



Statement of Work Fabrication of Arm Cavity Baffle (Machined Parts) for Advanced LIGO

The following documents are incorporated into and made a part this purchase order. Click on the following LIGO Document Control Center (DCC) links to access these documents or go on line to the LIGO Public DCC at <https://dcc.ligo.org/> to access the DCC#.

1.0 Terms:

<u>DCC #</u>	<u>Description</u>
C080185-v1	Laser Interferometer Gravitational Wave Observatory (LIGO) Commercial Items or Services Contract General Provisions California Institute of Technology "Institute", LIGO Rev 11/12/08
F0810001-v4	Technical Direction Memorandum.

2.0 Quality Control:

<u>DCC #</u>	<u>Description</u>
Q0900001-v4	Advanced LIGO Supplier Quality Requirements, dated 2/10/10, describes following contractor/supplier QA/QC actions for this procurement:
<input checked="" type="checkbox"/> 3.1 Pre-Award Inspection	<input checked="" type="checkbox"/> 3.9 Discrepant Material Storage
<input checked="" type="checkbox"/> 3.2 Supplier In Process Quality Control	<input checked="" type="checkbox"/> 3.10 Quality Records
<input checked="" type="checkbox"/> 3.3 In Process Inspection	<input checked="" type="checkbox"/> 3.11 Drawing and Specification Change Control
<input checked="" type="checkbox"/> 3.4 Pre-Ship Inspection	<input type="checkbox"/> 3.12 Welding Certification
<input checked="" type="checkbox"/> 3.5 Receiving Inspection	<input checked="" type="checkbox"/> 3.13 End Item Data Package (including Certifications of Compliance)
<input checked="" type="checkbox"/> 3.6 Discrepant Material	<input type="checkbox"/> 4.1 Design Verification
<input checked="" type="checkbox"/> 3.7 Material Review Action	<input checked="" type="checkbox"/> 4.2 Raw Material Procurement
<input checked="" type="checkbox"/> 3.8 Material Review Actions at Contractor	<input checked="" type="checkbox"/> 4.3 Traceability of Materials
	<input checked="" type="checkbox"/> 4.4 Calibration Program
	<input type="checkbox"/> 4.5 Critical Interface
	<input checked="" type="checkbox"/> 4.6 Cleanliness
	<input checked="" type="checkbox"/> 4.7 Packaging
	<input checked="" type="checkbox"/> 4.8 Storage
	<input checked="" type="checkbox"/> 4.9 Transport
	<input type="checkbox"/> 4.10 Customs

For the above list the Supplier shall: 1) Identify the corresponding sections/paragraphs in their existing QA/QC system 2) meet or exceed the design requirements contained in the attached engineering documents for each area called out.

LIGO prefers to utilize the vendors existing QA/QC programs to the fullest extent possible consistent with the LIGO QA and QC requirements. All bidders are requested to submit a written description/plan of their existing QA/QC system with their quotes. The bidder must also submit QA/QC plans for managing subcontractor work and materials.

In the event that a prospective contractor lacks an existing quality system, the contractor/vendor shall develop and implement a quality assurance program in compliance with requirements negotiated at contract/PO award.

3.0 End Item Data Package:

At the time of delivery of the parts, the Supplier shall also 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
- Dimensional & QC inspection reports—this shall include a report showing that parts have been inspected and fall within specified tolerances.
- Certificate or statement of compliance with all contract and drawing process restrictions.

4.0 Included Documents:

Arm Cavity Baffles: Metal Mechanical Parts and Quantities, see Section 9.0. In addition to the drawings, the contractor will be provided with CAD solid models of the parts (SolidWorks Professional 2009, SP5.0) CAD files will be supplied in the format preference of vendor.

<u>DCC #</u>	<u>Description</u>
E0900364-v7	LIGO Metal in Vacuum Specification
E0900023-v10	Process for Manufacturing Cantilever Spring Blades for AdvLIGO
Q1100003-v1	Acceptable Quality Level (AQL) for Inspection of LIGO Components

5.0 Scope:

- 5.1 This SOW is for the fabrication of various individual piece parts of sheet metal and machined parts per the thirty-seven (37) unique drawings listed in **Table 1: Parts List, Delivery Quantities and Schedule**.
- 5.2 Acceptance Test: A First Article Assembly will be fabricated, assembled and approved at the vendor site for fit check prior to fabrication of complete order. Assembly instructions and fasteners will be supplied by LIGO.
- 5.3 Inspect using AQL Level 1.0.
- 5.4 Some piece parts will require electro-polish processing, as specified in drawing. These parts must be handled with clean gloves after electro-polish process. See parts denoted by “*” in **Table 1: Parts List, Delivery Quantities and Schedule**.
- 5.5 For part number D1002608 - SLC ACB Suspension Blade, heat treatment and nickel plate process will be the responsibility of LIGO.
- 5.6 ALIGO will supply material required to fabricate piece parts made of 18 GA Enamel Steel A424 Type I and Maraging Steel C250.

Return unused materials to: LIGO Laboratory
California Institute of Technology
Attn: Michael Smith
MS 100-36
391 S. Holliston Ave.
Pasadena, CA 91125

- 5.7 Upon acceptance, all piece parts fabricated from 18 GA Enamel Steel A424 Type I will be satisfactorily packaged and shipped to vendor specified by ALIGO for porcelain coating, as specified in Section 9.0. Part numbers D1000973 and D1002357-0X must be packaged in a manner which maintains the ‘accordion’ configuration. Shipping containers will be constructed for multiple use.
- 5.8 All other piece parts will be shipped as specified in Section 9.0. Shipping containers will be constructed for multiple use.

6.0 Quantity Requirements

See Table 1 for required quantities.

7.0 Delivery Requirements

The deliveries are FOB at these destinations, i.e. the contractor has responsibility for shipping title and control of goods until they are delivered and the transportation has been completed. The contractor selects the carrier and is responsible for the risk of transportation and for filing claims for loss or damage.

7.1 Packaging

All packaged items shall have appropriate labels attached to properly identify the following:

- Destination Site
- LIGO Assembly – ARM CAVITY BAFFLE
- LIGO Contact person and information
- Part ID, serial number or other identifying data
- Shipping manifest with long text description of enclosed items

7.2 Shipping Containers

The contractor is responsible for providing shipping containers and transportation which protects these parts from damage from the transportation environment (weather, handling, accidents, etc.). Mating edges of parts should be especially protected from damage during shipping.

