



Statement of Work C1203960-v4

1.0 Scope (LIGO sub-system)

This SOW is for the procurement of the custom manufactured in-vacuum components of the PCAL Periscope Frame.

2.0 Document Access

Many supplemental documents and specifications are incorporated into and made a part this Statement of Work. Click on the document links to access these documents from the LIGO Document Control Center (DCC) or go on line to the LIGO Public DCC at <https://dcc.ligo.org/> to access the DCC#. Component and assembly drawings and models are available in Solidworks 2012 and will be provided.

3.0 Commercial Terms and Applicable LIGO Specifications:

Note: The documents listed below are invoked for this Statement of Work and comprise additional requirements which are integral to this Statement of Work.

- [LIGO-C080185-v1](#) LIGO Commercial Items or Services Contract General Provisions
- [LIGO-Q0900001-v5](#) Advanced LIGO Supplier Quality Requirements
- [LIGO-Q1100003-v1](#) Acceptable Quality Level (AQL) for Inspection of LIGO Components
- [LIGO-E0900364-v8](#) Metal Components for use in the Advanced LIGO Vacuum System

4.0 Quality System:

Referring to the above referenced LIGO Specification Q0900001, Suppliers should include a copy of their current ISO 9001, AS9100, or TS16949 certification in their bid package. Suppliers lacking current certification must send a copy of their Quality Manual with their bid package.

5.0 Parts/Assemblies to be manufactured, Quantity Required, and Inspection requirements:

Note: refer to Section 8.0 for delivery schedule and location

Drawing #	Part Description	Total Qty:	AQL number (Inspection Frequency)
D1200993-1-v4	ALIGO, PCAL PERISCOPE FRAME (ETMY ASSEMBLY)	3	1.0 for all component parts
D1200993-2-v4	ALIGO, PCAL PERISCOPE FRAME (ETMX ASSEMBLY)	3	1.0 for all component parts

Note: refer to [LIGO-Q1100003-v1](#) for the AQL table.

6.0 Manufacturing:

6.1 Requirements:

- **THE SUPPLIER HAS THE RESPONSIBILITY TO MANUFACTURE EACH COMPONENT SUCH THAT EACH ASSEMBLY WILL BOLT TOGETHER WITHOUT INTERFERENCE. (Minor alignment with hand pressure is acceptable) THIS REQUIREMENT SUPERSEDES THE DIMENSIONAL AND GD&T TOLERANCES ON THE COMPONENT DRAWINGS. LIGO reserves the right to witness a fit check of each assembly at the supplier's facility before shipping.**
- Suppliers must refer to the LIGO Specifications referenced in Section 3 for additional, and in some cases, non-industry standard requirements.
- Please note, per the drawings and LIGO spec. E0900364, both sides of D1200726 and D1200727 must be machined to a surface finish of 63 microinch Ra or better.
- Please note, per LIGO spec. E0900364, the surface finish of the cutouts of D1200725, D1200726, D1200727, and D1102354 must be a machined finish, not waterjet or laser. Those methods may be used to rough out the holes but the final finish must be machined.
- Before rolling D1102354, the rollers must be cleaned to remove grease and oils and the surfaces of D1102354 must be protected by paper or other suitable material to prevent the embedding of foreign particles, grease and oil into the surface.
- Please note that all non-STI threads are to be $+0.005''$ (GH11 taps). $+0.005$ plug gages are required for inspection of the threaded holes.

6.2 Sub-Contracted Work:

- LIGO expects that at least 2/3 (by dollar value) of the contracted work be performed by the Supplier named on the Purchase Order. The Supplier shall be responsible for all sub-contracted work.

6.3 Precedence:

All parts are to be manufactured to the referenced 2D drawings. If there are any discrepancies between the drawings and the CAD models, the drawings take precedence. However, please also contact a LIGO representative to resolve any discrepancies or uncertainties in the documentation or instructions.

6.4 Special Instructions:

Per Flag Note 5 on the drawings, all component parts must be marked with the component part number and serial number. A spreadsheet should be provided cross-referencing the component serial numbers which make up each unique assembly serial number (Refer to the first bullet point in 6.1 above).

6.5 Exclusions:

- Supplier is NOT responsible for the procurement of fasteners (Items 6 and 7 in the BOM of D1200993-1 and D1200993-2).
- Supplier is NOT responsible for the procurement and installation of Heli-Coils. DO NOT INSTALL HELI-COILS.

7.0 End Item Data Package:

Before delivery of the parts, the Supplier shall provide the following data, as a minimum:

- Any as-built modifications (with approval of the LIGO Contracting Officer) as mark-ups to the drawings
- Material certifications
- Electro-polish certifications, if applicable
- Inspection reports of all dimensional features for the number of parts specified per the AQL number and referenced in the AQL table [LIGO-Q1100003-v1](#) and any other inspection requirements detailed in Section 5 of this SOW
- Certificate of compliance for each part number stating conformance to contract and drawing requirements
- Serial number spreadsheet detailed in section 6.4.

8.0 Delivery Requirements:

8.1 Shipping Containers and Packaging:

- Crating and shipping charges will be handled separately from this SOW and subsequent PO.
- The wood crates and inner packing must be sufficiently robust to protect the components from damage from the transportation environment (weather, handling, accidents, etc.). Mating edges of parts should be especially protected from damage during shipping. The crates should be closed with screws or latches (not nails) to facilitate reusing the crates.
- The part and serial number of the assembly(ies) must be written on the outside of the crates.

8.2 Shipping Destination(s):

The deliveries are FOB the vendor's manufacturing facility.

LIGO Hanford Observatory (LHO)

Attn: Rick Savage
127124 North Route 10
Richland, WA 99354

8.3 Delivery Schedule:

- First assembly: 6-8 weeks ARO. LIGO requests that manufacturing of subsequent assemblies not start until after the successful fit check and acceptance of the first assembly.
- Subsequent assemblies: one assembly every 2 weeks after acceptance of the first assembly.
- If unable to meet the requested delivery schedule, please state the best delivery.



LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY (LIGO)

COMMERCIAL ITEMS OR SERVICES CONTRACT

GENERAL PROVISIONS CALIFORNIA INSTITUTE OF TECHNOLOGY "INSTITUTE"

GENERAL PROVISION TITLE

1. Offer and Contract
2. Time of Delivery
3. Improper Delivery
4. Assignment
5. Authority of Institute Representative and Required Notices
6. Changes
7. Force Majeure
8. Existing Commercial Computer Software – Licensing
9. Export Licenses
10. Disputes and Governing Law
11. Inspection and Acceptance
12. Insurance
13. Indemnification
14. New Material
15. Order of Precedence
16. Payment
17. Use of Name
18. Title and Risk of Loss
19. Government Title to Property Purchased or Fabricated with Contract Funds
20. Taxes
21. Termination
22. Warranty
23. Audit and Records
24. Site Visits
25. Nondiscrimination
26. Equal Employment Opportunity
27. Anti-Kickback
28. Clean Air Act and the Federal Water Pollution Contract Act
29. Debarment and Suspension
30. Byrd Anti-Lobbying Amendment
31. Copeland "Anti-Kickback" Act
32. Davis Bacon Act
33. Surety Bonds
34. Rights to Inventions – 37 CFR part 401
35. Patent Rights - Bayh-Dole Act [35 U.S.C. 200 et seq.]

(See Page 2 for Individual General Provision Applicability)

APPLICABILITY OF INDIVIDUAL GENERAL PROVISIONS

APPLICABLE TO ALL TRANSACTIONS IN THE UNITED STATES

The term *United States* includes the several States of the United States, the District of Columbia, the Commonwealth of Puerto Rico, the Virgin Islands, American Samoa, Guam, Wake Island, the Canal Zone, and all other territories and possessions of the United States, and the term *States* includes any one of the forgoing.

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| 1. Offer and Contract | 16. Payment |
| 2. Time of Delivery | 17. Use of Name |
| 3. Improper Delivery | 18. Title and Risk of Loss |
| 4. Assignment | 19. Government Title to Property Purchased or Fabricated with Contract Funds |
| 5. Authority of Institute Representatives and Required Notices | 20. Taxes |
| 6. Changes | 21. Termination |
| 7. Force Majeure | 22. Warranty |
| 8. Existing Commercial Computer Software – Licensing | 23. Audit and Records |
| 10. Disputes and Governing Law | 24. Site Visits |
| 11. Inspection and Acceptance | 25. Nondiscrimination |
| 13. Indemnification | 26. Equal Employment Opportunity |
| 14. New Material | 28. Clean Air Act and the Federal Water Pollution Control Act |
| 15. Order of Precedence | |

TAXES

20. The applicability of State sales tax is addressed on the face of the Purchase Order
[For imports] Value Added Tax (VAT) is addressed on the face of the Purchase Order

APPLICABLE IN SPECIAL CIRCUMSTANCES ACCORDING TO THEIR TERMS

9. **[For exports]** Compliance with Export Regulations
12. **[Suppliers Working on Site]** Insurance
27. **[For Contracts in excess of \$100,000]** Anti-Kickback Enforcement Act of 1986
29. **[For Contracts in excess of \$25,000]** Debarment and Suspension
30. **[For Contracts of \$100,000 or More]** Byrd Anti-Lobbying Amendment
31. **[For designated Construction/Repair Contracts in excess of \$2,000]** Copeland “Anti-Kickback” Act
32. **[For designated Construction/Repair Contracts in excess of \$2,000]** Davis-Bacon Act
33. **[For designated Construction/Repair Contracts in excess of \$500,000]** Surety Bonds
34. **[For designated Experimental, Development or Research Work]** Rights to Inventions- 37 CFR part 401
35. **[For designated Experimental, Development or Research Work]** Patent Rights - Bayh-Dole Act [35 U.S.C. 200 et seq.]

APPLICABLE TO ALL TRANSACTIONS IN THE UNITED STATES

These provisions **do not apply to foreign suppliers** performing outside the United States.

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|----------------------------------|---|
| 25. Nondiscrimination | 32. Clean Air Act and the Federal Water Pollution Control Act |
| 27. Equal Employment Opportunity | |

This agreement is a subcontract pursuant to an NSF Cooperative Agreement (CA) between the NSF and the Institute, [PHY-0328418](#).

1. **OFFER AND CONTRACT** The following terms, together with such terms, plans, specifications or other documents as attached or incorporated by reference as set forth on the face of this purchase order, constitute the offer of the Institute to Supplier and shall, when accepted, constitute the entire agreement ("Contract") between the Institute and Supplier. Institute hereby gives notice of its objection to any different or additional terms. This Contract is valid only as written. If price, terms, shipping date or other expressed condition of this Contract are not acceptable, the Institute must be notified and any variation must be accepted in writing prior to shipment or delivery. This Contract shall be deemed to have been accepted (a) in the absence of written notification of non-acceptance by the Supplier within a reasonable time, or (b) upon timely delivery of the products identified to the shipping address specified on the face of the order.
2. **TIME OF DELIVERY** Time is of the essence in this Contract. If delivery dates cannot be met, Supplier must notify the Institute immediately. Such notification shall not, however, constitute a change to the terms of this Contract except as the order may be modified in writing by the Institute.
3. **IMPROPER DELIVERY** In addition to other remedies provided by law, the Institute reserves the right to refuse any goods or services and to cancel all or any part of this Contract if Supplier fails to deliver all or any part of the goods or services in accordance with the terms and conditions of this Contract. Acceptance of any part of this order shall not bind the Institute to accept any future shipments nor deprive it of the right to return goods already accepted.
4. **ASSIGNMENT** The Supplier shall have no right to assign this Contract or any benefits from this Contract without prior written consent of the Institute.
5. **AUTHORITY OF INSTITUTE REPRESENTATIVES AND REQUIRED NOTICES; FACSIMILE AND ELECTRONIC SIGNATURES ACCEPTABLE**
 - (a) No order, notice, or direction received by the Supplier and issued pursuant to this Contract shall be binding upon either the Supplier or the Institute, unless issued or ratified in writing by the Institute Purchasing Agent, the Director of Procurement Services, or by representatives designated in writing by either of them.
 - (b) The parties agree that facsimile (fax) or electronic signature copies of contract documents are just as binding as originally-executed documents.
6. **CHANGES** The Institute may at any time, by a written order to the Supplier, make changes within

the general scope of this Contract in any one or more of the following: (a) drawings, designs, or specifications; (b) method of shipment or packing; and (c) time or place of delivery. If any such change causes an increase or decrease in the cost of, or the time required for, the performance of any part of the work under this order, an equitable adjustment may be made in the order price or delivery schedule or both, and the order shall be modified in writing accordingly. Any claim by Supplier for adjustment under this Article must be asserted within 30 days from the date of receipt by Supplier of the notification of change; provided, however, that the Institute, if it decides that the facts justify such action, may receive and act upon any such claim asserted at any time prior to final payment under this purchase order. Nothing in this clause shall excuse Supplier from proceeding with this order as changed.

7. **FORCE MAJEURE** Each party shall not be liable for damages arising out of either its failure to deliver or any delay in delivery caused by strikes, lockouts, fires, war, or acts of God. The Supplier shall notify the Institute in writing as soon as it is reasonably possible after the commencement of any event triggering a delayed delivery or inability to deliver.
8. **EXISTING COMMERCIAL COMPUTER SOFTWARE – LICENSING** (This Article is applicable to the acquisition of any existing commercial computer software under this Contract.)
 - a) Where the Supplier proposes its standard commercial software license, only those applicable portions that comply with the provisions of this Contract are incorporated into and made a part of this Contract.
 - (b) If the Supplier does not propose its standard commercial software license until after this Contract has been issued, or at or after the time the computer software is delivered, such license shall nevertheless be deemed incorporated into and made a part of this Contract under the same terms and conditions as in paragraph (a) above. For purposes of receiving updates, correction notices, consultation, and similar activities on the computer software, any authorized user may acknowledge receipt of a registration form or card and return it directly to the Supplier; however, such signing shall not add to or alter any of the terms and conditions of this Contract.
 - (c) If the specified computer software is shipped or delivered to the Institute, it shall be understood that the Supplier has unconditionally accepted the terms and conditions set forth in this Article, and that the terms and conditions of this Contract (including the incorporated license) constitute the entire agreement between the parties concerning rights in the computer software.
 - (d) Supplier understands and agrees that the computer software may be: (1)

Used, or copied for use, in or with any computer owned or leased by, or on behalf of the Institute provided that the software is not used, nor copied for use, in or with more than one computer simultaneously, unless otherwise permitted; (2) Reproduced for safekeeping (archives) or backup purposes; (3) Modified, adapted, or combined with other computer software, provided that the modified, combined, or adapted portions of the derivative software incorporating restricted computer software shall be subject to the same restricted rights; and (4) Disclosed and reproduced for use by Institute designees in accordance with this Article. (e) Supplier agrees that the software may be used by the Institute in support and furtherance of any of its obligations to the US Government or other funding organization. (f) Supplier warrants that it has the right to sell, license, or transfer the license for the software furnished to the Institute under this Contract in accordance with the terms of this Contract.

9. **EXPORT LICENSES** The Supplier shall comply with all U.S. export control laws and regulations, including the International Traffic in Arms Regulations (ITAR), 22 CFR Parts 120 through 130, and the Export Administration Regulations (EAR), 15 CFR Parts 730 through 799, in the performance of this Contract. In the absence of available license exemptions/exceptions, the Supplier shall be responsible for obtaining the appropriate licenses or other approvals, if required, for exports of hardware, technical data, and software, or for the provision of technical assistance.

10. **DISPUTES AND GOVERNING LAW** (a) Any dispute or claim arising out of, in connection with, or relating to this Contract shall be submitted for resolution to ascending levels of management of the parties. If the dispute cannot be resolved after such negotiations, either party may pursue any appropriate legal recourse not inconsistent with the provisions of this Contract. (b) Pending any decision, appeal or judgment or the settlement of any dispute, Supplier agrees to proceed diligently with the performance of the requirements of this Contract. (c) This Contract shall be construed and enforced in accordance with the laws of the State of California. Disputes will be adjudicated in Los Angeles, California.

11. **INSPECTION AND ACCEPTANCE** The Institute shall have the right to inspect the work and activities of the Supplier under this Contract in such manner and at all reasonable times as are deemed appropriate. Final inspection shall be at the Institute's premises unless otherwise agreed in writing. The Institute, at its option, may reject any non-conforming items and (i) return such non-conforming items to the Supplier at the Supplier's

risk and expense for credit to the Institute at the full invoice price plus all transportation and other related costs, or (ii) hold them for disposition in accordance with the Supplier's instructions at the Supplier's expense, including storage and handling. If the Institute rejects items as nonconforming, the quantities under this Contract will automatically be reduced unless the Institute otherwise notifies the Supplier. The Supplier will not replace quantities so reduced without written instruction by the Institute. Payment for nonconforming goods shall not constitute an acceptance thereof, limit, or impair the Institute's right to assert any legal or equitable remedy, or relieve the Supplier's responsibility for latent defects. The Institute may also opt for a refund of the amount paid under this Contract.

12. **INSURANCE** (This Article is applicable when the Supplier will be entering Institute-controlled premises.) (a) The Supplier shall, at its own expense, provide and maintain during the entire performance period of this Contract at least the following types and minimum amounts of insurance with the Institute named as an additional insured in policies for comprehensive liability insurance with a licensed carrier authorized to do business in the State of California: (1) Workers' Compensation and Employer's Liability Insurance, as required by applicable Federal and State workers' compensation and occupational disease statutes. The Employer's Liability coverage shall be at least \$100,000, except in states with exclusive or monopolistic funds that do not permit worker's compensation to be written by private carriers. (2) Comprehensive Liability Insurance, including automobiles (owned, non-owned, or leased), completed operations, products, and contractual liability, for a combined single limit of not less than \$1,000,000 for all deaths, injuries, and property damage arising from one accident or occurrence. (b) Insurance Certificates and Endorsements. Before commencing work under this Contract, the Supplier shall furnish (i) certificates of insurance for the coverages specified in paragraph (a) above, and (ii) an additional insured endorsement naming the Institute as an additional insured to the Contract for the coverage specified above. Such certificates and the endorsement 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, or (ii) until 30 days after the insurer or the Supplier gives written notice to the Institute, whichever period is longer. Also, such certificates and the endorsement shall (i) cover contractual liability assumed under this Contract, and (ii) be primary and noncontributing to any insurance procured by the Institute. The Supplier agrees to

permit the Institute to examine its original policies, should the Institute so request. Should the Supplier at any time neglect or refuse to provide the insurance required herein, or should such insurance be canceled, the Institute shall have the right to procure same and the costs thereof shall be deducted from monies then due or thereafter to become due to the Supplier.

13. **INDEMNIFICATION** The Supplier agrees to defend, indemnify and hold harmless the Institute from and against all claims, liability and expenses, including reasonable legal fees, arising from any actual or claimed: (i) injury to any person or property resulting from any act or omission of Supplier, its employees or agents, excepting such liability as may result solely from the negligent acts or omissions of the Institute or its employees; and (ii) infringement of any patent, copyright, or trademark by reason of the sale or use of the goods provided by Supplier hereunder. The Supplier's obligations hereunder shall survive acceptance of the goods and payment thereof by the Institute.
14. **NEW MATERIAL** Unless this Contract specifies otherwise, the Supplier represents that the supplies are new and are not of such age or so deteriorated as to impair their usefulness or safety. If the Supplier believes that furnishing other than new material will be in the Institute's interest, the Supplier shall so notify the Purchasing Agent in writing and request authority to use such material.
15. **ORDER OF PRECEDENCE** To the extent there is inconsistency among any documents relating to this order, the inconsistency will be resolved in the following order of priority: (a) These General Provisions; (b) The details specified on the order, or description of products or services; (c) any other documents the Institute agrees in writing to incorporate by reference.
16. **PAYMENT** (a) Invoices shall be submitted in duplicate to the attention of the Institute's Accounts Payable Department, unless otherwise specified, and shall contain the following information as applicable: (i) Contract number, (ii) item number, (iii) description of supplies or services, (iv) size, (v) quantity, (vi) unit price, (vii) extended totals and (viii) any other information which may be specified on the face of this Contract. Any applicable state sales or use taxes or Federal excise taxes shall be shown separately on the invoice. (b) The Institute shall pay the Supplier, upon the submission of proper invoices, the prices stipulated in this Contract for supplies delivered and accepted or services rendered and accepted, less any deductions provided in this Contract. (c) The Institute shall make its best effort to make payments within the net period, if any, specified in the Contract, measured from the date of receipt of

the goods or services at the destination or the date of receipt of the invoice, whichever is later. Discount time periods will be measured from the same date. Payment shall be deemed to have been made on the date the check is mailed or on the date on which an electronic funds transfer was made. In no event will the Institute be liable for or pay a surcharge, interest, or any kind of penalty as a result of the Institute's payment not being made within the net period, if any, specified in the Contract or the date of payment by electronic funds transfer. (d) Payment for goods or services in accordance with this paragraph will not waive or otherwise affect the right of the Institute to inspect such goods or services or to reject, or revoke acceptance of, nonconforming goods.

