Tim Thompson

## DESIGN REQUIREMENTS FOR THE LIGO AIR BEARINGS



### 1. Loads (total for each Air Bearing)

X- Direction (along beam path)

Bellows - 106 lb., 4 bellows 14.78 mm excursion

Y- Direction\*

Bellows - 275 lb., 4 bellows 16.53 mm excursion

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Bellows - 233 lb., 4 bellows 12.65 mm excursion

Applied - BSC weight = ~ 3,000 lb. (weight supported by the air bearing)

- HAM weight = ~ 1,500 lb.

\*Note: The combined motion in the Y-Z plane is 20.81 mm excursion.

### 2. Motion Capability:

Translations:

X- Direction = +/- 22.23 mm (0.875 in)

Y- Direction = +/- 22.23 mm (0.875 in)

Z- Direction = None

Rotations:

X-X = +/- 2.5 Degrees

Y-Y = +/- 2.5 Degrees

Z-Z = +/- 2.5 Degrees

\*Note: The Air Bearing motion capabilities are greater than the excursions given in #1 above to allow ample motion for initial positioning. Initial positioning is required to account for tolerance, loads and other external factors.

## 3. Motion:

Velocity:

X, Y, Z = 0.01 cm/s (*maximum*)

Acceleration:

X, Y, Z = 0.001 cm/ s<sup>2</sup> (*maximum*)

4. Duty Cycle = &lt; 1%

5. Life expectancy = 20 years

## 6. Nominal Operating Environment:

Temperature = 22 +/- 2 °C

Humidity = 20 - 70 %

Contaminants (cleanliness) = clean environment

Radiation = none

Earthquakes = Designed to withstand a 0.4 g static equivalent lateral and vertical load (total weight) without catastrophic failure - the part must remain structurally sound. Applying a 0.4 g load in all three directions simultaneously can be conservative, therefore the 100-40-40 rule\* can be used to account for phase differences between the X, Y and Z motions.

\*Note: The 100-40-40 rule is used by civil engineers to account for phase differences between the three axes. The rule is applied to the seismic problem by using 100% of the static equivalent load in one direction and 40% of the static equivalent load in the two orthogonal directions. The worst case is dependent on the problem.

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Pneumatic = Air supplied by LIGO and air quality Requirements supplied by vendor.

Utility = All utilities/cabling will not create or result in loads greater than 10 lbs.

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Source = Supplied by HYTEC and LIGO.

Quality = Requirements will be supplied by the air bearing manufacturer.

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## 9. Smoothness:

The system must provide smooth/stable rigid body motions during air bearing motions. Flutter or an instability of any sort is not permissible at any time.

Air Bearing Pressurized:

Stiction = none

Friction = none

Air Bearing Unpressurized:

Creak\* = none

Friction = frictional forces will be greater than operational loads

\*Note: *Creak is a micro-burst of energy released into the system.*

10. System Stiffness:

The overall stiffness of the air bearing components must meet stack attenuation goals when unpressurized, > 25 Hz.

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The air bearing will incorporate mechanical safety stops to prevent any damage to the system caused by an errant actuator system and earthquake type movements. The stops will be configured to allow for the full range of mobility.

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Materials selected for construction of the bearing must meet the requirements shown above. In particular the infrequent use of the hardware will not effect the expected performance.