7.3 Shipping Locations:

7.3.1 LIGO Livingston Observatory (LLO)

Attn: Chris Guido
19100 LIGO Lane
Livingston, LA 70754

7.3.2 LIGO Hanford Observatory (LHO)

Attn: Gerardo Moreno
127124 North Route 10
Richland, WA 99354

7.3.3 LIGO Specified Vendor – to be provided at acceptance of bid.

8.0 Manufacturing Requirements

8.1 Precedence

The Statement of Work (SOW) sections below regarding processing or fabrication of the parts are meant to convey the scope and nature of the requested work. The parts are to be produced using the CAD models which will be provided to the contractor upon award.

8.2 Additional Restrictions

- Machine all surfaces to remove oxides and mill finish, unless otherwise stated. Abrasive removal techniques are not acceptable. No sanding of any type. No use of Scotch-Brite (tm) or similar abrasive products.
- All machining fluids must be fully synthetic, water soluble (not simply water miscible) and free of sulfur, chlorine, and silicone.
- Thoroughly clean part to remove all oil, grease, dirt, and chips with soap and water. Follow with solvent (acetone) wipe. Pay close attention to tapped holes.
- No repairs shall be made unless approved in advance, and in writing, by LIGO Laboratory.

8.3 Materials

Material is specified on the drawings. Use domestic materials only. All materials specified by drawings or SOW have been approved for use in the UHV environment in LIGO. No materials may be substituted or added without prior knowledge and testing by LIGO. Cast tooling plate is not permitted.

8.4 Machining

All parts are to be machined. No grinding or lapping with abrasive wheels, cloth or stones is permitted. No sanding of any type. No use of Scotch-Brite (tm) or similar abrasive products. No parts shall be cast or molded. Water soluble (not just water miscible) cutting fluid (lubrication) is to be used for all machining operations. The use of cutting fluids or lubricants, which contain sulfur, chlorine or silicone compounds is prohibited.

8.5 Finishing

Any required surface finish is defined in the drawings. Localized scratches, digs and blemishes should be minimized.

8.6 Marking

Parts shall be marked per drawing notes.

9.0 Delivery Schedule

Refer to Table 1 for delivery schedule. Early and/or partial deliveries are welcome. If this schedule cannot be accommodated, please provide an alternative delivery schedule for consideration with your bid package.

Table 1: Parts List, Delivery Quantities and Schedule

ITEM NO.	DRWG NUMBER	REV	DESCRIPTION	Total Order QTY	DELIVERY LOCATIONS -				
					LIGO Specified Vendor		LIGO Hanford, WA		LIGO Livingston, LA
					First Article 4/26/11	6/17/11	First Article 4/26/11	6/17/11	6/17/11
1	D1000684	V1	SLC TUBE LOWER MTG PLATE	11			1	6	4
2	D1000909	V1	SLC COPPER PLATE	11			1	6	4
3	D1000929	V1	SLC COPPER SUPPORT PLATE	11			1	6	4
4	D1000930	V1	SLC MAGNET HOLDER STEEL PLATE	11			1	6	4
5	D1000973	V1	ARM CAVITY BAFFLE SKIN	5	1	4			
6	D1000974	V1	ARM CAVITY BAFFLE TOP SKIN	11	1	10			
7	D1000975	V1	ARM CAVITY BAFFLE BTM SKIN	11	1	10			
8	D1000976	V1	ARM CAVITY BAFFLE CTR SKIN	11	1	10			
9	D1001009	V1	ARM CAVITY BAFFLE LO TUBE *	11			1	6	4
10	D1001026	V1	ARM CAVITY BAFFLE UP LEAF	11	1	10			
11	D1001027	V1	ARM CAVITY BAFFLE LOWER LEAF	11	1	10			
12	D1001120	V1	SLC EARTHQUAKE STOP RING	22			2	12	8
13	D1001138	V1	SLC ACB INTERFACE MTG PLATE	11			1	6	4
14	D1001186	V1	SCREW #3/4-10 X 4	15			2	8	5
15	D1001363	V1	ACB SIDE REINFORCING HATSECTION	22	2	20			
16	D1001365	V1	ARM BAFFLE MIDDLE REINFORCING PLATE	22	2	20			
17	D1001621	V1	ARM CAVITY BAFFLE UPPER MOUNTING HINGE	11			1	6	4
18	D1001622	V1	ARM CAVITY BAFFLE LOWER MTG HINGE	11			1	6	4
19	D1001700	V1	SLC INTERFACE MOUNTING CLAMP	66			6	36	24
20	D1001826	V1	SLC ACB BALANCING WEIGHT	44			4	24	16
21	D1002340	V1	SLC ACB SUSPENSION ROD	15			2	8	5
22	D1002357-01	V1	ARM CAVITY BAFFLE 1 HOLE SKIN - RIGHT QPD	2		2			
23	D1002357-02	V1	ARM CAVITY BAFFLE 1 HOLE SKIN - LEFT QPD	2		2			
24	D1002357-03	V1	ARM CAVITY BAFFLE 1 HOLE SKIN - RIGHT NO QPD	1		1			
25	D1002357-04	V1	ARM CAVITY BAFFLE 1 HOLE SKIN - LEFT NO QPD	1		1			
26	D1002560	V1	SLC DAMPING TUBE TOP PLATE	11			1	6	4
27	D1002561	V1	SLC DAMPING 8 DIA TUBE *	11			1	6	4

ITEM NO.	DRWG NUMBER	REV	DESCRIPTION	Total Order QTY	DELIVERY LOCATIONS -				
					LIGO Specified Vendor		LIGO Hanford, WA		LIGO Livingston, LA
					First Article 4/26/11	6/17/11	First Article 4/26/11	6/17/11	6/17/11
28	D1002581	V1	SLC SUSPENSION ROD SUPPORT	11			1	6	4
29	D1002608	V1	SLC ACB SUSPENSION BLADE *	15	1	14			
30	D1002609	V1	SLC BLADE MOUNTING BRACKET	11			1	6	4
31	D1002610	V1	SLC TUBE UP CONNECTOR PLATE	11			1	6	4
32	D1002612	V1	SLC UPPER TUBE *	11			1	6	4
33	D1002617	V1	SLC DAMPING TUBE LOWER PLATE	11			1	6	4
34	D1002618	V1	SLC TUBE LOWER CONNECTOR PLATE	11			1	6	4
35	D1002844	V1	SLC ACB BLADE CLAMP	11			1	6	4
36	D1003025	V1	QPD HOUSING	53	8	45			
37	D1100243	V1	SLC ACB 3 DEGREE SHIM	11			1	6	4

LIGO Document Control Center

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Accessing the DCC

LIGO User (upload and access all documents)

Public User (view public documents only)

Public Document Search

Old DCC Search Google Public Document Search:

Using the DCC

The Document Control Center is the central repository for electronic documents related to **LIGO**.

In order to access private documents, you will be prompted for your LIGO account name and password, of the form **albert.einstein**. If you do not have a LIGO account, you may request one from the **LIGO Directory**. If you have forgotten your password you may **reset it**.