17. **USE OF NAME** Supplier agrees not to use the name or trademarks of the Institute or any member its staff in sales promotional work or advertising, or in any form of publicity, without the prior written permission of the Institute.
18. **TITLE AND RISK OF LOSS** (a) Unless otherwise provided in Section 19 or elsewhere in this Contract, title to tangible property (property of any kind except intangible property and debt instruments) furnished under this Contract shall pass to the Institute upon formal acceptance by the Institute, regardless of when or where the Institute takes physical possession, unless the Contract specifically provides for earlier passage of title. (b) Risk of loss shall not pass to the Institute until the tangible property called for in this Contract has been actually received and accepted by the Institute at the destination specified. Supplier assumes all responsibility for packing, crating, marking, transportation and liability for loss or damage in transit, notwithstanding any agreement by Institute to pay freight, express or other transportation charges. Supplier agrees to trace lost or delayed shipments at the request of the Institute.
19. **GOVERNMENT TITLE TO PROPERTY PURCHASED OR FABRICATED WITH CONTRACT FUNDS** Title to tangible property shall vest in the Government upon acquisition when the tangible property is intended to be installed at, incorporated into, built, or necessary for the construction or operation of either the Hanford or Livingston Observatories. All Government property acquired in accordance with this Section 19 shall be subject to the requirements set forth below:
 1. Title.
 - (a) Tangible Property means property of any kind except intangible property and debt instruments. Title to all tangible property procured with funds provided through this Contract, and subject to this Section 19, shall vest in the Government as follows:

1) If this Contract contains a provision directing the Supplier to purchase material which the Government will reimburse as a direct item of cost under the Institute's primary Award, title to property shall pass to and vest in the Government upon delivery of such property to the Government, to the Institute, to the Supplier, to any subcontractor, or to any agent of the Government, of the Supplier, or of any subcontractor; and

2) Title to all other property shall pass to and vest in the Government upon the earliest to occur of the following:

(i) issuance of the property for use in contract performance pursuant to this Contract;

(ii) commencement of processing of the property or its use in contract performance pursuant to this Contract; or

(iii) reimbursement of the cost of the property by the Institute on behalf of the Government.

2. Legal title to all tangible property furnished by the NSF or acquired from other Government agencies shall remain with the Government, unless otherwise specified in this Contract.

3. Title to Government property shall not be affected by the incorporation or attachment thereof to any property not owned by the Government, nor shall any Government property lose its identity by reason of affixation to any reality.

4. All subcontracts issued or awarded with respect to the performance of this Contract shall include provisions regarding the determination of title to tangible property acquired by the subcontractor in accordance with Sections 18 and 19.

5. Should Supplier purchase tangible property pursuant to this Contract and subject to this Section 19, Supplier shall be a limited agent of the NSF solely for the purpose of transferring and vesting title to such tangible property in the Federal Government. The agent shall be solely responsible for the payment of the purchase price of tangible property acquired, and the agent shall have no authority to bind or obligate the Institute, NSF or the Federal Government for payment of the purchase price to any third party. Such agents shall be and shall remain liable for the risk of loss of, destruction of, or damage to tangible property acquired until such tangible property is transferred to the possession of the Government or acceptance by the Institute.

20. **TAXES** (a) **Except as may be otherwise provided on this order**, the contract price includes all applicable Federal, State, and local taxes and duties. With respect to transactions for which the

Institute may be exempt from any tax or duty, the Institute will provide, upon request, evidence to support its claim to such exemption. (b) The Institute will comply with all Federal and State income tax laws with respect to withholding and year-end tax reporting. (c) The Internal Revenue Service (IRS) requires the Institute to have on file a Taxpayer Identification Number (TIN) for every US person or US business that receives a payment, regardless if the payment is tax reportable or not. This information is provided on IRS Form W-9. US Citizens and Resident Aliens are required to complete a Form W-9 before receiving any payments from the Institute. A TIN can be any of the following: a Social Security Number (SSN) an Individual Taxpayer Identification Number (ITIN) or an Employer Identification Number (EIN). Failure to provide a TIN will result in delay of payment and/or backup withholding. (d) Foreign businesses providing services in the US for the Institute are required to provide the appropriate IRS Form W-8 (i.e., Form W-8BEN, W-8ECI, or W-8IMY). (e) Foreign individuals providing services in the US for the Institute are required to provide an IRS Form W-8BEN or IRS Form 8233 depending on the appropriate tax withholding treatment.

21. **TERMINATION** (a) **For Cause.** The Institute may terminate this Contract, or any part of it, for cause in the event of any default by the Supplier, or if the Supplier fails to comply with any Contract terms and conditions, or fails to provide the Institute, upon request, with adequate assurances of future performance. In the event of termination for cause, the Institute shall not be liable to the Supplier for any amount for supplies or services not accepted, and the Supplier shall be liable to the Institute for any and all rights and remedies provided by law. If it is determined that the Institute improperly terminated this Contract for cause, such termination shall be deemed a termination for convenience. (b) **For Convenience.** The Institute reserves the right to terminate this Contract, or any part hereof, for its sole convenience. In the event of such termination, the Supplier shall immediately stop all work hereunder and shall immediately cause any and all of its subcontractors to cease work. Subject to the terms of this Contract, the Supplier shall be paid a percentage of the Contract price reflecting the percentage of the work performed prior to the notice of termination, plus reasonable charges the Supplier can demonstrate to the satisfaction of the Institute, using its standard record keeping system, have resulted from the termination. The Supplier shall not be paid for any work performed or costs incurred which reasonably could have been avoided.

22. **WARRANTY** Supplier expressly warrants all goods and services delivered under this Contract to be free from defects in material and workmanship and to be of the quality, size and dimensions ordered. This express warranty shall not be waived by reason of the acceptance of the goods or services or payment by Institute. The Supplier shall provide the Institute with a copy of any standard warranty which is normally offered on a commercial product deliverable under this Contract. The commercial product warranty shall be deemed to be incorporated by reference and the Institute shall be entitled to all rights under such warranty.
23. **AUDIT AND RECORDS** Financial records, supporting documents, statistical records, and other records pertinent to this Contract shall be retained by the Supplier for a period of five years from acceptance by the Institute. Supplier agrees that the Institute, the National Science Foundation, the Comptroller General of the United States, or any of their duly authorized representatives, shall have access to any books, documents, papers and records of the Supplier which are directly pertinent to this Contract, for the purpose of making audits, examinations, excerpts and transcriptions.
24. **SITE VISITS** NSF and the Institute, through authorized representatives, have the right, at all reasonable times, to make site visits to review project accomplishments and management control systems and to provide such technical assistance as may be required. If any site visit is made by NSF or the Institute on the premises of the Supplier or a contractor under a subcontract, the Supplier shall provide and shall require its contractors to provide all reasonable facilities and assistance for the safety and convenience of the Institute or Government representatives in the performance of their duties. All site visits and evaluations shall be performed in such a manner that will not unduly delay the work.
25. **NONDISCRIMINATION** The Contract is subject to the provisions of Title VI of the Civil Rights Act of 1964 [42 U.S.C. § 2000d], Title IX of the Education Amendments of 1972 [20 USC §§ 1681 et seq.], the Rehabilitation Act of 1973 [29 U.S.C. § 794], the Age Discrimination Act of 1975 [42 U.S.C. §§ 6101 et seq], and all regulations and policies issued by NSF pursuant to these statutes. In accordance with these statutes, regulations, and policies, no person on the basis of race, color, national origin, sex, disability, or age shall be excluded from participation in, be denied the benefits of, or otherwise be subjected to discrimination under the Contract.
26. **EQUAL EMPLOYMENT OPPORTUNITY** This Contract is subject to the requirements of Executive Orders 11246 and 11375 and the rules and regulations or the Secretary of Labor (41 CFR Chapter 60) in promoting Equal Employment Opportunities.
27. **ANTI-KICKBACK ENFORCEMENT ACT OF 1986** This Contract is subject to the provisions of the Anti-Kickback Enforcement Act of 1986, Public Law 99-634 (41 U.S.C. 51-58). By accepting this order, Seller certifies that it has not paid kickbacks directly or indirectly to any Institute employee for the purpose of obtaining this or any other Institute purchase order or to obtain favorable treatment in an Institute matter.
28. **CLEAN AIR ACT AND THE FEDERAL WATER POLLUTION CONTROL ACT** – Should this Contract be for an amount in excess of \$100,000, Supplier agrees to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act (42 U.S.C. 7401 et seq.) and the Federal Water Pollution Control Act as amended (33 U.S.C. 1251 et seq.). Further, Supplier agrees as follows:
- To comply with all the requirements of Section 114 of the Clean Air Act [42 U.S.C. §7414] and Section 308 of the Clean Water Act [33 U.S.C. § 1318], respectively, relating to inspection, monitoring, entry, reports and information, as well as other requirements specified in Section 114 and Section 308 of the Clean Air Act and the Clean Water Act, respectively, and all regulations and guidelines issued thereunder before the Contract.
 - That no portion of the work required by the Contract will be performed in a facility listed on the Environmental Protection Agency List of Violating Facilities on the date that the Contract was awarded unless and until EPA eliminates the name of such facility or facilities from such listing.
 - To use its best efforts to comply with clean air standards and clean water standards at the facility in which the Contract is being performed.
 - To insert the substance of the provisions of this article into any nonexempt subcontract.
29. **DEBARMENT AND SUSPENSION** – (a) Supplier shall fully comply with the requirements stipulated in 2 CFR Part 180, as modified by 45 CFR 620.330 and shall ensure that any lower tier covered transaction, as described in 2 CFR 180.220 and modified by 45 CFR 620.200 and 620.220 includes a term or condition requiring compliance with these requirements. The Supplier acknowledges that failing to disclose the information required under 45 CFR § 620.335 may result in the termination of the Contract, or pursuance of other available remedies, including suspension and debarment. Supplier may access the Excluded Parties List System at <http://epls.arnet.gov>. (b) No contract at any tier shall be made to parties listed on the General Services Administration's List

of Parties Excluded from Federal Procurement or Nonprocurement Programs in accordance with E.O.s 12549 and 12689, "Debarment and Suspension." This list contains the names of parties debarred, suspended, or otherwise excluded by agencies, and contractors declared ineligible under statutory or regulatory authority other than E.O. 12549. Supplier, whose Contract exceeds the small purchase threshold, shall provide the required certification regarding its exclusion status and that of its principal employees.

30. **[FOR CONTRACTS OF \$100,000 OR MORE] BYRD ANTI-LOBBYING AMENDMENT** - Supplier warrants that Supplier has applied or bid on a Contract of \$100,000 or more and has filed the required certification. Each subcontracting tier must certify to the tier above that it will not and has not used Federal appropriated funds to pay any person or organization for influencing or attempting to influence an officer or employee of any agency, a member of Congress, officer or employee of Congress, or an employee of a member of Congress in connection with obtaining any Federal contract, grant or any other award covered by 31 U.S.C. 1352. Each tier shall also disclose any lobbying with non-Federal funds that takes place in connection with obtaining any Federal award. Such disclosures are forwarded from tier to tier up to the recipient.
31. **[FOR CONSTRUCTION/REPAIR CONTRACTS >\$2000] Copeland "Anti-Kickback" Act (18 U.S.C. 874 and 40 U.S.C. 276c)** Supplier shall comply with the Copeland "Anti-Kickback" Act (18 U.S.C. 874), as supplemented by Department of Labor regulations (29 CFR part 3, "Contractors and Subcontractors on Public Building or Public Work Financed in Whole or in Part by Loans or Grants from the United States").
32. **[FOR CONSTRUCTION/REPAIR CONTRACTS >\$2000] Davis-Bacon Act, as amended (40 U.S.C. 276a to a-7)** Supplier shall comply with the Davis-Bacon Act (40 U.S.C. 276a to a-7) and as supplemented by Department of Labor regulations (29 CFR part 5, "Labor Standards Provisions Applicable to Contracts Governing Federally Financed and Assisted Construction").
33. **[FOR CONSTRUCTION/REPAIR CONTRACTS >\$500,000] Surety Bonds - If so directed**, the Supplier shall furnish separate bid guarantees, performance and payment bonds to the Institute. Each bond shall set forth a penal sum in an amount not less than the Contract Price. Each bond furnished by the Supplier shall incorporate by reference the terms of this Contract as fully as though they were set forth verbatim in such bonds. In the event the Contract Price is adjusted by Change Order executed by the Contractor, the

penal sum of both the performance bond and the payment bond shall be deemed increased by like amount. The performance and payment bonds furnished by the Supplier shall be in form suitable to Institute and shall be executed by a surety, or sureties, reasonably acceptable to the Institute.

34. **[For designated Experimental, Development or Research Work] Rights to Inventions** - For non-profit organizations and small business firms, patent rights shall be governed by 37 CFR part 401, titled "Rights to Inventions Made by Non-Profit Organizations and Small Business Firms under Government Grants, Contracts and Cooperative Agreements".
35. **[For designated Experimental, Development or Research Work] Patent Rights** – Bayh-Dole Act [35 U.S.C. 200 et seq.]



REQUIREMENTS

Metal Components for use in the Advanced LIGO Vacuum System

APPROVALS	DATE	Document Change Notice
AUTHOR(S): Calum Torrie, Dennis Coyne, Ken Mailand	27-Oct-2010	see DCC record Status:

1 Introduction

All metal components intended for vacuum service shall have quality finishes on all surfaces, suitable for service in an Ultra-High Vacuum (UHV) system. These requirements define the restrictions and practices which must be followed for parts to be used in the LIGO UHV system.

Exceptions, additions or clarifications shall be obtained in writing from the LIGO Contractual Officer or the Contractual Officer's Technical Representative.

2 Scope

These requirements apply to metal components intended for in-vacuum service.

These requirements do not apply to cantilever blade springs. For this application please refer to LIGO-E0900023, Process for Manufacturing Cantilever Spring Blades

3 Purchase Order Specific Requirements

In addition to the requirements defined in this specification, additional requirements, specific to a particular procurement or part, may be defined in the Statement of Work (SOW) or Request for Quotation (RFQ).

4 General Requirements for Metal parts for use in Vacuum

4.1 Materials

The following requirements apply to all raw materials used for LIGO UHV components. **Substitutions and exceptions to these requirements must be in obtained in writing from LIGO in advance of manufacturing any components.**

- Only materials specified on the drawing may be used.
- Material Certifications are required for all materials. Tooling plate grade materials are not permitted.
- Materials must be of domestic (United States) origin.
- All materials are to be virgin material (i.e. no weld repairs or plugs; see also section 4.7))
- No cast or molded parts are permitted.

4.1.1 Welded (Seamed) Stainless Steel Tubing

Stainless steel seamed tubing, although an option, should not be the first choice if seamless tubing is available. The use of seamed steel tubing requires prior approval from LIGO.

If seamed tubing is utilized, the weld seam and any weld flash must meet the requirements listed below. If the weld flash does not meet the requirements, then it must be removed. Details, including fixtures and/or tooling required to remove this flash and a method for removal should be included in the quotation. The flash removal process must be inspected 100% visually and certified by the vendor and approved by LIGO.

With prior approval from a LIGO Contract Officer stainless steel seamed tubing can be used under the following conditions: -

1. Take a cross-sectional sample of the tube weld for every ~20 ft. of every continuous weld run (batch) and verify that the weld is Class B in Table V of Mil-Std-2219. The verification requires:
 - a) Visual inspection for weld discontinuities, porosity and inclusions,
 - b) X-ray for complete penetration and fusion and



REQUIREMENTS

Metal Components for use in the Advanced LIGO Vacuum System

- c) Weld flash must not extend into the interior of the tube more than .02". The weld flash must not be so rough or porous as to prevent adequate cleaning.
 - d) Microstructural examination of weld samples cross-sections. Cross-sections of weld samples, for microstructural examination, shall be prepared by cutting in an orientation perpendicular to the direction of the weld bead so that the size and shape of the weld and the heat-affected zone (HAZ) can be observed. Each weld sample shall be sectioned and polished by standard metallographic procedures (for example, mounted in an epoxy, polished with a 5 micron diamond paste and then be etched with Keller's reagent). The section samples shall be examined and photo-micrographed at approximately 15x. Any weld discontinuities shall be further examined and photographed at 50x to 200x magnification.
2. Supply inspection report for approval to the LIGO contract officer confirming that the as-received seamed welds conform to class B prior to continuing.
 3. Note: Prior to welding, all seamed tubing (inside and out) must be electro-polished per ASTM B-912- (reference LIGO E0900048 Welding Spec)

4.2 Final Surface Finishes

All final surfaces of all parts are to be machined. Machined surfaces must not have smeared metal or galling because these conditions can trap contaminants which could out-gas when the part is in service in the vacuum environment. No as-received or as-rolled rough surfaces will be accepted unless otherwise noted on the drawing or as an exception here:

4.2.1 Exceptions (allowable non-machined surfaces)

4.2.1.1 Extruded Sections (seamless tubes, angles, etc.) and Welded Stainless Steel Tubing

If extruded tubular sections (or angles or other stock shapes) are to be used, then machining the interior surfaces is not practical and machining the outer radius on the corners is prohibitive. In this case either

- a) All surfaces of all parts are to be machined, except those not practical to machine. In this case the inner surface and outer radius will be accepted "as extruded" or "as rolled", or
- b) The part is electro-polished to remove all surface oxides and potentially embedded contaminants refer to section 5.2.1.2 or 5.2.2.2.
- c) (For aluminum) The part is chemically cleaned / etched by acid or caustic process, refer to 5.2.1.
- d) As per section 11 of ASTM A554-10 the finished tubes shall be free of injurious defects and have a workmanlike finish. Surface imperfections such as handling marks, shallow pits and scratches shall not be considered as serious defects provided they are within 10% of the specified wall or 0.002 inch, whichever is greater.
- e) Each tube shall be individually wrapped and protected from scratches, pitting and digs during transport and handling. Each tube shall be inspected and handled appropriately.

4.2.1.2 Thin Sheet

Sheet metal shall be purchased in the 2B finish condition which should normally have a surface finish of 12-20 Ra. However, if the surface finish exceeds 32 Ra then:

- a) the surface finish should be discussed with LIGO Contractual office prior to acceptance, or
- b) the sheet shall be electro-polished as per section 5.2.2.2
- c) the sheet shall be chemically cleaned / etched by acid and / or caustic process, refer to section 5.2.1

Further questions related to machining all surfaces can be discussed with the LIGO Contractual officer or the Contracting Officer's Technical Representative. Under no circumstances shall the parts be anodized.