The LIGO DCC is built on top of **DocDB**. For more information on the DCC, please consult the **User's Manual**.

NEWS

The DCC will be shutdown for maintenance on March 8, 2011 at 5:30 PM Pacific for 1 hour to upgrade with **usability improvements for searching and authorship** and apply security patches.

There are backup read-only DCC systems at each Observatory (**dcc-lho.ligo.org** and **dcc-llo.ligo.org**) that may be used when the main system is unavailable.

All type G documents (Presentations) from the old document system have been **migrated**.

All type T documents (Technical Notes) from the old document system have been **migrated**.

All type E documents (Engineering) from the old document system have been **migrated**.

All type D documents (Drawings) from the old document system have been **migrated**.

The DCC was updated on October 8, 2009 to add a faster search engine, apply more restrictive author and file content searches by default, and to add a richer group hierarchy for document access starting with an Advanced LIGO Business group. Further details may be found **here**.

The DCC was updated on May 7, 2009 to offer support for Author Groups, granting access to documents based on who is an author, and adding custom access groups apart from the initial set of hierarchical groups. Further details may be found **here**.

The DCC was updated on February 26, 2009 to offer initial support for the public release of documents and QA approval of document metadata by the DCC support team. The full list of bugs and enhancements associated with this release are linked to the **version 2.1.0 support ticket**.

The new DCC was released to the LSC on Jan 26, 2009 as announced **here**.



LIGO Laboratory / LIGO Scientific Collaboration

LIGO-Q0900001-V4-P

Advanced LIGO

February 10th, 2010

Advanced LIGO Supplier Quality Requirements

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Distribution of this document:
LIGO Scientific Collaboration

This is an internal working note
of the LIGO Laboratory.

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Revision History

Revision LTR	Released By	Pages Affected	Date	DCN Number
00	Mick Flanigan	All	08/15/08	N/A
01	Mick Flanigan	All	08/29/08	N/A
02	Mick Flanigan	5, 6	02/10/10	N/A

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1. Quality Program Guideline

1.1. Purpose of this Document

The purpose of this document is to provide guidance, requirements and general procedures for a Quality Assurance and Quality Control program (QA/QC) as it applies to procurements and contracted effort. It provides recommendations on the policies and phrases to be used in all “Request for Proposal” (RFP) or “Request for Quote” (RFQ) solicitations to be sent to prospective suppliers and vendors for Advanced LIGO components, parts, or services. The audience for this document is the LIGO technical and procurement staff, as well as the potential suppliers bidding against and RFQ/RFP. Section 3 and 4 provide detailed descriptions of the applicable sections in the RFQ/RFP that are checked by the LIGO procurements and Engineering teams, providing suppliers definitions to assist in formulating the bids.

Advanced LIGO is a project undertaken by the LIGO Laboratory (or simply ‘LIGO’).

This document is intended for use when the supplier is manufacturing and/or assembling components, or providing services, which require a LIGO review of the supplier QA/QC monitoring. LIGO engineering, projects, procurement and QA teams will make determinations on the applicability of this document on a case by case basis.

1.2. Purpose of a Quality Program

A Quality Program is a framework for ensuring completeness, correctness, reliability and maintainability of a system and its components. The specific goals and deliverables of a Quality program for Advanced LIGO are:

- 1.2.1. All designs are to be carefully reviewed and finalized through an Advanced LIGO Design Review process.
- 1.2.2. The supplier has an accurate and complete set of design specifications, drawings, and material and performance characteristics.
- 1.2.3. The supplier maintains an internal quality program to ensure systems are fabricated, assembled, and tested to specifications provided by LIGO.
- 1.2.4. The supplier ensures appropriate workmanship, including but not limited to certification, safety, handling, cleanliness and documentation.
- 1.2.5. The supplier will provide appropriate packaging and shipping methods to protect the component(s) from damage in transit.
- 1.2.6. The supplier shall provide reliability estimates, maintenance procedures and schedules, if applicable.

1.2.7. Both LIGO and the supplier may, in general (depending upon the particular aspects and criticality of the effort), participate in pre-award audits, in process inspections; post-assembly and post-install inspections and acceptance testing. Enable LIGO and the supplier to establish specific expectations, and mechanisms, up front on remedying issues which arise during fabrication and testing, where the component does not meet design, assembly or performance specifications due to improper manufacturing, faulty sub-components, or improper fit or performance of critical interfaces, or improper packaging and shipping methods. An example is a Material Review Board (MRB)

1.3. Relevant Documents

LIGO-E010613-02, Generic Requirements & Standards for Detector Subsystems [in particular section 9]

LIGO-E030350-A, Drawing Requirements

Other documents specific to the given RFP/RFQ will be provided as part of the package and not referenced here. Also additional documents may be released once the bid process is complete and contract award is taking place.

2. Procurement Process

2.1. Pre-Procurement Activities

RFPs and RFQs shall be written to use contractor/vendor existing QA systems to the fullest extent possible consistent with the provisions outlined in LIGO Quality Assurance Plan M960076-P. Should a contractor lack an existing quality system, the contractor shall develop a quality assurance plan in compliance with the requirements negotiated at contract award.

2.2. LIGO Procurement Documentation

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

- 2.2.1. Technical documents, drawings, and specifications, identified by revision.
- 2.2.2. Preservation, packaging, storage, and shipping requirements.
- 2.2.3. Requirements for component longevity.
- 2.2.4. Specific Inspection and Test requirements.
- 2.2.5. End Item Data Package requirements.
- 2.2.6. Requirements for source inspection by customer.
- 2.2.7. Safety Performance requirements.

2.3. Supplier Bid Package Requirements

As part of the bid package, and for consideration in contract award, the supplier shall confirm the intent to comply with the following Quality Program requirements (if and as applicable):

- 2.3.1. Provide with the deliverables all supplier-generated technical documents, drawings, and specifications, identified by revision, with all red line items updated in electronic format (source files and Adobe Acrobat) for the as-built system or component.
- 2.3.2. Adhere to all shipping, packaging and cleanliness requirements as required in the Advanced LIGO design documents.
- 2.3.3. Submit all tests and inspection reports to LIGO immediately following completion, in agreed upon electronic format.
- 2.3.4. Fulfill requirements for source inspection by customer, which can include a pre-award inspection, in process audits, as well as a pre-ship inspection.
- 2.3.5. Provide a copy of their existing QA/QC program, with a strategy for implementing in conformance to Advanced LIGO requirements, if necessary.

3. Manufacture, Assembly and Receiving Inspection Requirements

3.1. Pre-Award Inspection

Prior to contract award LIGO staff may perform an audit of the prospective supplier quality programs. The need to perform an audit will be determined by the Contracting Officer's Technical Representative (COTR), the subsystem leader and/or the chief engineer, based on criticality, cost, and use case of components. The audit scope includes but is not limited to:

- Calibration program review.
- Maintenance and reliability programs for manufacturing equipment.
- Critical worker certification levels (i.e., welding, electrical, CNC, etc.).
- 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.

3.2. Supplier in Process Quality Control

Critical processes shall be controlled using manufacturing travelers or procedures established and qualified prior to LIGO equipment production. As an example, these manufacturing procedures shall include:

- Equipment to be used including calibration requirements.

- Identification of operational constraints.
- Workmanship standards.
- Call-outs for inspections, tests, and other verification processes.
- Acceptance criteria.

3.3. 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 fabrication and assembly by planning Mandatory Control Points (MCPs). Suppliers shall document all deficiencies and discrepancies, and report immediately to LIGO. Electronic format, via email transmission, is the preferred method of report delivery.

3.4. Pre-Shipment Inspection

Supplier shall inspect and validate system integrity prior to shipment of equipment to any LIGO site. LIGO may choose to send a representative to participate in inspections deemed critical. Pre-shipment inspection of equipment to be delivered to the LIGO observatories shall include the following (as appropriate):

- End Item Data Package review.
- Certificate of Compliance, where required.
- Shipping documentation such as the manifest or shipper.
- LIGO property control documentation, when LIGO materials are in possession of a supplier.
- Verification of the adequacy of the shipment packaging and weather protection.
- Evidence of contractor quality assurance acceptance.
- Evidence of safety requirements compliance.
- Verification that transportation environmental controls and monitoring requirements will be satisfied.

3.5. Receiving Inspection

Receiving inspection will be performed to ensure that articles procured by LIGO, or its suppliers, conform to contractual or procurement document requirements prior to release of payment to supplier. This will be a time-critical activity. Receiving inspection includes the following (as applicable):

- Inspection of incoming hardware and documentation for compliance to applicable Drawings, Specifications, and/or other documentation specified by the procurement documentation.
- Evidence of acceptance by contractor/supplier inspection.
- Evidence of source inspection acceptance as applicable.
- Identification of deviations from requirements specified in the procurement documentation.
- Securing dispositions of discrepant materials.
- Verification that equipment complies with shipping, handling and safety constraints.
- Identification of hardware acceptance status with appropriate labels.
- Documentation of receiving inspection, one copy stored at site and a second sent to procurements for potential release of payments, shall be completed by LIGO personnel.

3.6. Discrepant Material

When an article does not conform to applicable engineering design documentation it shall be identified as non-conforming. It shall be segregated from on-going work operations, and held for further action. When a discrepancy has been identified and documented it shall be reported immediately to the responsible LIGO science or engineering personnel and the LIGO Quality Assurance Officer.

Only LIGO personnel responsible for the item submitted to the discrepancy evaluation process, or their designees are authorized to issue dispositions for the discrepant item. Initial discrepant hardware dispositions include the following:

- Rework to drawing or specification.
- Repair: Articles that are modified to a useable state but remain nonconforming to drawing or specification requirements.
- Return to vendor.
- Use-as-is: Articles that are useable in the present state without further processing.
- Suspended Action: Articles of which resolution is determined after drawing or specification change, or after hardware fit check.
- Scrap.

LIGO quality assurance representative concurrence is required for all LIGO science or engineering personnel discrepant material dispositions.

3.7. Material Review Action

The Material Review Action shall determine dispositions of nonconforming articles that cannot be resolved by the initial discrepant hardware disposition. For discrepant articles submitted to Material Review Action the LIGO Project Manager shall, with the concurrence of the LIGO Quality Assurance Officer, determine the final disposition.

3.8. Material Review Actions at Contractor

Material Review Actions conducted at a contractor are the responsibility of that contractor. LIGO personnel will not participate as members of the contractor's Material Review Board. However, Contractor Material Review Actions will be subject to review and concurrence by LIGO engineering and quality assurance personnel. Contractor Material Review Actions shall become a part of the EIDP.

3.9. Discrepant Material Storage

Discrepant Material shall be identified and to the degree possible, separated from acceptable material until the disposition action has been completed.

3.10. Quality Records

The LIGO Quality Assurance Office will maintain quality records which provide evidence of inspections, tests, as built configuration, and Material Review Actions.

The LIGO Project Office will establish a facility and procedures for the long term storage of LIGO project QA documentation and other related records. Satellite record storage facilities may also be established at the observatory sites for equipment or materials located at or peculiar to the site. This data shall be maintained for at least the duration of the 20 year operational life of the observatories.

3.11. 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.

All such documents shall be marked to indicate that they have been included in the system. Supplier shall ensure distributed copies of master documents must be marked as controlled or uncontrolled. Controlled documents should be numbered serially (1,2,3...n) and recorded in the contract file.

A controlled document 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.

Controlled documents must be returned to QA or the contract administrator at the end of their use. At that time they will be removed from the controlled list.

The supplier shall take appropriate measures to control obsolete and uncontrolled documents from contaminating the contract work. This includes a method of marking, checking out, or destroying.

Upon receipt of drawing and specification changes, the supplier Quality Assurance or other appropriate personnel will remove obsolete drawing specification and issue the latest drawing specification to proper personnel. Obsolete drawings will be marked “obsolete” if needed for record or destroyed.

3.12. Welding Certifications

For any work on Advanced LIGO parts or components that requires welding, Caltech will require any contractor to supply certifications for the welders performing the work. Certifications must show valid dates, as well as certified welding type/class for the work to be done. All welders who will be performing work will be required to be certified for the work, and samples of work may be requested.

3.13. End Item Data Package

The end item data package is the set required documents to be supplied to LIGO upon delivery of ordered parts or services, which may include but is not limited to the following items:

- As Built Modifications (with approval of the LIGO Contracting Officer) as markups to the drawings
- Material Certifications
- Dimensional and QC reports, including all test procedures and results
- Certificate or Statement of Compliance with all contract and process restrictions
- Welding Certifications

Specific items above pertinent to a given contract will be called out in the statement of work, as well as any additional EIDP requirements not listed above.

4. Supplier Quality Assurance Review: Definitions

4.1. Design Verification

At appropriate stages of the design process, design verification shall be performed to ensure that the proposed design meets the requirements (see M0500220). This will normally be accomplished through the Design Review process. However, additional design verifications may be instituted where critical elements are involved, or where a potential for errors may have significant impact to functional performance, cost or schedule. In particular if a supplier/contractor/vendor is tasked with design effort, LIGO must plan to review the delivered design before authorization to fabricate.