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Metal Components for use in the Advanced LIGO Vacuum System

4.2.2 Surface Roughness

The required surface roughness is defined in the drawing block entitled "finish". Please note if finish is called out on the drawing it is in Ra. If no call-out is included in this block, then the maximum surface finish shall default to:

- 63 micro-inch (Ra) for stainless all surfaces
- 63 micro-inch (Ra) for aluminum all surfaces
- 32 micro-inch (Ra) for sheet metal. See section 4.2.1.2.

Localized scratches, digs and blemishes should be minimized and addressed through visual inspection and QA. If such blemishes compromise the function or performance of the part (e.g. a stray light control baffle), then limits on acceptable scratches and digs should be defined in the drawing or associated process specification.

4.3 Machining Fluids / Coolant

All machining, and tapping, fluids must be fully synthetic, water soluble (not simply water miscible) and free of sulfur, chlorine, and silicone. Reference LIGO document [LIGO-E0900237-v5](#) for a list of approved coolants. If this is difficult or expensive please talk to LIGO staff about an exemption.

4.4 Abrasive Removal Techniques

4.4.1 Grinding

No grinding or lapping with abrasive wheels, cloth or stones is permitted for the final surface, unless otherwise noted on the drawing. Grinding (e.g. Blanchard grinding) is acceptable if all ground surfaces are machined afterwards.

4.4.2 Sanding

No parts are to be sanded with abrasive techniques e.g. sanding, grinding. Stainless steel wool can be used.

4.4.3 Scotch-Brite™

The use of Scotch-Brite™ or similar products is not permitted at any time.

4.4.4 Water Jet Cutting

The use Water Jet Cutting is permitted on sheet metal parts which will later be porcelain coated. For all other parts, the Water Jet Cut surface must be removed by traditional machining methods. Electro-polishing may be used to remove the Water Jet Cut surface if a written exemption is granted by LIGO.

4.5 Electrical Discharge Machining (EDM)

The use of EDM is not permitted unless the porous re-cast layer is removed by conventional machining techniques. Removal of the re-cast layer by electro-polishing may be used if a written exemption is granted by LIGO.

4.6 De-burring

All sharp edges and corners shall be rounded or chamfered per the drawing. De-burring should be done on the lathe or mill as much as possible or with de-burring tools, filing and / or stainless steel wire brushes. Tumbling or use of standard steel wool is not acceptable for de-burring, however clean stainless steel wool is okay. All de-burring tools, files and stainless wire brushes must be clean and free of oils and contaminants.



REQUIREMENTS

Metal Components for use in the Advanced LIGO Vacuum System

4.7 Repairs

No repairs shall be made unless approved in advance, and in writing, by LIGO Laboratory. In general weld repairs and press fit insert repairs are never acceptable. The material shall be virgin material. Special circumstances can be reviewed if/when brought to the attention of LIGO. Complete LIGO form [Q110001 Request for Deviation](#) and email to quality@ligo.org.

4.8 Heli-Coil Holes

All Heli-Coil holes are to be machined according to the steps specified in the Emhart Heli-Coil Product catalog, HC2000 Rev. 4 page 17. These steps include drilling, countersinking, tapping, and gauging the holes to sizes specified on the LIGO part drawings. All Heli-Coil threaded holes shall be 100% gauged with appropriate gauge tools according to the [Emhart catalog](#).

5 Cleaning

5.1 Standard Cleaning of Metal Components before delivery to LIGO

- a) Unless otherwise specified on the drawing, SOW, or RFQ the standard requirement is for all components to be thoroughly cleaned to remove all ink, oil, grease, dirt, and chips.
- b) All inks (stamping, Sharpie, etc) should be removed with solvent such as acetone or isopropanol.
- c) Use Soap (such as Simple Green) and water to remove machining fluids.
- d) Thoroughly rinse soap with clean water (DI or distilled preferred).
- e) Parts should be dried thoroughly with clean air, nitrogen, or lint-free cloth.
- f) Wrap parts to protect from damage and to maintain cleanliness during shipment. Avoid the use of materials that shed particulates such as newspaper. Bubble wrap is recommended for many parts.

5.2 Further Cleaning (only if specified)

These cleaning steps only apply if called out in the individual SOW and/or RFQ and/or drawing or other LIGO Specification. Additional questions related to this section on further cleaning can be discussed with the LIGO Contractual officer or the Contracting Officer's Technical Representative.

5.2.1 Aluminum

5.2.1.1 Chemical cleaning of Aluminum

- a) Standard clean parts per 5.1 above.
- b) Wash parts with Alkaline Soak Cleaner and inspected for cleanliness using the water break test (refer to ASTM A380-06 and ASTM F22).
- c) Acid etch the parts to achieve less than 0.0005 material removal. Under no circumstances should the parts be anodized. Section 10 of LIGO document [E960022](#) can be referred to for additional information.
- d) Thoroughly rinse parts with DI or distilled water and inspect all surfaces for cleanliness.
- e) Thoroughly dry parts with clean air, nitrogen, or lint-free cloth.
- f) Wrap parts to protect from damage and to maintain cleanliness during shipment. Avoid the use of materials that shed particulate such as newspaper. Bubble wrap is recommended for many parts.

5.2.1.2 Electro-polishing of Aluminum

Aluminum may be electro-polished to achieve a material removal of .001 inch per surface. Due to the lack of commonly recognized industry standards, please talk to LIGO about proposed suppliers and processes before proceeding.



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Metal Components for use in the Advanced LIGO Vacuum System

5.2.2 Stainless Steel

5.2.2.1 Pickling & Passivation of Stainless Steel

1. Clean parts per section 5.1 above, inspect for cleanliness using the water break test (refer to ASTM A380-06 and ASTM F22).
2. Stainless steel parts shall be pickled and passivated (citric acid preferred) at room temperature, with special attention paid to sufficiently agitate the solution or flush the inside of the box section. The pickling and passivation process formulation, time and temperature should be chosen to achieve slight chemical etching (<0.0005 inch). (Ref. ASTM A380 for pickling and ASTM A967 for passivation)
3. Rinse parts with DI or distilled clean water. After rinsing, visually inspect the surfaces for cleanliness.
4. Dry Parts using dry nitrogen blow-off or bake at approximately 130°F. Re-inspect for cleanliness.
5. Wrap parts to protect from damage and to maintain cleanliness during shipment. Avoid the use of materials that shed particulate such as newspaper. Bubble wrap is recommended for many parts.

5.2.2.2 Electro-polishing of Stainless Steel

Electro-polishing of Stainless Steel parts is allowed. If using electro-polishing on a part, follow similar steps to those outlined in section 5.2.2.1 Pickling and Passivation of Stainless Steels. The use of Scotch-Brite™ or similar products is never permitted.

6 Coatings

- No coatings are to be applied unless specified on the drawing or associated process specification. In particular, no aluminum parts are to be anodized.
- The Statement of Work should define if the machining vendor is responsible to apply coatings specified on the drawing. If in doubt, ask.
- As applicable, refer to the process specification for coatings as defined on drawings (for example, LIGO E1000083 Specification for Enameled Steel to be used in the LIGO Ultra High Vacuum System).
- Autocatalytic (Electroless) Nickel Plating, when required, should be applied per ASTM B733-97 Type III (2-4 wt% Phosphorus). Due to the outgassing concerns for UHVV service, the specific cleaning/etching and plating process steps proposed by the plating company shall be submitted to LIGO for approval. Refer to section 2.5 of [LIGO-E0900023-v10](#) for suggested process steps.



LIGO Laboratory / LIGO Scientific Collaboration

LIGO-Q0900001-v5

3 February 2010

Advanced LIGO Supplier Quality Requirements

Jeff Lewis, Bob Anderson, Calum Torrie

Distribution of this document:
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1. Scope

This document is intended for Suppliers and potential Suppliers to LIGO when specified on the Statement of Work (SOW). Supplier requirements are defined, including: the Supplier's Quality System; inspection, material handling, packaging and shipping procedures.

2. Supplier Quality System

2.1. Certified or Compliant

During the Request for Proposal (RFP) or Request for Quote (RFQ) process, preference will be given to potential and current suppliers who are currently ISO 9001, AS9100, or TS16949 certified. LIGO can still contract with suppliers who are not certified but those suppliers typically have ISO 9001 compliant Quality Systems. Potential suppliers having neither an ISO 9001 certified nor compliant Quality System will be required to create a quality document addressing the main points of ISO 9001 with respect to the LIGO work. Only potential suppliers lacking certification shall submit a copy of their Quality System along with the bid package for consideration.

2.2. Calibration Program

The supplier shall maintain an ISO 9001 compliant calibration program of all instruments and tools required for the inspection of all LIGO production parts and assemblies manufactured by the supplier or sub-contractor.

3. Procurement Process

3.1. Pre-RFP/RFQ Supplier Visit

A LIGO representative may conduct a visit or audit to gage a potential supplier's Quality System, facilities, equipment and personnel capabilities, and capacity. The LIGO representative can explain any LIGO specific requirements that are not clear.

3.2. LIGO Procurement Documentation

LIGO will provide the supplier with the following documentation in support of the bid process (if applicable):

- 3.2.1. Statement of Work (SOW)
- 3.2.2. Technical documents, drawings, and specifications, identified by revision. Solid Models are available on request.
- 3.2.3. On-line access to all applicable LIGO specifications

3.3. Pre-Award Inspection

Prior to contract award LIGO staff may perform an audit of the prospective supplier's Quality System. The audit scope includes but is not limited to:

- Understanding of the various LIGO requirements and specifications. This should be an opportunity for both parties to communicate.
- Supplier QA/QC program and how it will be implemented for Advanced LIGO contracts.
- Manufacturing methodologies, especially as regards cleanliness and use of approved materials and fluids.
- Cleaning and packaging methodologies compared to RFP/RFQ requirements.
- Critical worker certification levels (i.e., welding, electrical, CNC, etc.).

- Calibration program review.

4. Manufacture, Assembly, and Inspection Requirements

4.1. Manufacturing Planning / Traveler

Unless otherwise instructed, the supplier shall create planning for each manufacturing job which identifies the following components. This planning shall be available for review by LIGO before, during, or after manufacturing.

- The schedule of operations, including the type of process to be performed (ie, mill, lathe, deburr, outside processing, etc.)
- Machinist sign-off and date, including quantity conforming and non-conforming
- Identification and definition of the inspection points during the manufacturing process
- Inspector sign-off and date, including quantity conforming and non-conforming
- Identification of process specifications, as applicable, for internal and external processes
- Identification of operational constraints, as appropriate (ie, no abrasive metal removal techniques for parts destined for Ultra High Vacuum use.)

4.2. First Article Inspection

LIGO may wish to witness or inspect the First Article part before the rest of the order is completed. The requirement for this will be defined on the Statement of Work if applicable.

4.3. In-Process Inspection

In-process inspections shall be performed where subsequent assembly stages will prevent/limit inspection access, and to detect defects early in the process. In-process inspections shall be identified in the manufacturing planning (see Section 4.1 above).

4.4. Final Inspection

The Supplier shall conduct a Final Inspection of all component parts and assemblies to verify completion and conformance of the following items:

- Conformance to all applicable drawings, SOW, and specifications.
- End Item Data Package review (refer to SOW for complete list)
- LIGO property control documentation, when LIGO materials are in possession of a supplier.
- Evidence of safety requirements compliance, if applicable.
- Shipping documentation such as the manifest or shipper.
- Verification of the adequacy of the shipment packaging and weather protection.
- Verification that transportation environmental controls and monitoring requirements will be satisfied.

4.5. Source Inspection

Source inspection by LIGO personnel may be required. The supplier will be notified of this in advance of shipping the components.

4.6. Discrepant Material

Discrepant parts must be identified and segregated immediately upon detection. If the discrepant parts are required to complete an order and the parts can be reworked to comply with the drawing and/or specifications and with no effect on the delivery date

then LIGO does not need to be notified. If the parts can be reworked to comply with the drawing and/or specifications but the rework process will adversely affect the delivery date, then the LIGO Contracting Officer must be notified.

Please immediately contact LIGO to discuss discrepant parts that cannot be reworked to comply with the drawing and/or specification. Suppliers should use the LIGO form [Q110001 Request for Deviation](#) to formalize a request to submit or rework discrepant parts which will not comply to the drawing and/or specifications. Email the completed form to quality@ligo.caltech.edu for a disposition.

The supplier must retain records of any rework processes as part of the job traveler package.

4.7. Drawing and Specification Change Control

All drawings and specifications will be controlled by the suppliers Quality Assurance Department, including receipt and distribution. Upon receiving the order/contract, all drawings will be verified as to correct number and revision.

Controlled documents must be kept updated at every document change or engineering change. The contract administrator under the guidance of QA will insure that all controlled documents, whether in house or out, will be updated.

Occasionally, LIGO may need to revise drawings for design or manufacturing reasons after the purchase order has been issued. These changes are normally discussed with the supplier in advance of official notification to come to a common agreement on the feasibility and implications of the desired changes. When the change will have no adverse effect on the cost or delivery of the part(s) then a Technical Directive Memorandum will be issued by LIGO to formally document the change. If the change is estimated to affect either cost or delivery of the part(s), then a Change Request will be initiated and sent to the supplier, followed by a revised Purchase Order.

Upon receipt of drawing and specification changes, the supplier Quality Assurance or other appropriate personnel will remove obsolete drawing and/or specifications and issue the latest drawing and/or specification to proper personnel. Obsolete drawings shall either be marked "obsolete" if needed for records or destroyed.

4.8. Welding Certifications

Suppliers of parts or assemblies requiring welding which will be used in an Ultra High Vacuum environment must refer to LIGO specification [E0900048 Welding Specification for Weldments used within the Advanced LIGO Vacuum System](#). This specification details numerous welding specific requirements. The SOW will state if this specification is invoked for a certain part or order.

4.9. End Item Data Package

The end item data package is the set of required documents to be supplied to LIGO upon delivery of ordered parts or services. Refer to the Statement of Work (SOW) for the complete list of documents to be included.

**Acceptable Quality Level (AQL) for Inspection of LIGO Components**

AUTHOR(S)	DATE	Document Change Notice, Release or Approval
Jeff Lewis, Bob Anderson	2/11/2011	see LIGO DCC record Status

1 Scope

This document defines the number of components to be 100% inspected from a manufacturing lot of a particular size based on a specified AQL number.

2 Definition

The maximum percent defective (or the maximum number of defects per 100 units) that, for the purposes of sampling inspection, can be considered satisfactory as a process average.

3 Procedure**AQL Number**

Lot Size	0.25	0.4	0.65	1.0	1.5	2.5	4.0	6.5	10
2 to 8	*	*	*	*	*	5	3	2	2
9 to 15	*	*	*	13	8	5	3	2	2
16 to 25	*	*	20	13	8	5	3	3	2
26 to 50	*	32	20	13	8	5	5	5	3
51 to 90	50	32	20	13	8	7	6	5	4
91 to 150	50	32	20	13	12	11	7	6	5
151 to 280	50	32	20	20	19	13	10	7	6
281 to 500	50	48	47	29	21	16	11	9	7
501 to 1200	75	73	47	34	27	19	15	11	8
1201 to 3200	116	73	53	42	35	23	18	13	9
3201 to 10,000	116	86	68	50	38	29	22	15	9

* Denotes inspection of entire lot. Acceptance Criteria (C) = 0

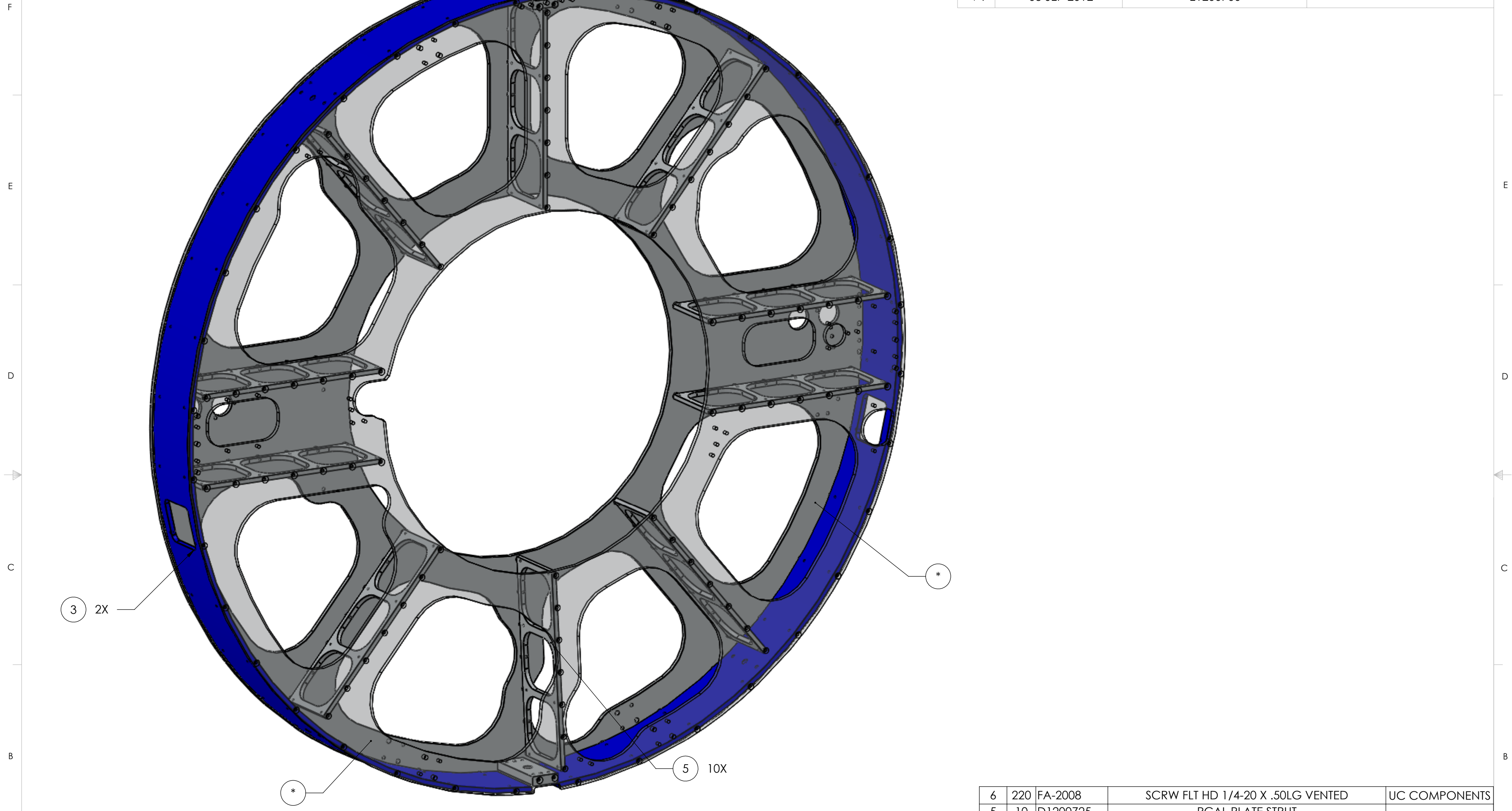
Table 1. AQL Inspection Frequency.

Use Table 1. to determine the number of pieces from a manufacturing lot to 100% inspect for a specified AQL number. For example: a lot of 100 parts with an AQL number of 1.0 signifies that 13 parts shall be 100% inspected. With the Acceptance Criteria (C) = 0, then if one feature on one part is found to be non-conforming then the entire lot shall have that feature inspected.

The first and last part of a manufacturing lot must always be inspected.