4.2. Raw Material Procurement

Suppliers of raw materials shall provide certifications and country of origin indicating that materials being provided are in compliance with requirements specified in the procurement documents. Reports of chemical and physical tests are required for critical usage materials to verify conformance to applicable specifications and drawings.

4.3. Traceability of Materials

Materials considered critical for LIGO observatories' successful operations, or used in the vacuum system, shall require identification and country of origin by lot, batch or production run. Materials process records shall be delivered by the supplier and retained in the LIGO Documentation Control Center. Questions regarding traceability requirements for specific items should be directed to the LIGO Quality Assurance Officer.

4.4. Calibration Program

The supplier shall maintain a calibration program of all instruments and tools requiring calibration. Schedules of calibration shall be in accordance with the instrument or tool manufacturers' recommendations. Labels on the instrumentation and tools or their cases shall be in plain view, and have a calibration record referenced to a report on file with the supplier, as well as a date of performed calibration, due date for next cycle, as well as a signature and disposition of calibration (pass or fail). All instruments that have failed calibration will be required to have on file a document showing repair, repair facility, reason for out of spec, and recalibration report showing unit has passed. Out of calibration is defined as a device that is not only out of spec on measurement accuracy, but also one that may function properly but has not sustained an up to date calibration certification.

4.5. Critical Interfaces

A Critical Interface is defined as that particular junction between systems or components which have a specific design characteristic and/or requirement, which are critical to the proper function of the overall LIGO system. If these design requirements or characteristics are not met then there could be an increased likelihood of improper functioning, system failure, and/or damage to itself and/or other attached systems or components. It is the responsibility of the LIGO teams to identify and call out all critical interfaces in the design documents and drawings, and to ensure that appropriate standards of inspection and testing are applied to the systems at these interfaces.

The supplier shall perform levels of inspection as defined by the LIGO teams during the manufacturing and assembly process, including verification to design specifications and (if appropriate) interface tests for fit, function and/or performance. Development and performance of the test plan will be in accordance with the negotiated contract, and the final test plan will be reviewed by the supplier and the LIGO team(s). The supplier shall provide LIGO teams with the results from all tested critical interfaces, and the LIGO team(s) shall work with the supplier to assess the results and review discrepancies and proposed solutions.

4.6. Cleanliness

All components are to meet cleanliness standards as outlined in the technical documents provided to the vendor. Cleanliness and contamination control will be particularly sensitive with systems and components installed in the vacuum chambers. As part of the bid package, all suppliers of in-vacuum components must include detailed plans for achieving and maintaining cleanliness of manufactured items during the manufacturing process, through the final cleaning process, as well as processes to maintain this state during transport and storage.

4.7. Packaging

Guidelines shall be developed for packaging to provide sufficient protection for LIGO equipment from the point of manufacture to the delivery at the LIGO observatory sites. Suppliers must ensure that all packaging will meet requirements as defined in the RFP or RFQ, and any deficiencies are reported immediately to LIGO representatives. This includes packaging to protect against environmental, shock, transport noise and vibration, as well as protection from ESD and contamination as required in the negotiated contract or PO. LIGO staff will inspect all packaging upon arrival at a LIGO facility for damage and deficiencies. Note that components and assemblies which have been cleaned for in-vacuum service have special packaging requirements as defined in E960022.

All packaged items shall have appropriate labels attached to properly identify the following:

- Destination Site
- LIGO Subsystem team
- Boldly identify components as clean or environmentally sensitive to prevent opening and contamination in receiving area.
- List any special handling notifications or warnings
- LIGO Contact person and information
- Part ID, serial number or other identifying data
- Shipping manifest with long text description of enclosed items

4.8. Storage

Supplier shall protect system or components against environmental damage or unauthorized personnel access prior to shipment of finished goods. All items shall be stored with appropriate labeling to ensure removal from storage and transport of item is accurate.

4.9. Transport

Transport of items to LIGO facilities shall be handled via LIGO approved shipper, and will be insured as directed in the LIGO-Supplier's contract. All critical and/or environmentally sensitive items must be shipped in a manner that will minimize damage in transit. Supplier and shipping company shall utilize proper ride mechanism (air ride or other specific suspension types, isolation techniques, etc), container types and handling methods to protect sensitive items, such as optics and electronics, from vibration, shock pulse, impacts and crushing, as defined by LIGO. Shipping containers and the items they contain shall be properly secured for transport to avoid falling and shuffling of goods internally.

4.10. Customs

Customs documentation will be filled out appropriately to ensure proper handling, contamination controls and timely throughput while in possession of customs agents. This includes labeling which clearly defines contents, hazards, valuation and contact information. For all customs requirements please contact Rod Luna at Caltech, email luna_r@ligo.caltech.edu

5. System Integration and Commissioning Inspection Requirements

5.1. System Integration Inspection Process

With few exceptions, system installation, integration and commissioning are LIGO Laboratory responsibilities with no supplier involvement. Final inspection shall consist of the following:

- Verification of the product (subsystem or subassembly) against requirements and test parameters identified as requirements in the subsystem documentation.
- Verification of key physical and interface parameters.
- Verification of Configuration.
- Verification of quality of workmanship.
- Verification of a complete set of as-built documentation