NOTES CONTINUED:

REV.	DATE	DCN #	DRAWING TREE #
V1	09 JUL 2012	E1200700	
V2	13 JUL 2012	E1200700	
V3	20 AUG 2012	E1200700	
V4	03 SEP 2012	E1200700	



D1200993-1 ALIGO, PCAL PERISCOPE FRAME (ETMY)

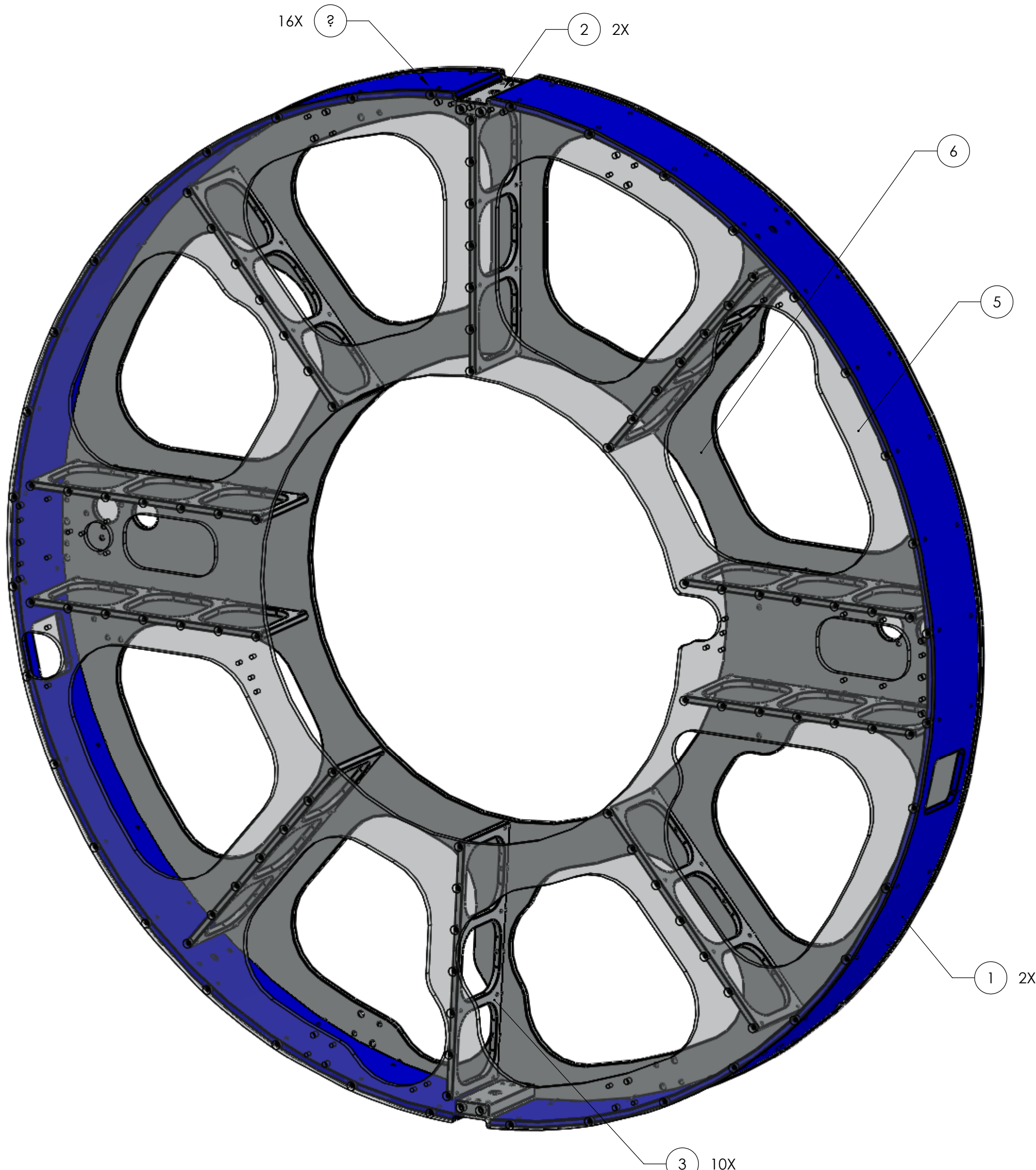
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	SUPPLIER
6	220	FA-2008	SCRW FLT HD 1/4-20 X .50LG VENTED	UC COMPONENTS
5	10	D1200725	PCAL PLATE STRUT	
4	2	D1200731	PCAL PLATE RING CONNECTOR	
3	2	D1102354	PCAL SUSPENSION RING RECEIVE SIDE	
2	2	D1200727-1	PCAL PLATE MIRROR MTG	
1	2	D1200726-1	PCAL PLATE CAMERA MIRROR MTG	
BOM Table				

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES, .005-.015, FOR MACHINED PARTS. ROUND ALL EDGES APPROXIMATELY R.02 FOR SHEET METAL PARTS. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.	
MATERIAL	N/A
FINISH	N/A μinch


CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
SYSTEM	ADVANCED LIGO
SUB-SYSTEM	AOS
NEXT ASSY	D1200174

PART NAME					ALIGO, PCAL PERISCOPE FRAME				
DESIGNER	S. SHANKLE	13 JUL 2012	SIZE	DWG. NO.		REV.			
DRAFTER	S. SHANKLE	09 JUL 2012	c	D1200993		v4			
CHECKER	S. SHANKLE	09 JUL 2012							
APPROVAL	S. SHANKLE	09 JUL 2012	SCALE: 1:12	PROJECTION:			SHEET 1 OF 2		



D1200993-2 ALIGO, PCAL PERISCOPE FRAME (ETMX)

6	1	D1200727-2	PCAL PLATE MIRROR MTG	
5	1	D1200726-2	PCAL PLATE CAMERA MIRROR MTG	
4	220	FA-2008	SCRW FLT HD 1/4-20 X .50LG VENTED	UC COMPONENTS
3	10	D1200725	PCAL PLATE STRUT	
2	2	D1200731	PCAL PLATE RING CONNECTOR	
1	2	D1102354	PCAL SUSPENSION RING RECEIVE SIDE	
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	SUPPLIER
BOM Table				


CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SIZE	DWG. NO.	REV.
C	D1200993	v4
SCALE: 1:12	PROJECTION:	SHEET 2 OF 2

⑤ SCRIBE, ENGRAVE (A VIBRATORY TOOL MAY BE USED), LASER MARK OR MECHANICALLY STAMP (NO INKS OR DYES) DRAWING PART NUMBER, REVISION (AND VARIANT OR "TYPE" IF APPLICABLE) ON NOTED SURFACE OF PART FOLLOWED ON THE NEXT LINE WITH A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. USE MINIMUM 0.12" HIGH CHARACTERS, UNLESS THE SIZE OF THE PART DICTATES SMALLER CHARACTERS. EXAMPLE: DXXXXXX-VY, TYPE-XX, S/N XXX

6. APPROXIMATE WEIGHT = 24.23 LBS.

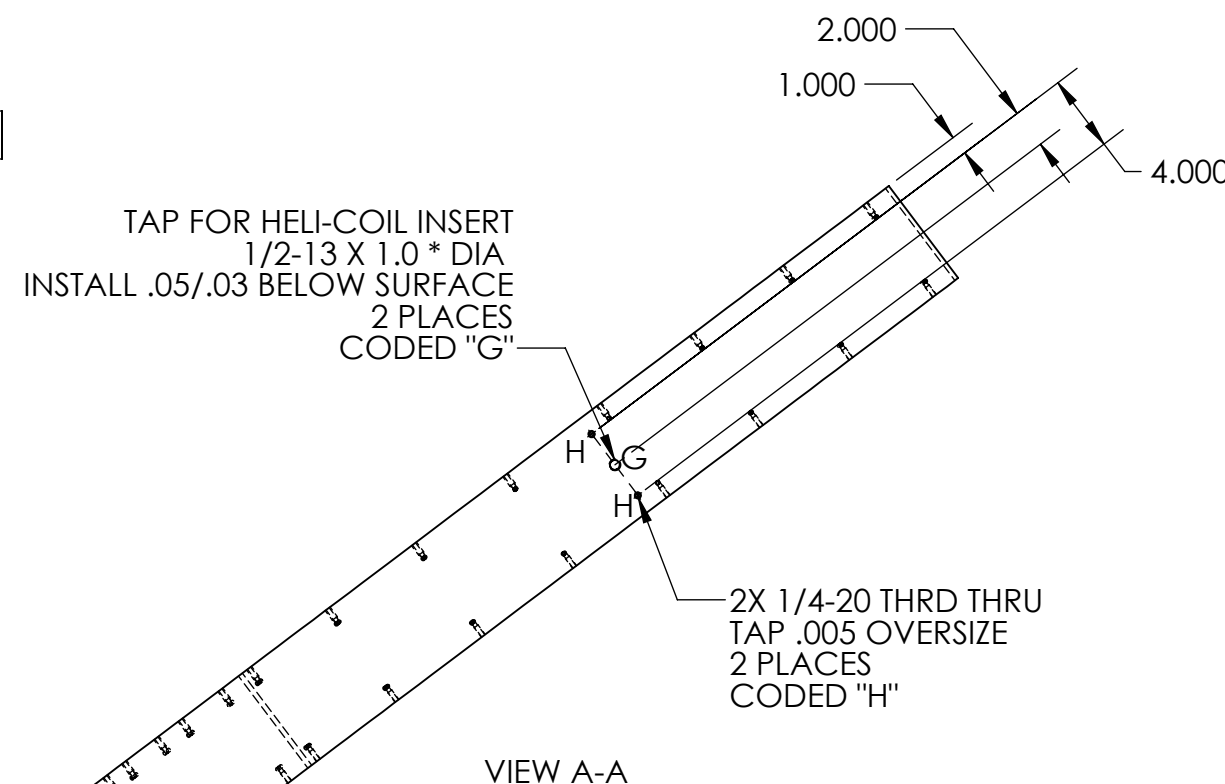
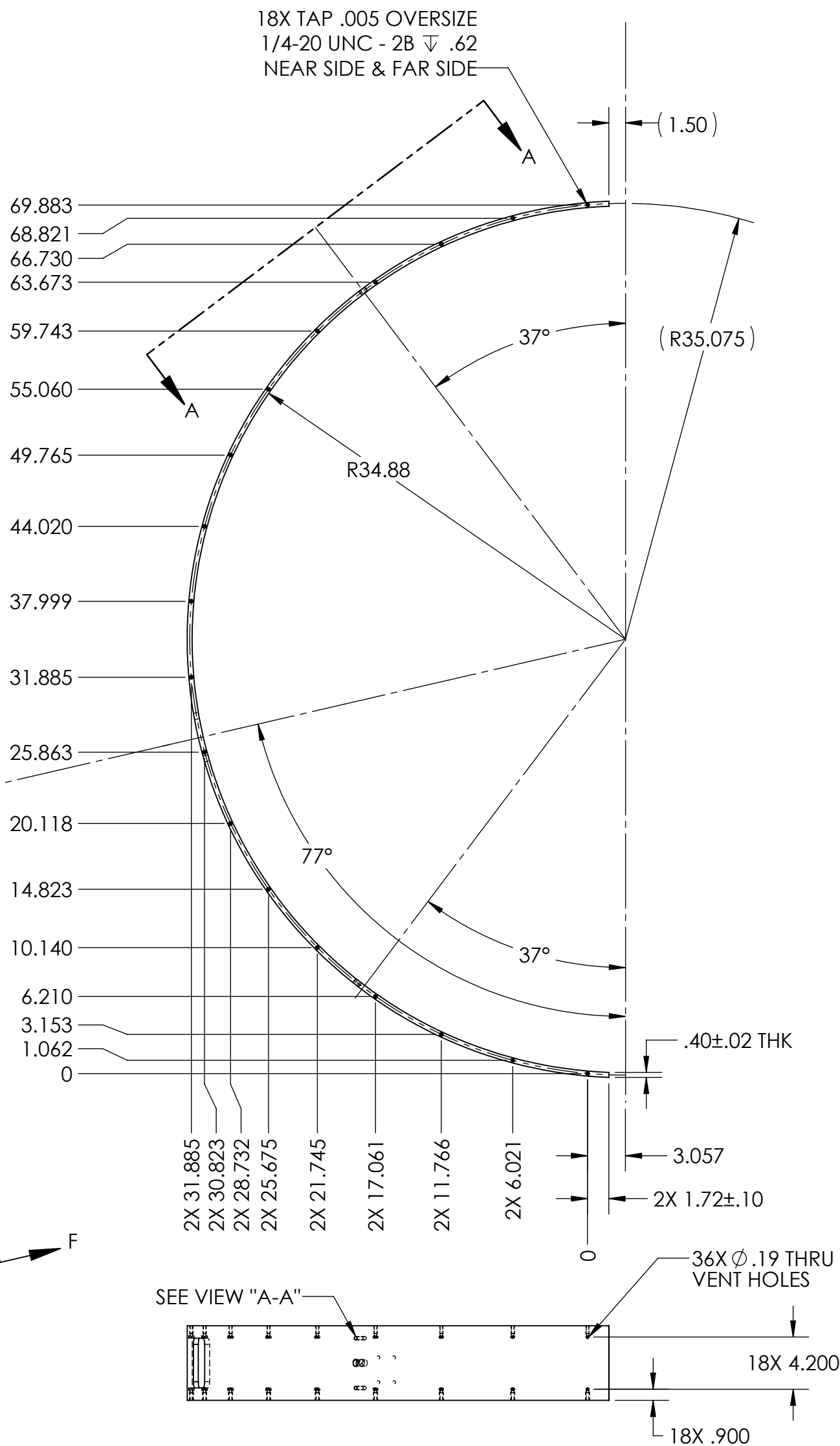
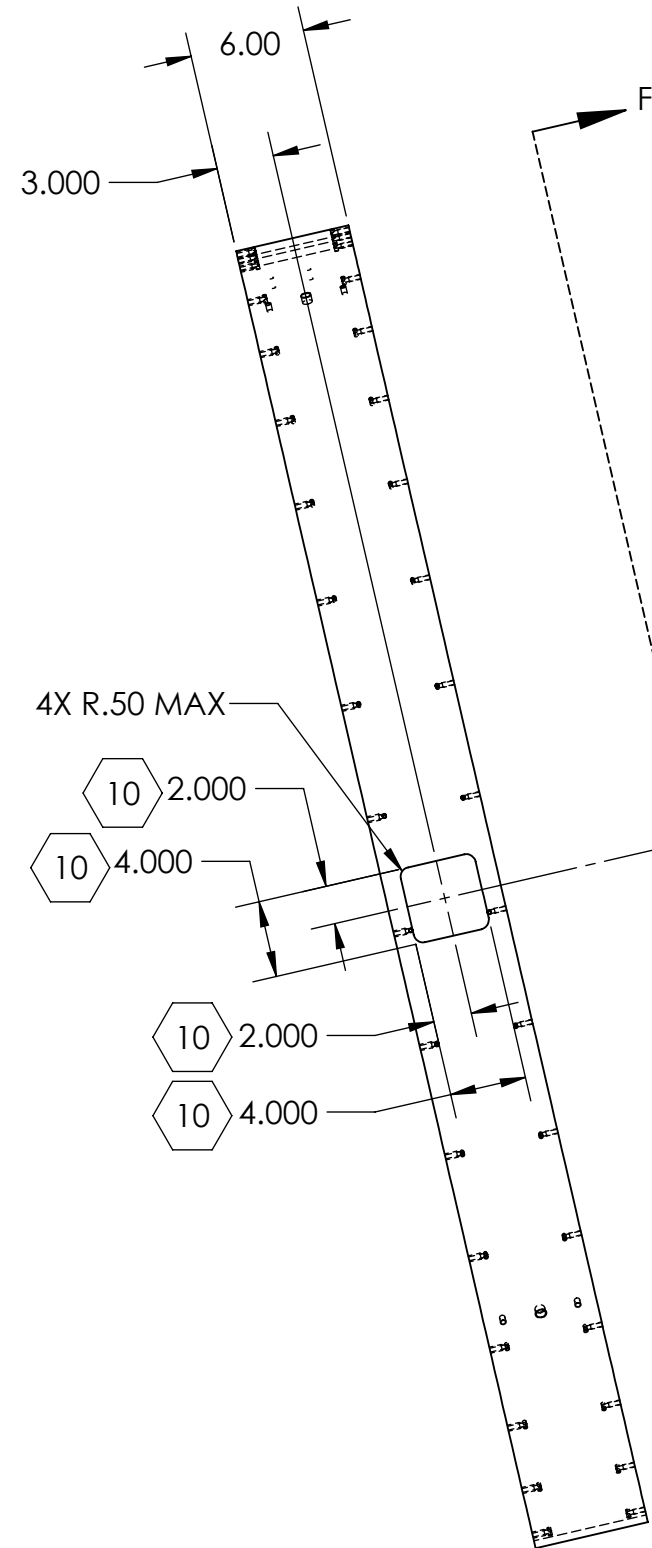
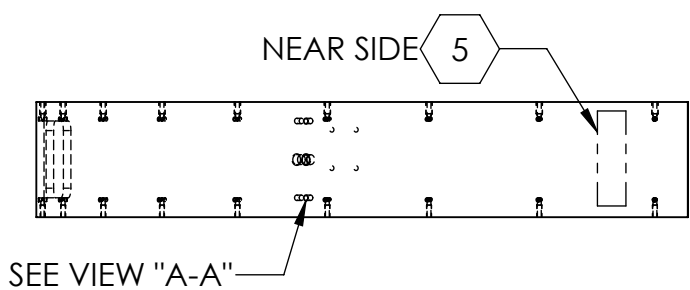
7. MACHINE ALL SURFACES TO REMOVE OXIDES AND MILL FINISH. USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED. REFER TO LIGO-E0900364.

8. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.

9. ALL MATERIAL IS TO BE VIRGIN MATERIAL (i.e. NO WELD REPAIRS, PLUGS OR RECYCLED MATERIAL). NO REPAIRS SHALL BE MADE UNLESS APPROVED IN ADVANCE, AND IN WRITING, BY LIGO LABORATORY. REFER TO LIGO-E0900364.

⑩ DIMENSIONS APPLY AFTER ROLLING.