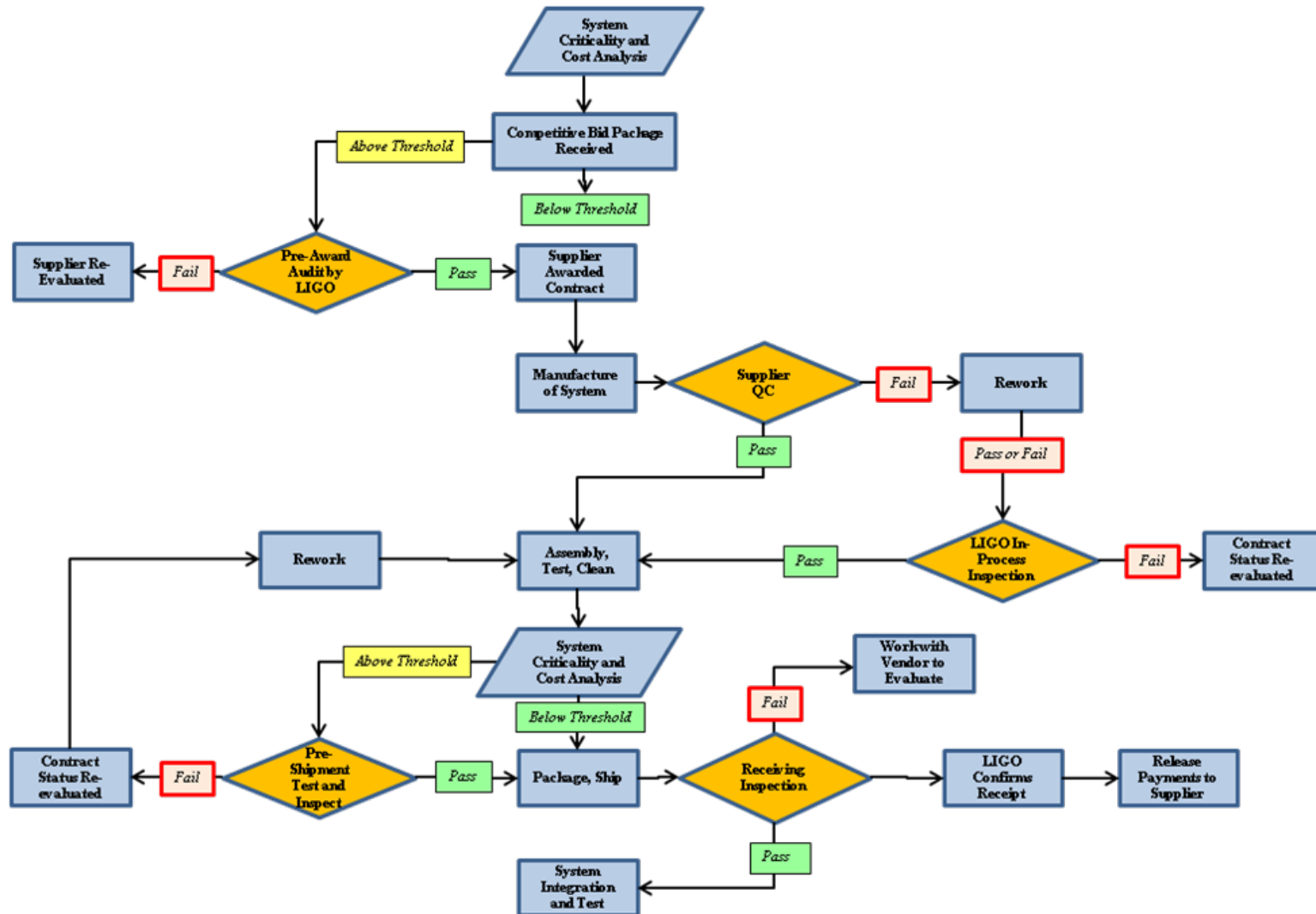
5.2. System Integration Acceptance Test

System integrated acceptance testing is a LIGO Laboratory responsibility. Acceptance testing shall be performed after completion of all required operations. LIGO final acceptance testing requirements are as follows:

- Commissioning acceptance testing plans and reports shall be reviewed and approved (and witnessed if possible) by LIGO QA personnel.
- The test shall be performed in accordance with the current version of the appropriate test procedure.
- Instruments and gages used to determine performance characteristics must be within the range of acceptable calibration parameters, including inspection cycles and tested against known standards.
- Tests shall be conducted in the order specified by the test procedure unless otherwise authorized by responsible LIGO engineering personnel.
- Completed test results shall be documented on authorized summary forms or test data sheets.
- Any deviations from the test procedure or discrepancies noted during the conduct of the test shall be documented.
- If appropriate, and to the extent practical, a post-test inspection shall be conducted of the item under test, for the purpose of identifying and recording any changes that may have occurred as a result of the test.



6. Advanced LIGO QA Inspection Workflow Chart





7. Glossary

Quality Assurance	QA is defined as a procedure or set of procedures intended to ensure that a product or service under development (before work is complete, as opposed to afterwards) meets specified requirements.
Quality Control	Quality control (QC) is a procedure or set of procedures intended to ensure that a manufactured product or performed service adheres to a defined set of quality criteria or meets the requirements of the client or customer.
System Criticality and Cost Analysis	Evaluation taken place to determine whether a system being manufactured meets the minimum threshold for applying additional inspection criteria. Example: An in vacuum component may not meet minimum cost levels to add a supplier pre-award inspection; however since it is in vacuum it is a critical item that requires added inspections. Determination of criticality and cost thresholds is set by the LIGO teams.
Cost Threshold	A LIGO determined value of a component or system which triggers or precludes an audit or inspection point. LIGO sub-teams will determine this value on a case by case basis, and is evaluated in conjunction with criticality thresholds. In some cases criticality thresholds may require a triggered audit or inspection despite the cost being below a threshold. LIGO has sole determination of these values, however at any time LIGO may require an audit or inspection, and will communicate these to the supplier ahead of time.
Criticality Threshold	A LIGO determined level of importance assigned to a system or component. This assignment is based upon factors including but not limited to duty cycle, installation area, redundancy, availability of spares, lead time to manufacture, etc. LIGO sub-teams are solely responsible for assigning criticality levels to components, and will make the determination for inspections and audits based on criticality independent of cost.
Pre Award Audit	Audit/Inspection by LIGO performed to determine to ability of a supplier to meet to the system or component manufacturing requirements including QA/QC. Safety, capacity, cleanliness, skill and stability.
In Process Inspection	Any inspection that takes place during the manufacturing process. This inspection may be performed by supplier as part of its regular quality control processes, or by LIGO as a spot check of workmanship or as a result of a deficiency in the performance of the supplier or the manufactured component.

Receiving Inspection	<p>Inspection at the LIGO site to verify that goods shipped arrive in good condition, without visible damage, contamination, or other problems that may have been caused during the packaging and shipping process. It is also the point at which LIGO team members look for problems related to improper packaging, as well as missing pieces or cartons. During a Receiving Inspection, LIGO team members will provide an inspection report noting any issues. If shipped item passes inspection it will be moved to the proper storage until its intended use. LIGO members will also submit a passed inspection report which authorizes procurements to release payments to supplier as agreed in contract.</p> <p>If the system does not pass receiving inspection, it will be at the discretion of the LIGO Project on how to handle the issues, which may include returning items to vendor, requiring vendor supported testing and rework, or additional testing at LIGO site before receiving inspection is signed off and payments are released to supplier.</p>
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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 foregoing.

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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.]

Embedded Adobe XML Form

The file https://dcc.ligo.org/public/0000/F0810001/004/Technical_Direction_Memo_template_F0810001-v4.pdf is an Adobe XML Form document that has been embedded in this document. Double click the pushpin to view.





REQUIREMENTS

Metal components intended for use in the Adv 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 should be obtained from the LIGO Contractual officer or the Contracting Officer's Technical Representative.

2 Scope

These requirements only apply to metal components intended for in-vacuum service; If the parts are not intended for in vacuum, then these requirements do not apply.