REV.	DATE	DCN #	DRAWING TREE #
V1	26 JUN 2012	E1200700	
V2	13 JUL 2012	E1200700	
V3	20 AUG 2012	E1200700	
V4	03 SEP 2012	E1200700	



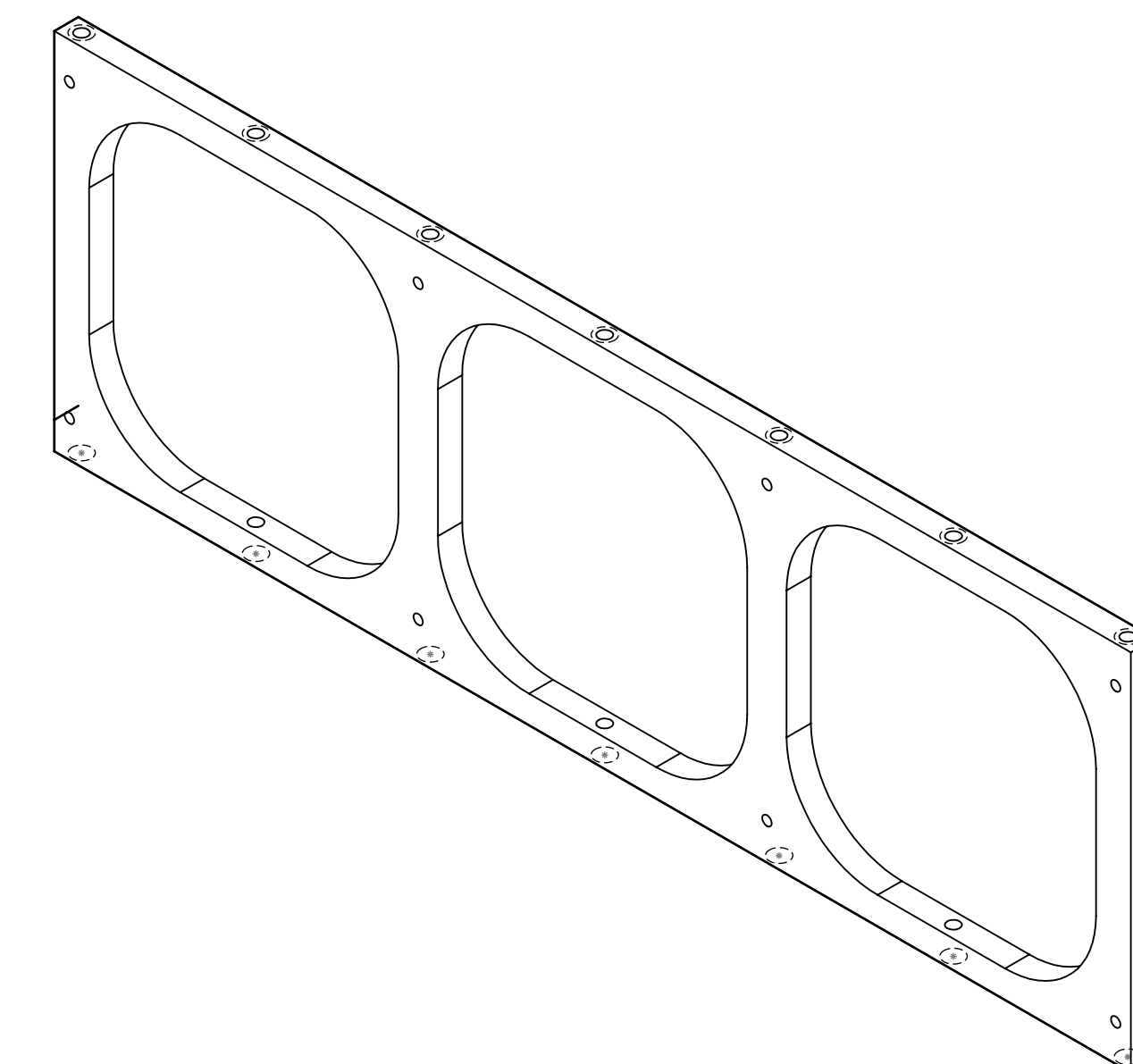
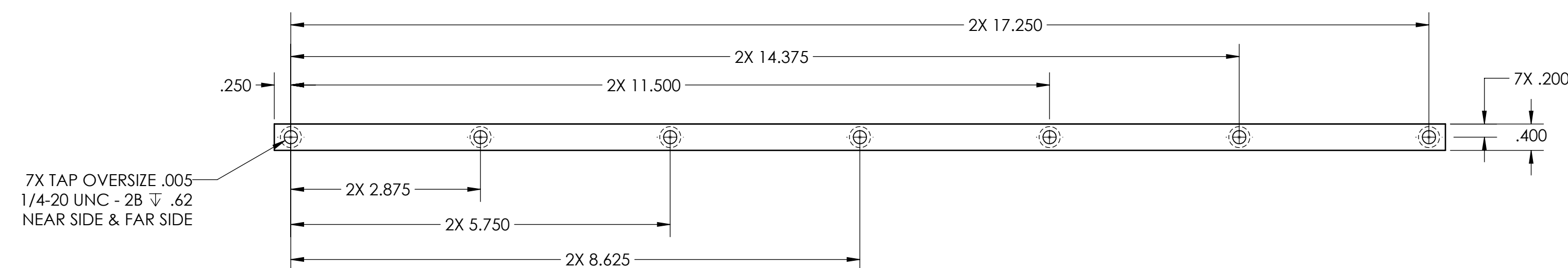
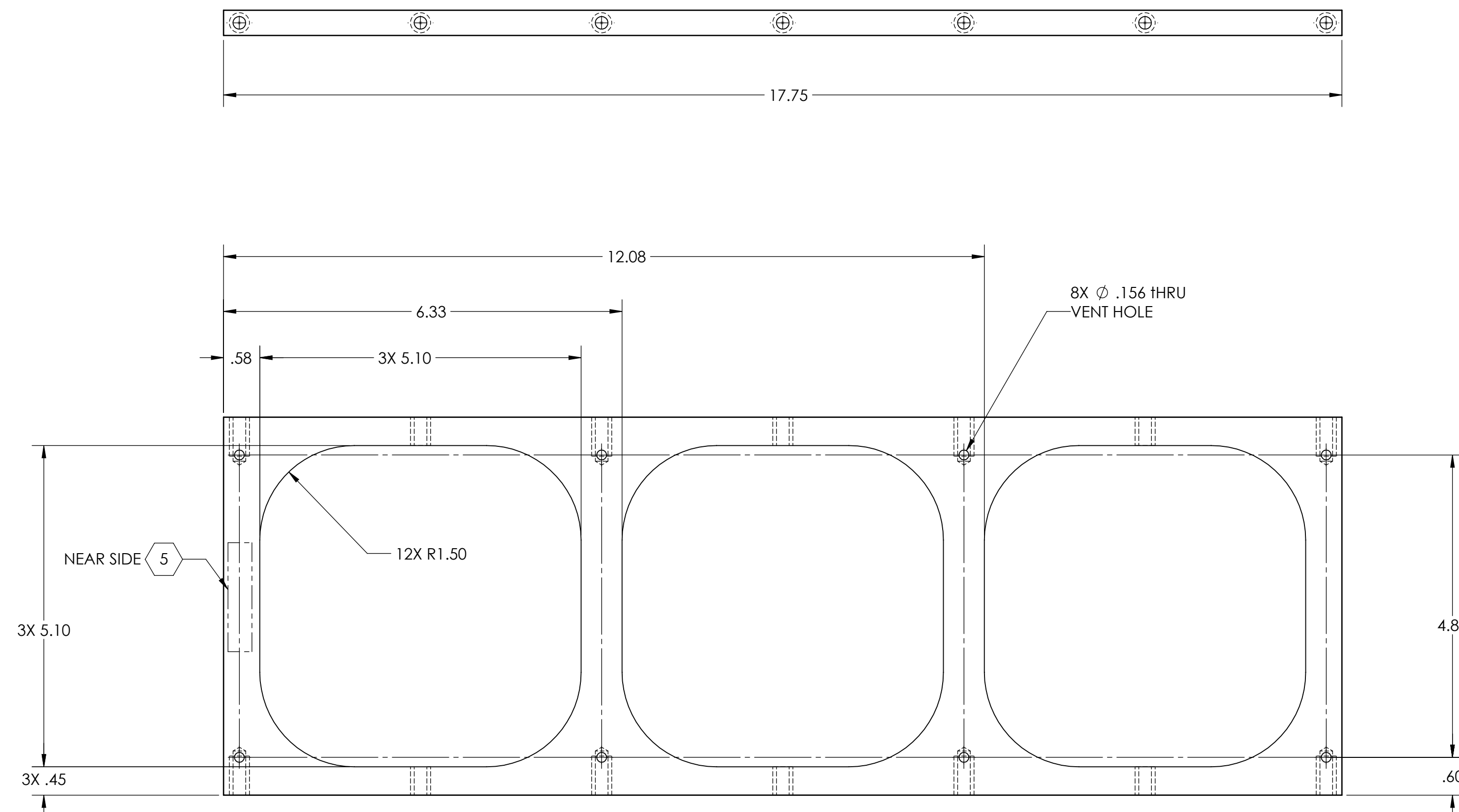
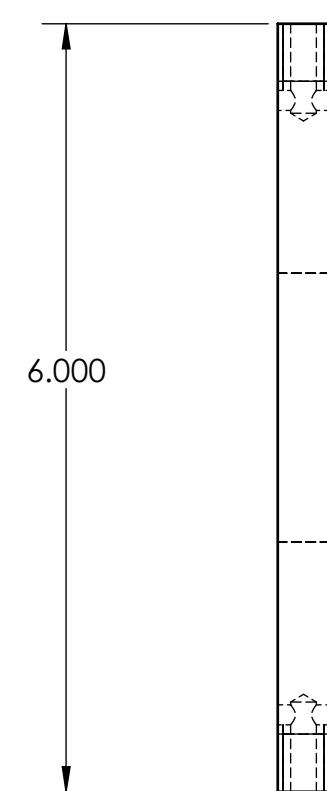
ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	SUPPLIER
3	2	1185-8EN500	INSERT, HELI-COIL, 1/2-13 X .50LG NITRONIC 60	HELI-COIL
2	1	D1102354	PCAL SUSPENSION RING RECEIVE SIDE	
1	36	1185-4EN500	INSERT, HELI-COIL, 1/4-20 X .50LG NITRONIC 60	HELI-COIL

BOM Table

<p>NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)</p> <p>1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES, .005-.015, FOR MACHINED PARTS. ROUND ALL EDGES APPROXIMATELY R.02 FOR SHEET METAL PARTS. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.</p>		<p>LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY</p>		<p>PART NAME PCAL SUSPENSION RING RECEIVE SIDE</p>							
<p>DIMENSIONS ARE IN INCHES</p> <p>TOLERANCES: .XX ± .05 .XXX ± .010</p> <p>ANGULAR ± 0.5°</p>		<p>SYSTEM ADVANCED LIGO</p> <p>NEXT ASSY D1200174</p>		<p>SUB-SYSTEM AOS</p>		<p>DESIGNER S. SHANKLE 26 JUN 2012 DRAFTER S. SHANKLE 26 JUN 2012 CHECKER S. SHANKLE 26 JUN 2012 APPROVAL S. SHANKLE 26 JUN 2012</p>		<p>SIZE DWG. NO. c D1102354</p>		<p>REV. v4</p>	
<p>MATERIAL 6061-T6 Al</p>		<p>FINISH 63 μinch</p>		<p>SCALE: 1:10</p>		<p>PROJECTION:</p>		<p>SHEET 1 OF 1</p>			

- NOTES CONTINUED:**
- 5. SCRIBE, ENGRAVE (A VIBRATORY TOOL MAY BE USED), LASER MARK OR MECHANICALLY STAMP (NO INKS OR DYES) DRAWING PART NUMBER, REVISION (AND VARIANT OR 'TYPE' IF APPLICABLE) ON NOTED SURFACE OF PART FOLLOWED ON THE NEXT LINE WITH A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. USE MINIMUM 0.12" HIGH CHARACTERS, UNLESS THE SIZE OF THE PART DICTATES SMALLER CHARACTERS. EXAMPLE: DXXXXXX-VY, TYPE-XX, S/N XXX
 - 6. APPROXIMATE WEIGHT = X.XXX LB.
 - 7. MACHINE ALL SURFACES TO REMOVE OXIDES AND MILL FINISH. USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED. REFER TO LIGO-E0900364
 - 8. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.
 - 9. ALL HELI-COIL HOLES TO BE PREPARED ACCORDING TO EMHART HELI-COIL PRODUCT CATALOG, HC2000, REV 4
 - 10. ALL HELI-COIL INSERTS TO BE INSTALLED BY LIGO PERSONNEL. AFTER DELIVERY OF FINISHED PARTS, USE NITRONIC 60 THREADED INSERTS.
 - 11. ALL MATERIAL IS TO BE VIRGIN MATERIAL (i.e. NO WELD REPAIRS, PLUGS OR RECYCLED MATERIAL). NO REPAIRS SHALL BE MADE UNLESS APPROVED IN ADVANCE, AND IN WRITING, BY LIGO LABORATORY. REFER TO LIGO-E0900364.

REV.	DATE	DCN #	DRAWING TREE #
V1	26 JUN 2012	E1200700	
V2	13 JUL 2012	E1200700	



ITEM NO.	QTY.	PART NUMBER	DESCRIPTION
1	1	D1200725	PCAL PLATE STRUT

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)	
1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES, .005-.015, FOR MACHINED PARTS. ROUND ALL EDGES APPROXIMATELY R.02 FOR SHEET METAL PARTS. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.	
DIMENSIONS ARE IN INCHES	
TOLERANCES: .XX ± .02 .XXX ± .007	
ANGULAR ± 0.5°	
MATERIAL	6061 Alloy
FINISH	63 μinch

CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
SYSTEM	ADVANCED LIGO
SUB-SYSTEM	AOS
NEXT ASSY	D1200174

PART NAME				PCAL PLATE STRUT			
DESIGNER	S. SHANKLE	26 JUN 2012	SIZE	DWG. NO.	REV.		
DRAFTER	S. SHANKLE	26 JUN 2012	D	D1200725	v2		
CHECKER	S. SHANKLE	26 JUN 2012	SCALE:	1:2	PROJECTION:		
APPROVAL	S. SHANKLE	26 JUN 2012			SHEET 1 OF 1		

D1200725 - PCD Plate Strut, PART PDM REV: X-010, DRAWING PDM REV: X-002

NOTES CONTINUED:
 5. SCRIBE, ENGRAVE (A VIBRATORY TOOL MAY BE USED), LASER MARK OR MECHANICALLY STAMP (NO INKS OR DYES) DRAWING PART NUMBER, REVISION (AND VARIANT OR "TYPE" IF APPLICABLE) ON NOTED SURFACE OF PART FOLLOWED ON THE NEXT LINE WITH A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. USE MINIMUM 0.12" HIGH CHARACTERS, UNLESS THE SIZE OF THE PART DICTATES SMALLER CHARACTERS. EXAMPLE: DXXXXXX-VY, TYPE-XX, S/N XXX

6. APPROXIMATE WEIGHT = 59.5 LBS.

7. MACHINE ALL SURFACES TO REMOVE OXIDES AND MILL FINISH. USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED. REFER TO LIGO-E0900364

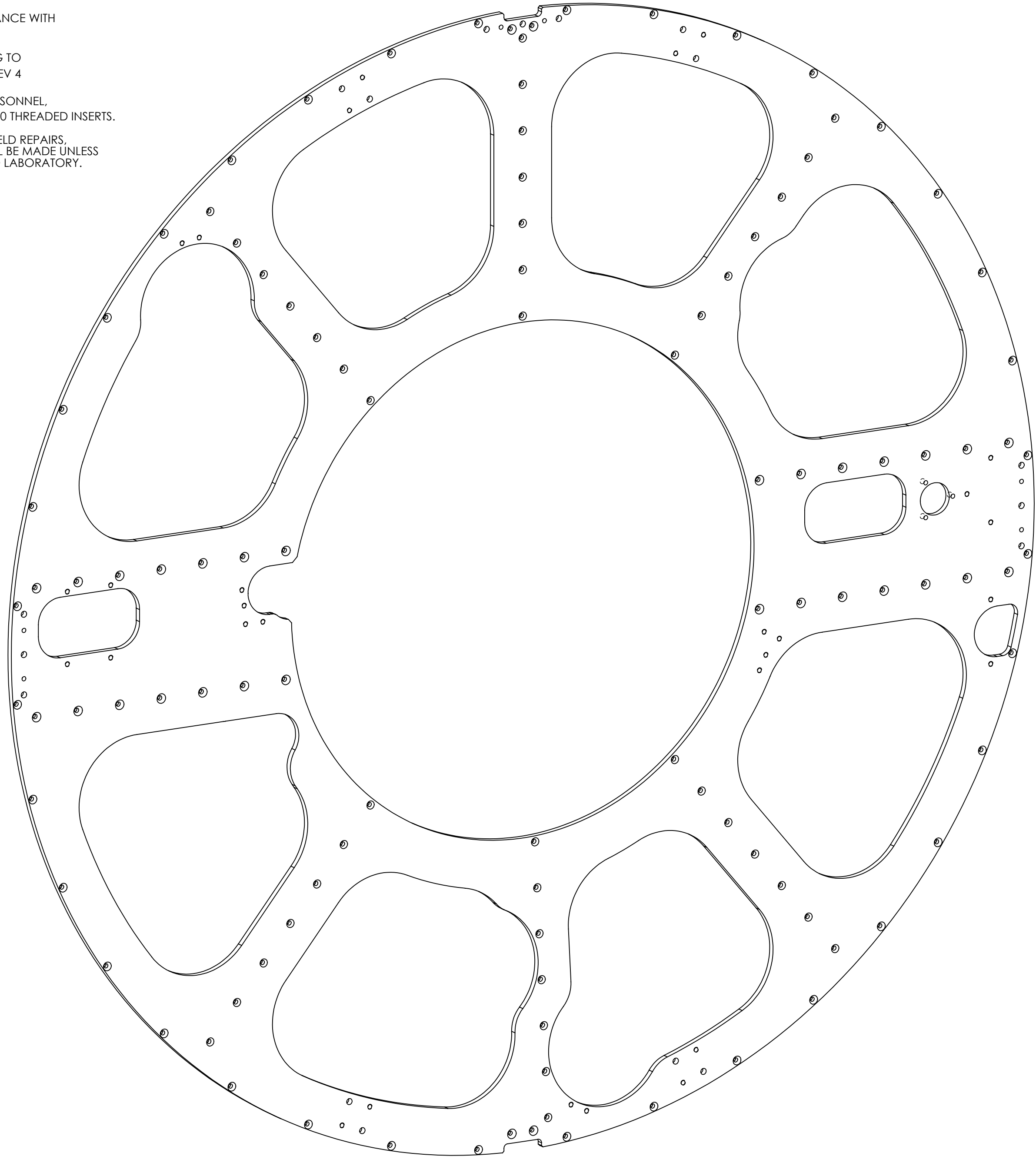
8. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.

9. ALL HELI-COIL HOLES TO BE PREPARED ACCORDING TO EMHART HELI-COIL PRODUCT CATALOG, HC2000, REV 4

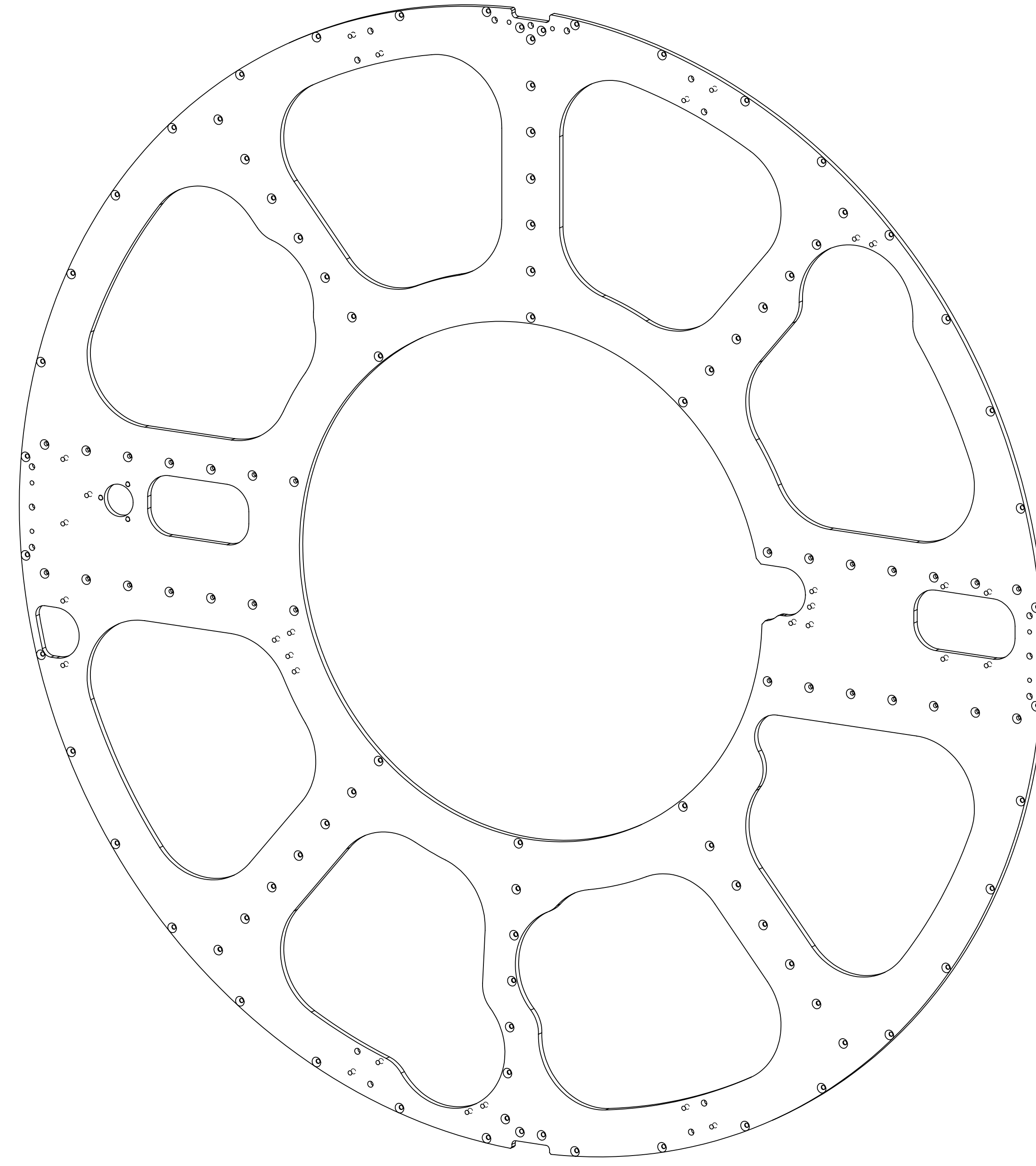
10. ALL HELI-COIL INSERTS TO BE INSTALLED BY LIGO PERSONNEL. AFTER DELIVERY OF FINISHED PARTS, USE NITRONIC 60 THREADED INSERTS.

11. ALL MATERIAL IS TO BE VIRGIN MATERIAL (i.e. NO WELD REPAIRS, PLUGS OR RECYCLED MATERIAL). NO REPAIRS SHALL BE MADE UNLESS APPROVED IN ADVANCE, AND IN WRITING, BY LIGO LABORATORY. REFER TO LIGO-E0900364.

REV.	DATE	DCN #	DRAWING TREE #
V1	26 JUN 2012	E1200700	
V2	13 JUL 2012	E1200700	
V3	20 AUG 2012	E1200700	
V4	03 SEP 2012	E1200700	



**D1200726-1
 (COUNTERSINK OPPOSITE DATUM "A" SURFACE)**



**D1200726-2
 (COUNTERSINK ON DATUM "A" SURFACE)**

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	SUPPLIER
2	9	1185-4EN375	INSERT, HELI-COIL 1/4-20 X .38 LG NITRONIC 60	HELI-COIL
1	1	D1200726-1	PCAL PLATE CAMERA MIRROR MTG	

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)	
1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES, .005-.015, FOR MACHINED PARTS. ROUND ALL EDGES APPROXIMATELY R.02 FOR SHEET METAL PARTS. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.	
DIMENSIONS ARE IN INCHES TOLERANCES: .XX ± .05 .XXX ± .010 ANGULAR ± 0.5°	MATERIAL: 6061 Alloy FINISH: 63 μinch

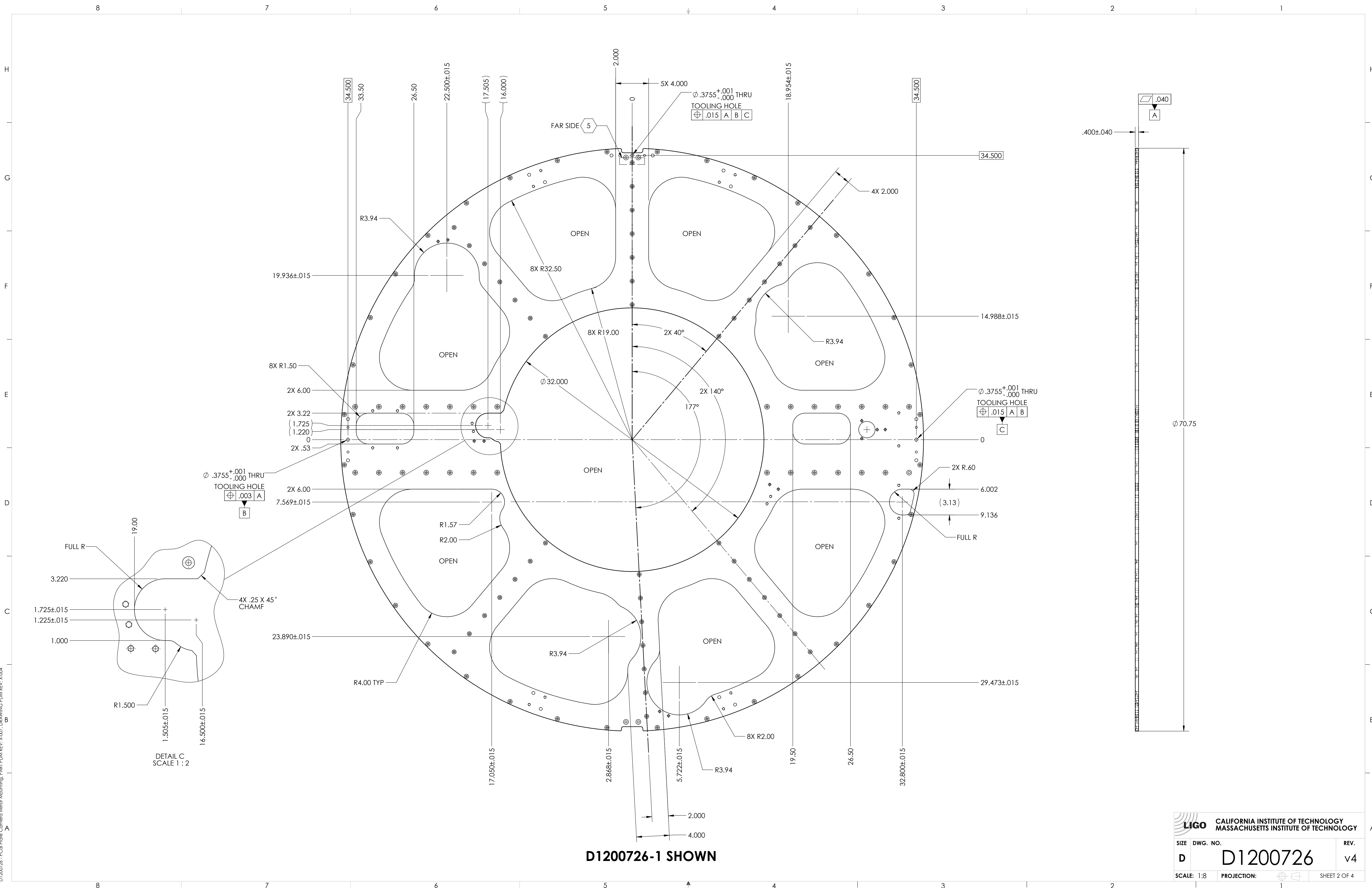
LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SYSTEM: ADVANCED LIGO SUB-SYSTEM: AOS

NEXT ASSY: D1200174

PART NAME		DESIGNER		SIZE		DWG. NO.		REV.	
PCAL PLATE CAMERA MIRROR MTG		S. SHANKLE		10 JUN 2012		D		D1200726	
CHECKER		S. SHANKLE		26 JUN 2012		SCALE: 1:8		PROJECTION:	
APPROVAL		S. SHANKLE		26 JUN 2012		SHEET 1 OF 4		v4	

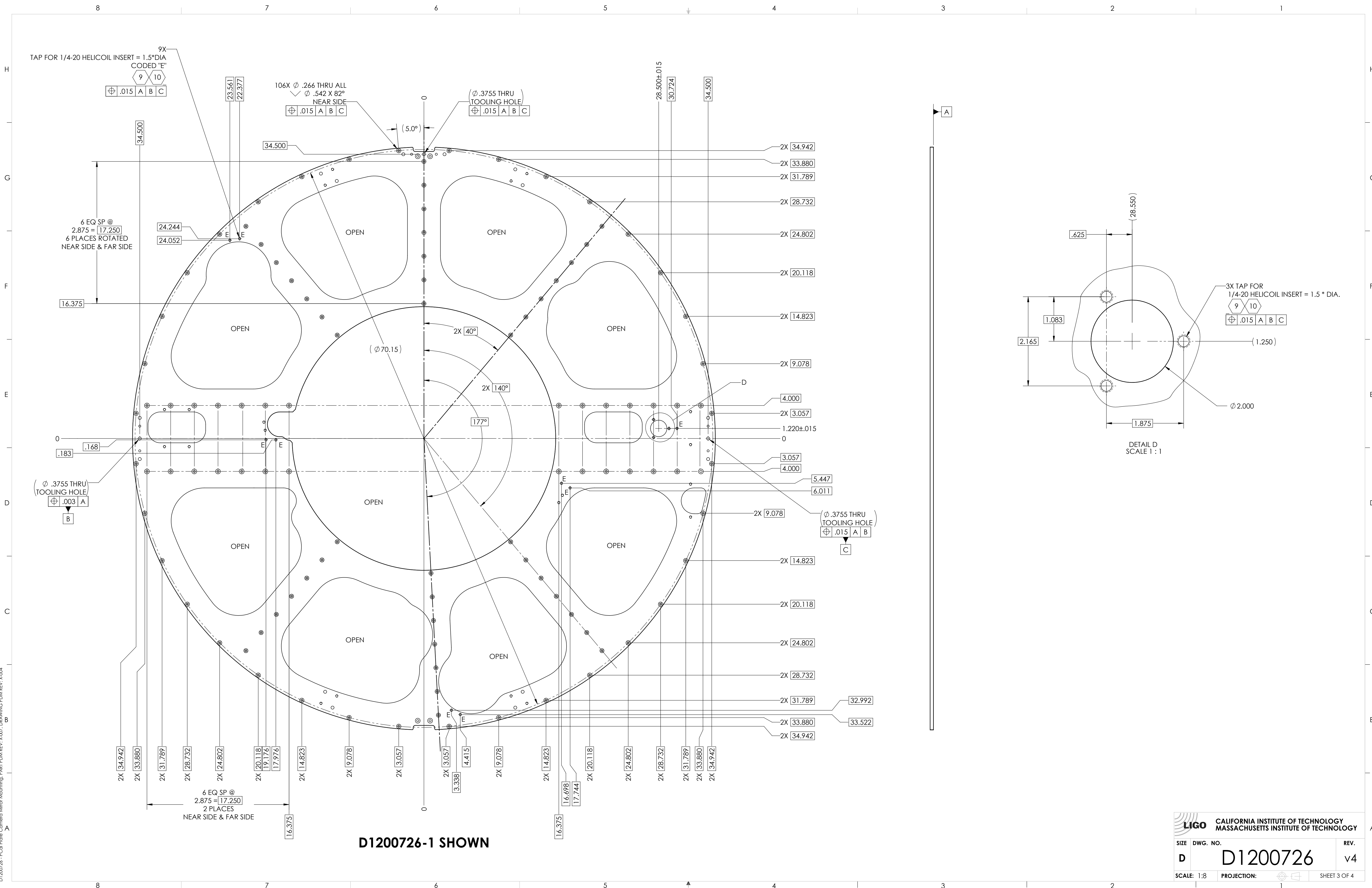
D1200726 - PCAL Plate Camera Mirror Mounting - PART FDM REV: X-007 - DRAWING FDM REV: X-004



D1200726-1 SHOWN

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		
SIZE	DWG. NO.	REV.
D	D1200726	v4
SCALE: 1:8	PROJECTION:	SHEET 2 OF 4

D1200726 - FCI Plate Camera Mirror Mounting - FAR FDM REV: X-007 DRAWING FDM REV: X-004

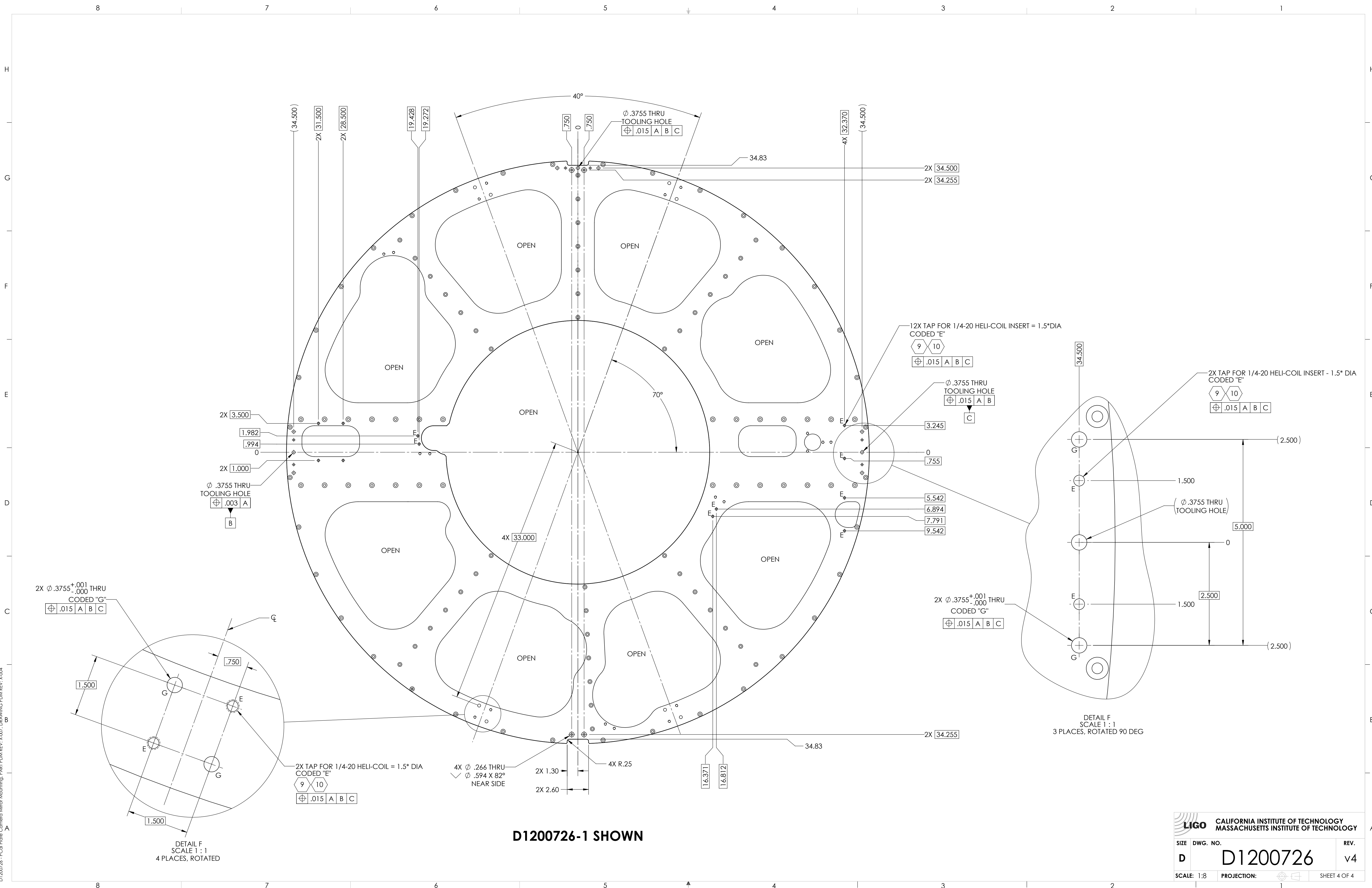


D1200726-1 SHOWN

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SIZE DWG. NO.	REV.
D D1200726	v4
SCALE: 1:8	PROJECTION:
SHEET 3 OF 4	

D1200726 - FCI Plate Camera Mirror Mounting - PART FDM REV. X-007 - DRAWING FDM REV. X-004



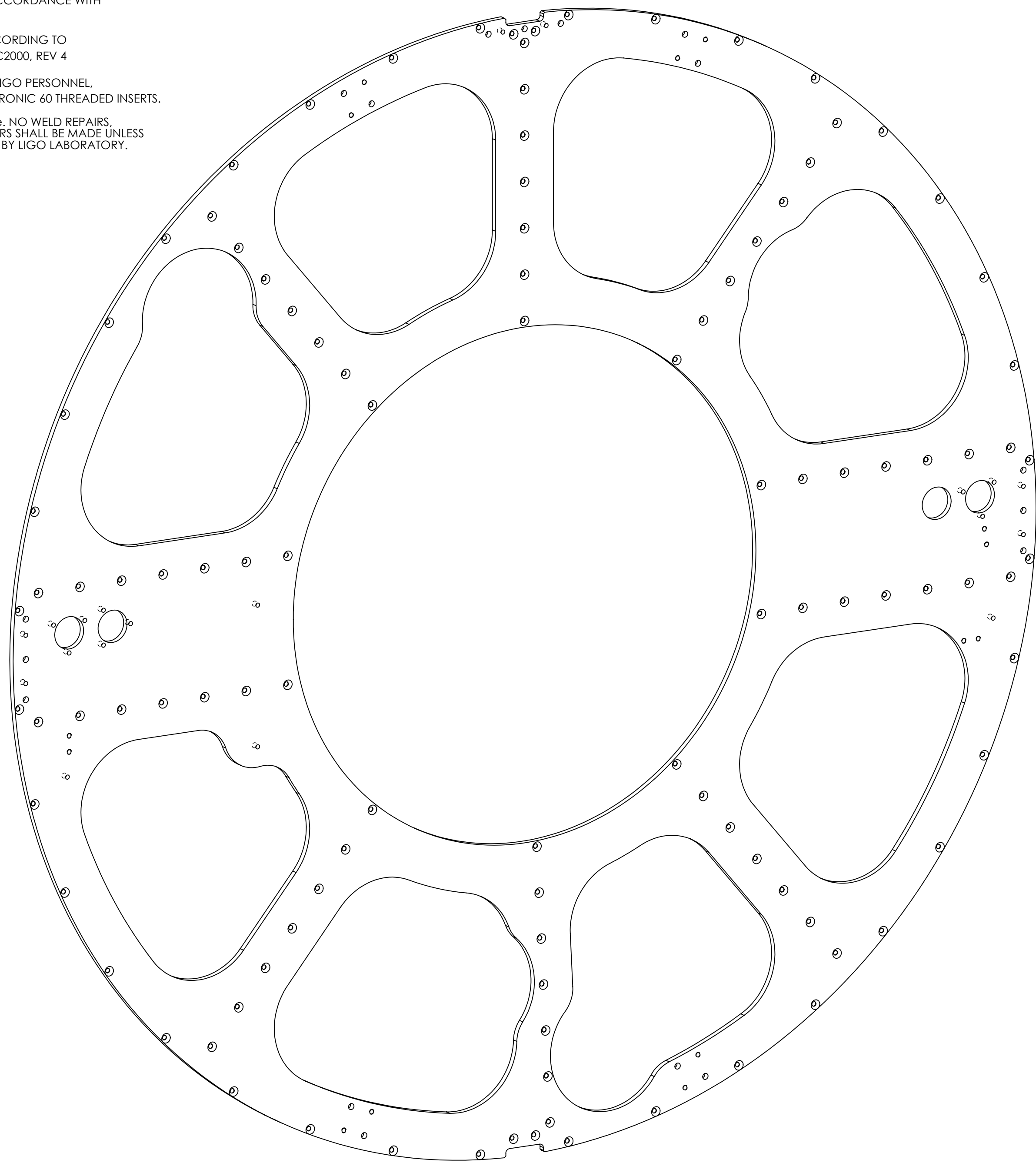
D1200726-1 SHOWN

CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
SIZE DWG. NO.	REV.
D	D1200726
SCALE: 1:8	SHEET 4 OF 4