In addition these requirements do not apply to cantilever blade springs, all weldments and porcelain steel. For these applications, see the following references:

LIGO-E0900023, Process for Manufacturing Cantilever Spring Blades

LIGO-E0900048, Welding Specification for Weldments used within the Advanced LIGO Vacuum System

LIGO-E1000083, Specification for Enameled Steel Sheet to be used in the LIGO Ultra-High Vacuum System

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 in vacuum

4.1 Materials

Only materials (specific alloys) approved for use in the LIGO UHV system may be used. All materials should be specified on the drawing. No substitutions may be made without prior approval by the Contracting Officer or the Contracting Officer's Technical Representative.

Tooling plate material is not permitted.

All material is to be virgin material (i.e. no weld repairs or plugs unless approved in advance in writing by LIGO (see also section 4.8)



REQUIREMENTS

Metal components intended for use in the Adv LIGO Vacuum System

4.2 Castings, Moldings

No cast or molded parts are permitted.

4.3 Machining

All final surfaces of all parts are to be machined; No as received, as rolled, as milled surfaces will be accepted, unless otherwise noted on the drawing.

All machining, and tapping, fluids must be fully synthetic, water soluble (not simply water miscible) and free of sulfur, chlorine, and silicone. 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. Scotch-Brite™ or similar products are not permitted. Stainless steel wool can be used if sanding is required.

4.4.3 Scotch-Brite™

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

4.5 Finishing (Surface roughness)

The required surface roughness (finish) 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 surface finish should default to: -

- 63 micro-inch (Ra) for stainless all surfaces
- 63 micro-inch (Ra) for aluminum all surfaces
- large thin sheet should have a surface 32 micro-inch (Ra)

Refer to section 4.9 for exceptions.

Localized scratches, digs and blemishes should be minimized and addressed though 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.



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Metal components intended for use in the Adv LIGO Vacuum System

In general no coatings or finishes shall be applied to any metal parts, with the exception of silver or other approved coatings for tribology or thermal control reasons. If any coatings or finishes are required they will be defined in the drawing or associated process specification. In particular no aluminum parts are to be anodized.

4.6 Cleaning requirements

Thoroughly clean part to remove all ink, oil, grease, dirt, and chips with soap and water. Solvents may be used.

4.7 De-burring

All sharp edges and corners shall be rounded. You can de-burr with de-burring tools, filing and / or stainless steel wire brushes. Tumbling or use of steel wool is not acceptable for de-burring. All deburring tools, files and stainless wire brushes must be clean and free of contaminants.

4.8 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 should be virgin material. Special circumstances can be reviewed if/when brought to the attention of LIGO Contracting Officer's Technical Representative (COTR), through a Material Review Board (MRB) process.

4.9 Exceptions

When it is not practical to machine all surfaces, e.g.

1) 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 electropolished to remove all surface oxides and potentially embedded contaminants refer to section 5.1 or 5.2, or
- c) (for aluminum) the part is chemically cleaned / etched by acid or caustic process, refer to section 5.1

2) if large thin sheet is used with a surface finish higher than the standard 32 micro-inch (Ra) is delivered from the supplier either

- a) the surface finish should be discussed with LIGO Contractual office prior to acceptance, or
- b) the sheet should be electropolished as per section 5.1 or 5.2
- c) the sheet should be chemically cleaned / etched by acid and / or caustic process, refer to section 5.1



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Metal components intended for use in the Adv LIGO Vacuum System

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 should the parts be anodized.

5 Further Cleaning (only if specified)

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

5.1 Aluminum

5.1.1 Chemical clean

1. First the parts or assemblies are de-burred, and cleaned, removing all possible machining residue.
2. The part(s) are then washed with Alkaline Soak Cleaner and inspected for cleanliness using the water break test.
3. The part(s) are then to be chemically cleaned / etched by acid and / or caustic process. At this step in the process Scotch-Brite™ or similar mildly abrasive pads can be used. This is the only step where Scotch-Brite™ is permitted.
4. The acid formulation, time and temperature should be chosen to achieve slight chemical etching (<0.0005 inch).
5. Under no circumstances should the parts be anodized.
6. The part(s) are then thoroughly rinsed with clean water. After rinsing, a full visual inspection is performed, to assure a satisfactory surface finish has been achieved uniformly, over the entire part(s).
7. The parts are then dried, re-inspected and packaged for shipment.

5.1.2 Electropolish

Electropolishing Aluminum parts is also allowed. If using electropolishing on a part follow similar steps to those outlined in section 5.2.1 Pickling. The use of Scotch-Brite™ or similar products is not permitted.

5.2 Stainless Steel

5.2.1 Pickling & Passivation

1. First the parts or assemblies are de-burred, and cleaned, removing all possible machining residue and inspected for cleanliness using the water break test..
2. Stainless steel parts are to be pickled and passivated at room temperature, with special attention paid to sufficiently agitate the solution or flush the inside of the box section used in the particular design. The pickling and passivation process formulation, time and temperature should be chosen to achieve slight chemical etching (<0.0005 inch).



REQUIREMENTS

Metal components intended for use in the Adv LIGO Vacuum System

3. The part(s) are then thoroughly rinsed with clean water. After rinsing, a full visual inspection is performed, to assure a satisfactory surface finish has been achieved uniformly, over the entire part(s).
4. The parts are then dried, re-inspected and packaged for shipment.

5.2.2 Electropolish

Electropolishing stainless steel parts is also allowed. If using electropolishing on a part follow similar steps to those outlined in section 5.2.1 Pickling. The use of Scotch-Brite™ or similar products is not permitted.

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	Manufacturing Process for Cantilever Spring Blades for Advanced LIGO	

APPROVALS	DATE
AUTHORS: Calum I. Torrie, Ken Mason, Dennis Coyne, Janeen Romie, Doug Cook, Mike Meyer, Mick Flanigan	12 July 2010
CHECKED: Dennis Coyne	12 July 2010
APPROVED: Dennis Coyne (refer to associated DCC file card to confirm approval)	12 July 2010

1 Scope

This process specification is for manufacture of cantilever spring blades for Advanced LIGO. It includes material requirements, limitations on shaping, detail on the nickel plating process and details of the age hardening fixture. These springs are for use in an Ultra-High Vacuum (UHV) system.

2 Manufacturing Process

The following is the default process. An alternative process is defined in Section 3 below. Please ask LIGO staff if this option has not been defined for you. All manufactures should respond with a summary of how they are going to follow the following processes.

2.1 Material

The sheet, plate or block material is called out on the associated drawing for the cantilevered spring. Materials are limited to either Maraging C-250 per AMS-6520¹ or Maraging C-300 per AMS 6521. The sheet or plate should be hot rolled, de-scaled and solution annealed.

The material grain direction shall be oriented parallel to the long axis of the blade spring.