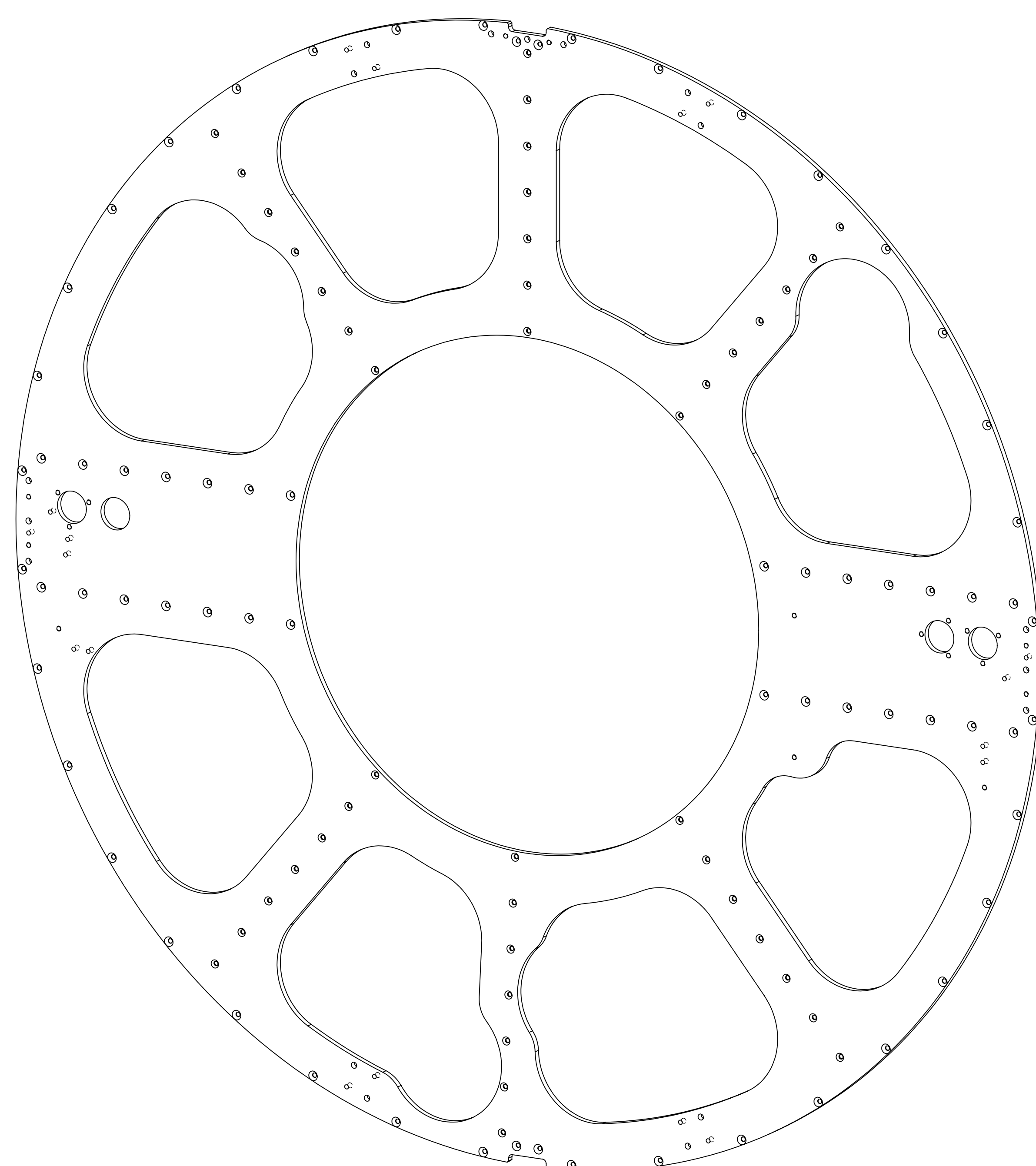
D1200726-1 FCD File Camera Mirror Mounting - PAR FDM REV: X-007 DRAWING PDM REV: X-004

- NOTES CONTINUED:
- 5. SCRIBE, ENGRAVE (A VIBRATORY TOOL MAY BE USED), LASER MARK OR MECHANICALLY STAMP (NO INKS OR DYES) DRAWING PART NUMBER, REVISION (AND VARIANT OR 'TYPE' IF APPLICABLE) ON NOTED SURFACE OF PART FOLLOWED ON THE NEXT LINE WITH A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. USE MINIMUM 0.12" HIGH CHARACTERS, UNLESS THE SIZE OF THE PART DICTATES SMALLER CHARACTERS. EXAMPLE: DXXXXXX-VY, TYPE-XX, S/N XXX
 - 6. APPROXIMATE WEIGHT = 59.5 LBS.
 - 7. MACHINE ALL SURFACES TO REMOVE OXIDES AND MILL FINISH. USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED. REFER TO LIGO-E0900364
 - 8. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.
 - 9. ALL HELI-COIL HOLES TO BE PREPARED ACCORDING TO EMHART HELI-COIL PRODUCT CATALOG, HC2000, REV 4
 - 10. ALL HELI-COIL INSERTS TO BE INSTALLED BY LIGO PERSONNEL. AFTER DELIVERY OF FINISHED PARTS, USE NITRONIC 60 THREADED INSERTS.
 - 11. ALL MATERIAL IS TO BE VIRGIN MATERIAL (i.e. NO WELD REPAIRS, PLUGS OR RECYCLED MATERIAL). NO REPAIRS SHALL BE MADE UNLESS APPROVED IN ADVANCE, AND IN WRITING, BY LIGO LABORATORY. REFER TO LIGO-E0900364.

REV.	DATE	DCN #	DRAWING TREE #
V1	26 JUN 2012	E1200700	
V2	13 JUL 2012	E1200700	
V3	20 AUG 2012	E1200700	
V4	03 SEPT 2012	E1200700	



**D1200727-1
(COUNTERSINK ON DATUM "A" SURFACE)**



**D1200727-2
(COUNTERSINK OPPOSITE DATUM "A" SURFACE)**

ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	SUPPLIER
2	4	1185-4EN375	INSERT, HELI-COIL, 1/4-20 X .375LG, NITRONIC 60	HELI-COIL
1	1	D1200727-1	PCAL PLATE MIRROR MTG	

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)	
1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES, .005-.015, FOR MACHINED PARTS. ROUND ALL EDGES APPROXIMATELY R.02 FOR SHEET METAL PARTS. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.	
DIMENSIONS ARE IN INCHES	
TOLERANCES: .XX ± .05 .XXX ± .010	
ANGULAR ± 0.5°	
MATERIAL	6061 Alloy
FINISH	63 μinch

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SYSTEM: **ADVANCED LIGO** SUB-SYSTEM: **AOS**

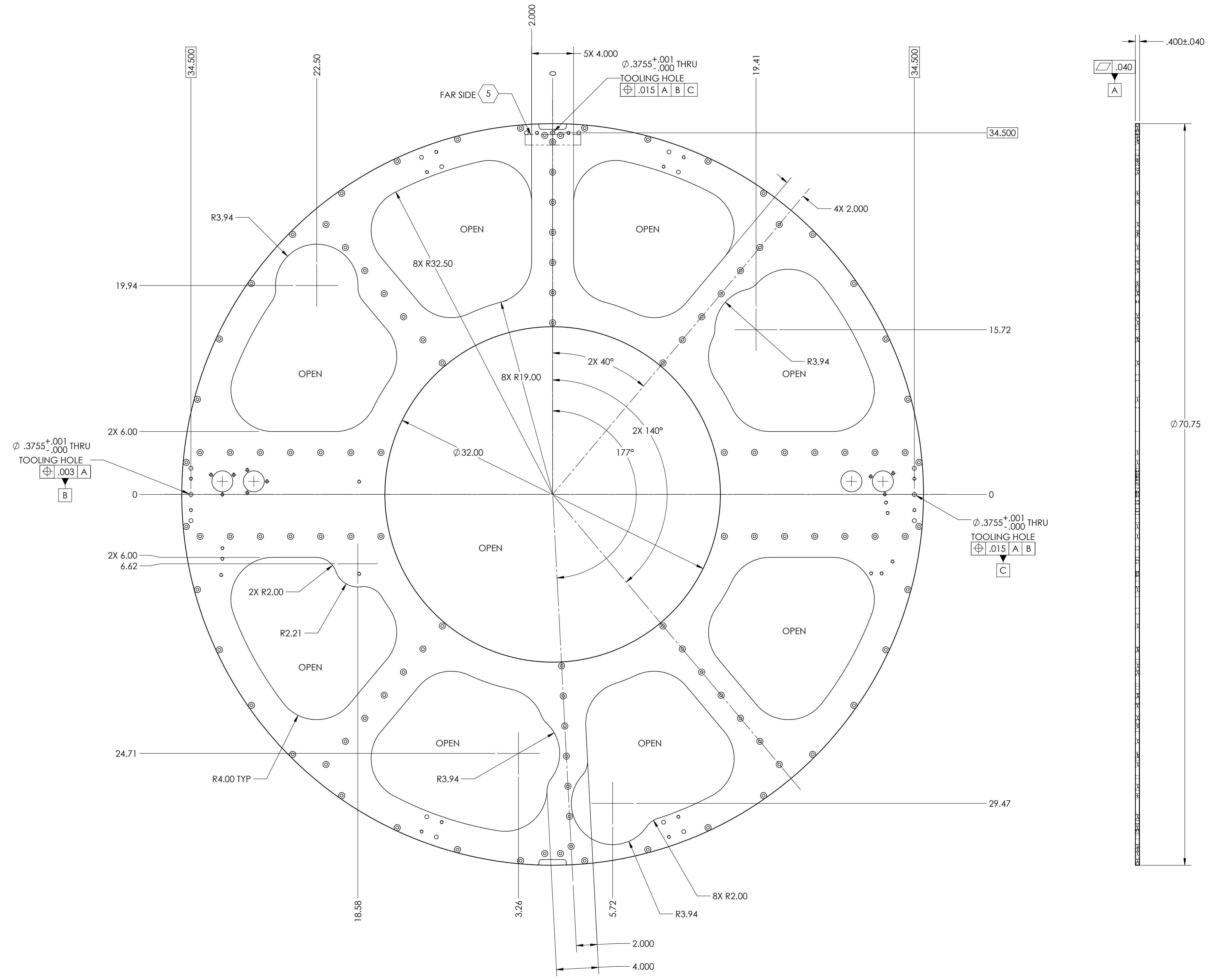
NEXT ASSY: **D1200174**

PART NAME		DESIGNER		SIZE		DWG. NO.		REV.	
PCAL PLATE MIRROR MTG		S. SHANKLE	10 JUN 2012	D		D1200727		v4	
CHECKER		S. SHANKLE	26 JUN 2012	SCALE: 1:8		PROJECTION:		SHEET 1 OF 4	
APPROVAL		S. SHANKLE	26 JUN 2012						

D1200727-1 - PCAL Plate Mirror Mounting, PART PDM, REV-X-008, DRAWING PDM, REV-X-005

8 7 6 5 4 3 2 1

H
G
F
E
D
C
B
A



D1200727-1 SHOWN

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SIZE	DWG. NO.	REV.
D	D1200727	v4
SCALE: 1:8	PROJECTION:	SHEET 2 OF 4

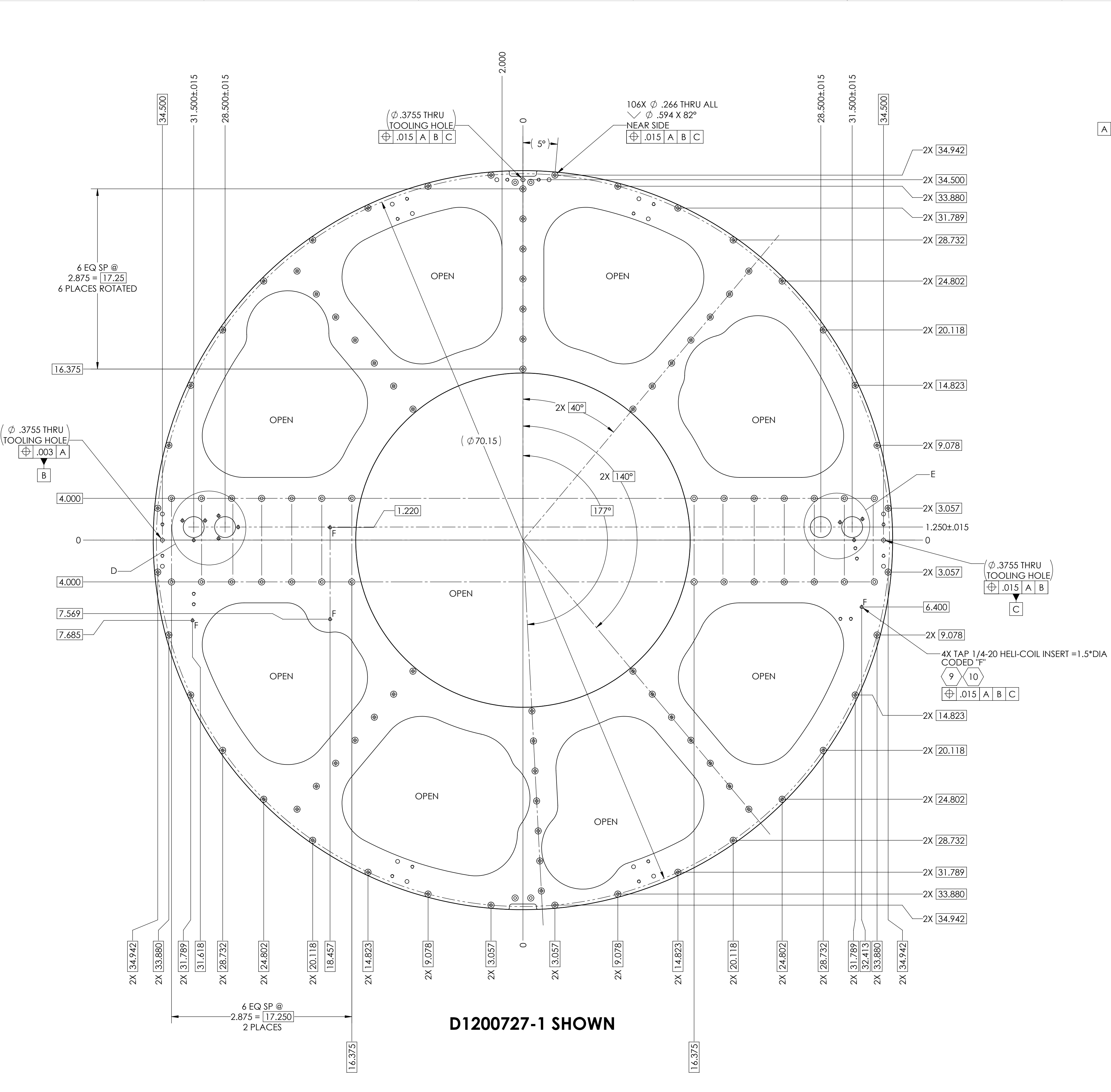
8 7 6 5 4 3 2 1

H
G
F
E
D
C
B
A

D1200727-1 FCI Plate Mirror Mounting, PART PDM REV: X-008, DRAWING PDM REV: X-005

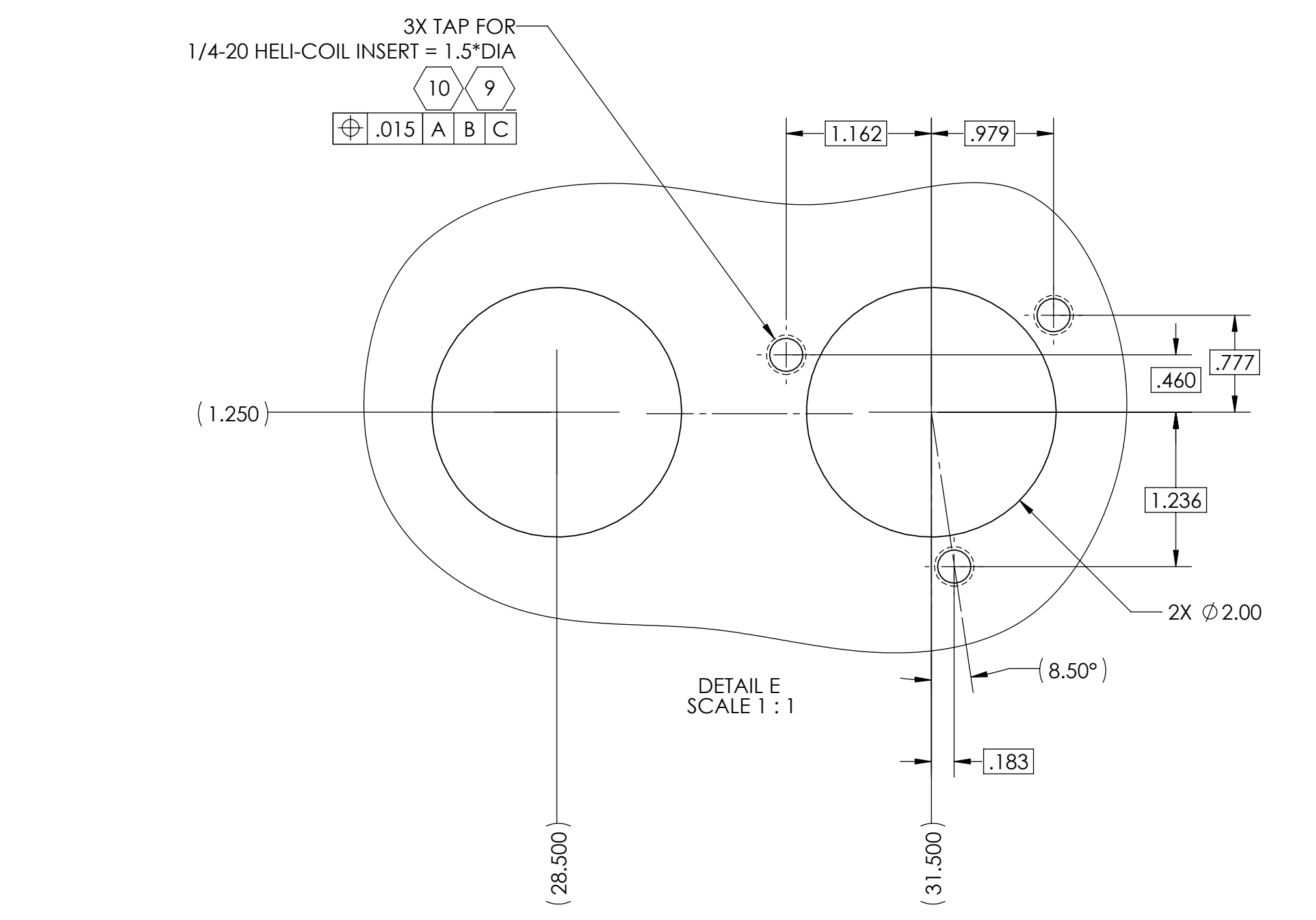
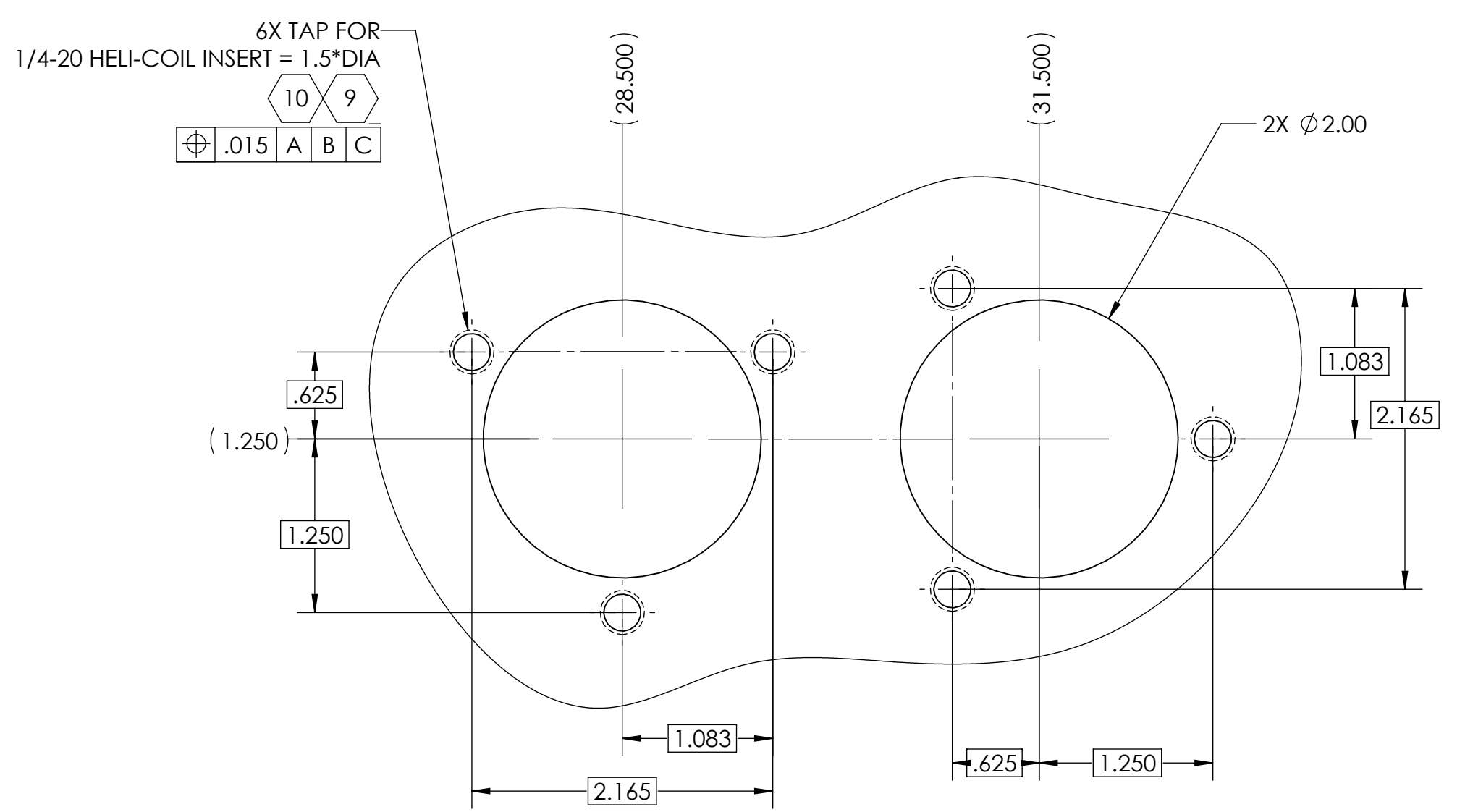
8 7 6 5 4 3 2 1

H
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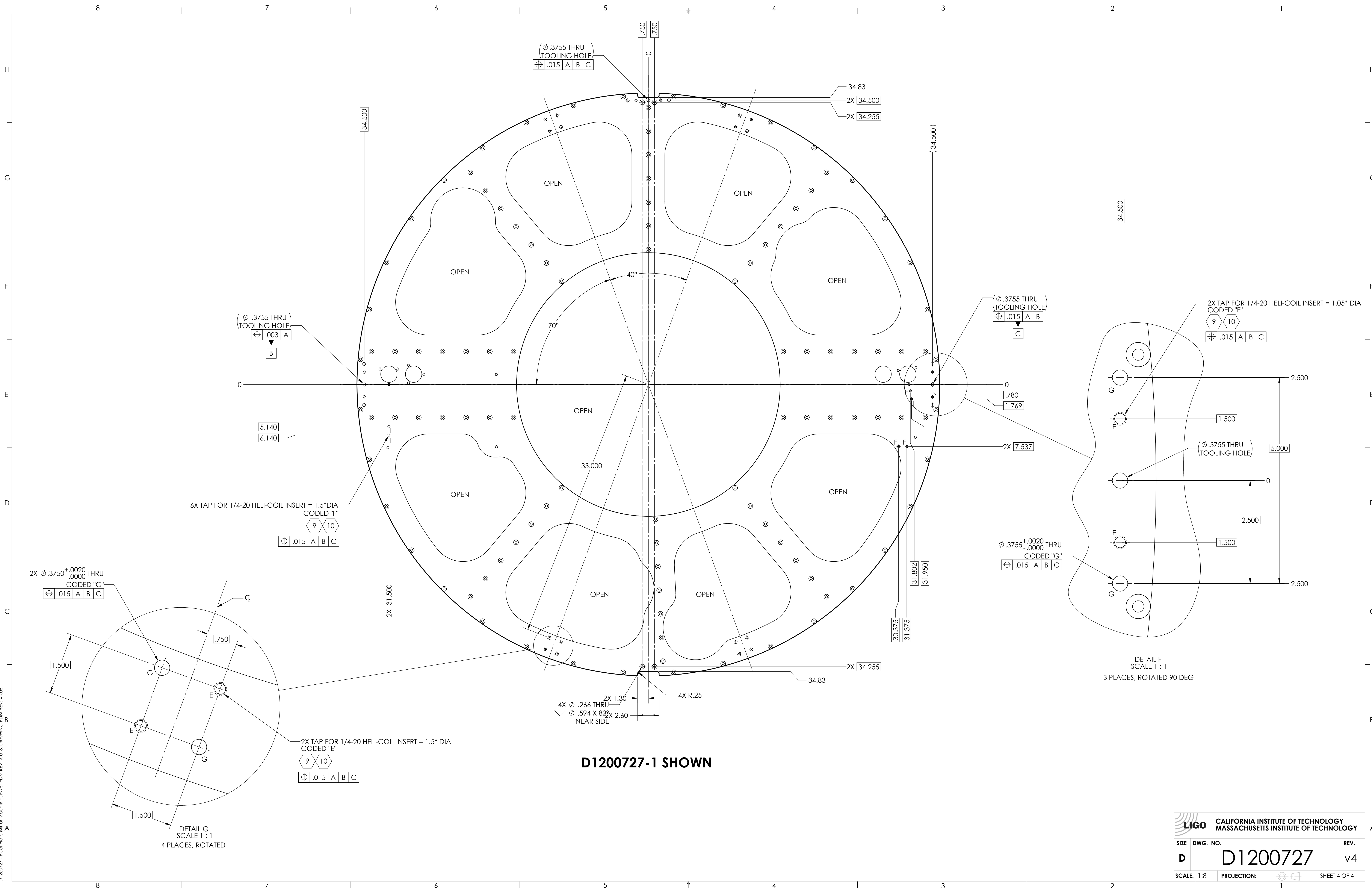


D1200727-1 SHOWN

A



D1200727-1 FCD File Mirror Mounting PART PDM REV: X-008 DRAWING PDM REV: X-005



(ϕ .3755 THRU)
TOOLING HOLE
 \oplus .015 A B C

34.83
2X $\boxed{34.500}$
2X $\boxed{34.255}$

(ϕ .3755 THRU)
TOOLING HOLE
 \oplus .003 A
B

(ϕ .3755 THRU)
TOOLING HOLE
 \oplus .015 A B
C

6X TAP FOR 1/4-20 HELI-COIL INSERT = 1.5"DIA
CODED "F"
 $\frac{9}{10}$
 \oplus .015 A B C

2X TAP FOR 1/4-20 HELI-COIL INSERT = 1.05" DIA
CODED "E"
 $\frac{9}{10}$
 \oplus .015 A B C

2X ϕ .3750 $^{+.0020}$ $_{-.0000}$ THRU
CODED "G"
 \oplus .015 A B C

ϕ .3755 $^{+.0020}$ $_{-.0000}$ THRU
CODED "G"
 \oplus .015 A B C

4X ϕ .266 THRU
 \checkmark ϕ .594 X 8.25 X 2.60
NEAR SIDE

D1200727-1 SHOWN

2X TAP FOR 1/4-20 HELI-COIL INSERT = 1.5" DIA
CODED "E"
 $\frac{9}{10}$
 \oplus .015 A B C

DETAIL G
SCALE 1 : 1
4 PLACES, ROTATED

DETAIL F
SCALE 1 : 1
3 PLACES, ROTATED 90 DEG

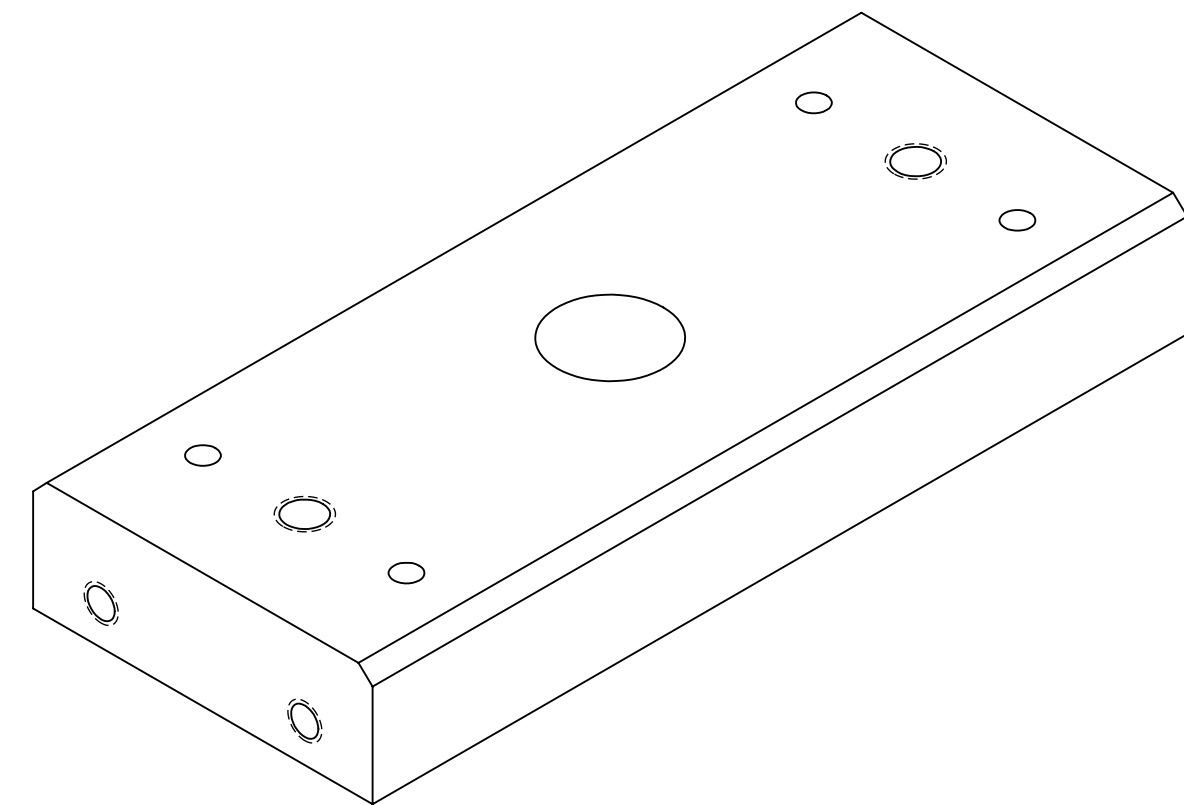
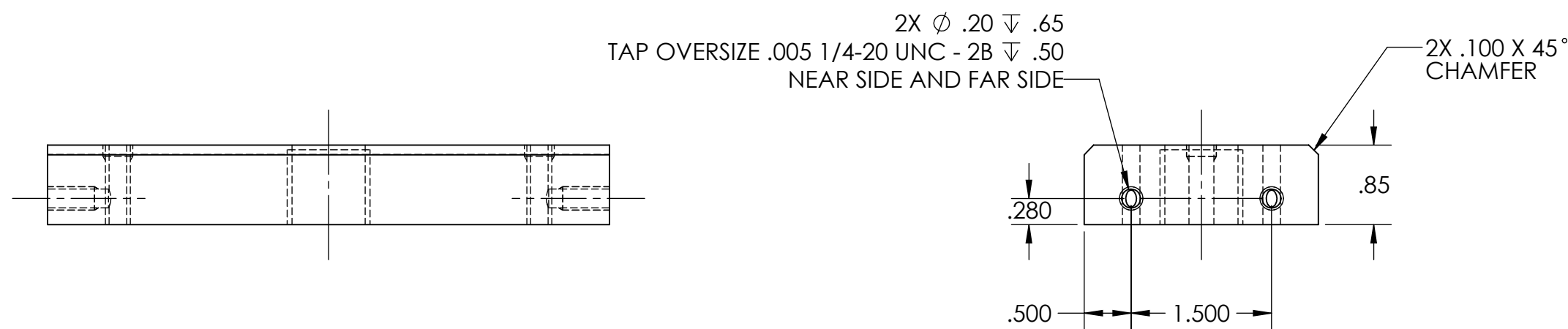
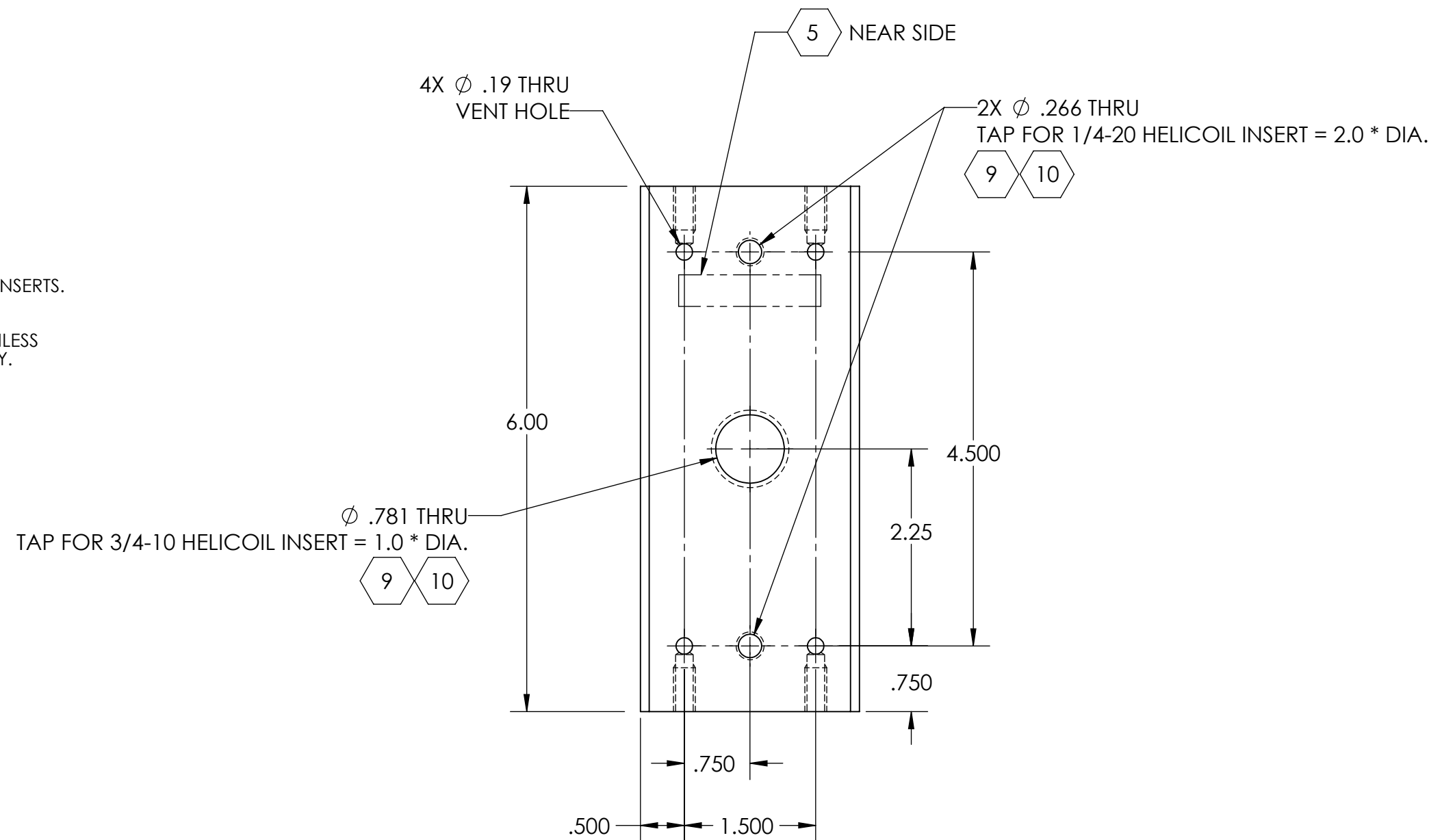
LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
SIZE DWG. NO.	REV.
D D1200727	v4
SCALE: 1:8	PROJECTION:
SHEET 4 OF 4	

D1200727-1 FCD File Mirror Mounting, PART PDM, REV: X-008, DRAWING PDM, REV: X-005

NOTES CONTINUED:

- 5. SCRIBE, ENGRAVE (A VIBRATORY TOOL MAY BE USED), LASER MARK OR MECHANICALLY STAMP (NO INKS OR DYES) DRAWING PART NUMBER, REVISION (AND VARIANT OR "TYPE" IF APPLICABLE) ON NOTED SURFACE OF PART FOLLOWED ON THE NEXT LINE WITH A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. USE MINIMUM 0.12" HIGH CHARACTERS, UNLESS THE SIZE OF THE PART DICTATES SMALLER CHARACTERS. EXAMPLE: DXXXXXX-VY, TYPE-XX, S/N XXX
- 6. APPROXIMATE WEIGHT = X.XXX LB.
- 7. MACHINE ALL SURFACES TO REMOVE OXIDES AND MILL FINISH, USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED. REFER TO LIGO-E0900364
- 8. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.
- 9. ALL HELI-COIL HOLES TO BE PREPARED ACCORDING TO EMHART HELI-COIL PRODUCT CATALOG, HC2000, REV 4
- 10. ALL HELI-COIL INSERTS TO BE INSTALLED BY LIGO PERSONNEL. AFTER DELIVERY OF FINISHED PARTS, USE NITRONIC 60 THREADED INSERTS.
- 11. ALL MATERIAL IS TO BE VIRGIN MATERIAL (i.e. NO WELD REPAIRS, PLUGS OR RECYCLED MATERIAL). NO REPAIRS SHALL BE MADE UNLESS APPROVED IN ADVANCE, AND IN WRITING, BY LIGO LABORATORY. REFER TO LIGO-E0900364.

REV.	DATE	DCN #	DRAWING TREE #
V1	26 JUN 2012	E1200700	
V2	13 JUL 2012	E1200700	
V3	20 AUG 2012	E1200700	



ITEM NO.	QTY.	PART NUMBER	DESCRIPTION	SUPPLIER
3	1	1185-12EN750	INSERT, HELI-COIL, 1/4-20 X .50 LG NITRONIC 60	HELI-COIL
2	2	1185-4EN500	INSERT, HELI-COIL, 1/4-20 X .50 LG NITRONIC 60	HELI-COIL
1	1	D1200731	PCAL PLATE RING CONNECTOR	

BOM Table

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES

TOLERANCES:
 .XX ± .02
 .XXX ± .005

ANGULAR ± 0.5°

1. INTERPRET DRAWING PER ASME Y14.5-1994.
2. REMOVE ALL SHARP EDGES, .005-.015. FOR MACHINED PARTS. ROUND ALL EDGES APPROXIMATELY R.02 FOR SHEET METAL PARTS.
3. DO NOT SCALE FROM DRAWING.
4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.

MATERIAL	6061 Alloy	FINISH	63 μinch
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LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SYSTEM: ADVANCED LIGO SUB-SYSTEM: AOS

NEXT ASSY: D1200174

PART NAME				PCAL PLATE RING CONNECTOR			
DESIGNER	S. SHANKLE	26 JUN 2012	SIZE	DWG. NO.	D1200731	REV.	v3
DRAFTER	S. SHANKLE	26 JUN 2012	c				
CHECKER	S. SHANKLE	26 JUN 2012					
APPROVAL	S. SHANKLE	26 JUN 2012	SCALE: 1:2	PROJECTION:			