Upon receipt of the material, measure hardness in several locations and verify a Rockwell C hardness of 29-33 for the annealed state. Measurements should only be performed using a Rockwell Type machine unless prior approval is obtained from LIGO staff. These measurements locations should be chosen so as not to create upsets or dimples in the final springs surfaces. Provide these measurements in certification documentation to LIGO.

2.2 Shaping

All shaping and forming operations are performed on the material in the annealed state with exception to the finish machining of thick springs.

The thin (< 0.4 inch, or < 10 mm), curved cantilevered springs used in LIGO suspension systems are ground to the required thickness, machined to plan form dimensions and then rolled to the radius of curvature defined on the associated drawing.

¹ Two materials that we know meet this specification are VascoMax c-250 (Allvac, an Alleghany Technology Company) and Marval 18 (Albert & Duval).

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The thick (> 0.4 inch, or > 10 mm) cantilevered springs used in the LIGO seismic isolation systems are either flat or curved. The flat springs are machined .010 - .015" oversize then age hardened per section 2.7.2. After age hardening the flat blades are finish ground to final thickness. The curved blades are cut by EDM .18 - .20" oversize and age hardened per section 2.7.2. After age hardening the curved blades are EDM cut to its final shape. This procedure is necessary to remove distortions that may occur during the age hardening.

All machining fluids shall be water soluble (not simply water miscible) and free of sulfur, chlorine and silicone, such as Cincinnati Milacron's Cimtech 410 (SSTL).

Machine all surfaces to remove oxides and mill finish. Abrasive removal techniques other than Blanchard grinding, surface grinding or double disk grinding, are not acceptable. These abrasive removal techniques are acceptable only if all surfaces are subsequently electropolished to remove a minimum of 0.0002 in, refer to section 2.5. Any additional methods must first be approved by the LIGO Contracts Technical Representative. A surface finish of 32 microinches is required. The vendor will need to confirm this surface finish in the inspection report.

Intermediate machining and strain relief steps are acceptable.

Thoroughly clean part to remove all oil, dirt and chips.

2.3 Dimensional Check


Perform initial dimensional check on all dimensions, including, but not limited to the thickness at various positions along the length, the radius and the height. If the dimensions are not within the tolerances called out on the drawing, forward this information to LIGO for review.

2.4 Cleanliness

The cleanliness of the blade springs must be maintained during all of the following steps. When not undergoing processing, the springs must be stored in cleaned & baked, covered, stainless steel containers or wrapped in clean UHV foil², handled only with latex gloves and exposed as little as possible to the environment.

Clean (and not previously used) latex gloves must be worn when clean parts are handled during the various processes below. If the gloves come in contact with anything other than clean surfaces, they must be replaced with new ones.

² Part # ASTM B 479, UHV Certified Aluminum Foil, All Foil, 4597 Van Epps Road, Brooklyn Heights, Ohio 44131
(216)661-0211 Voice; (216)398-4161 Fax

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2.5 Electroless Nickel Plating

Prior to nickel plating, the parts must be electrocleaned (or electropolished).

2.5.1 Electropolishing or Electrocleaning Qualification

Electrocleaning/electropolishing of maraging steel must be achieved by a process that does not leave behind black spotting or streaking on the material due to improper chemical baths. Only suppliers with proven experience performing electrocleaning work on maraging steel components are to be used. In addition post electrocleaning/electropolishing inspections must be performed prior to acceptance. Suppliers without a track history can be asked to provide coupons of LIGO supplied maraging steel processed through their electrocleaning steps prior to accepting any bids, and these coupons must pass a visual inspection by the cognizant engineer and LIGO QA Officer.

2.5.2 Electrocleaning and Nickel Plating Process

Specific thickness and heat treatments are called out below and for that reason no specific class or grade of electroless nickel plating is defined. The following process steps are suggested. Due to outgassing concerns for UHV service, the specific process steps proposed by the plating company should be submitted to LIGO for approval. Once cleaned, the springs must be kept in a clean condition, kept covered in clean stainless steel containers, or wrapped in UHV foil and handled carefully with latex gloves both prior to and after nickel plating. Cleaning should occur just prior to plating.

1. Alkaline Soak: Alkaline Soak for 30 minutes. A new batch of soak cleaner should be used and periodically replaced. Parts should remain wet with cleaning solution and not be allowed to dry out.
2. Rinse: Rinse in clean, ambient-temperature tap water. The tanks should be drained and rinsed out prior to starting. Cross rinsing or dirty rinses are not acceptable.
3. Alkaline Electrocleaning: 20 sec Cathodic / 40 sec Anodic / 20 sec Cathodic / 40 sec Anodic / 20 sec Cathodic / 40 sec Anodic; typically using 15-20 Amps/square foot. A new batch of the electro-cleaner solution (to be specified by vendor) should be used and periodically replaced. A bath with a filtration system will be accepted as an alternative to changing the fluid (after approval from LIGO) but changing the fluid is preferred.
4. Rinse in ambient temperature tap water (step 2 above).
5. Acid Clean: Place the parts in a 30 % (by volume) hydrochloric acid at ambient temperature for a minimum of 30 sec. Leave the parts in the acid until 10 sec after uniform gassing over the surface is observed, but for not more than 2 min. A new batch of the acid solution should be used and replaced at the same time as the soak and electrocleaners.
6. Rinse in ambient temperature tap water (step 2 above).
7. Repeat electrocleaning (step 3 above)
8. Rinse in ambient temperature tap water (step 2 above).

9. Electroless nickel plate with a low (<5%) phosphor bath as called out in table 1 of ASTM³ (Type III phosphorus % wt - 2% - 4%) to a thickness of 0.5 um (microns) / [0.0000197 inches]. We will accept a tolerance on the thickness from 0.4 to 0.6 microns / [0.0000157 to 0.0000236 inches]. Use a method, as called out in section 9 of the ASTM³ Designation B 733-97, to gauge the time required to obtain the required thickness .
10. Rinse blades with ambient temperature, de-ionized water.

2.6 Bake to prevent Hydrogen Embrittlement ⁴

The blade springs must be baked soon after plating to avoid any problems associated with hydrogen embrittlement. If the age hardening bake (see section 2.7) can begin within 1 hour of plating, then the following bake can be eliminated.

The bake to prevent hydrogen embrittlement should be carried out as soon as possible, preferably within 1 hour of the plating process but not later than 3 hours, as per ASTM B850-98 (2009). The springs should be baked 22 hours at 190-220 deg C, as per ASTM B850-98 (2009).

Handle the springs only with latex gloves and expose them as little as possible to the environment. The bake to prevent hydrogen embrittlement must occur in a clean, non-shedding oven with stainless steel surfaces, or in a clean stainless steel box insert within the oven. The preference would be to use a closed loop oven with circulating air for this step, meaning an oven where the heated air circulates in from the top and bottom and out through the sides continuously to maintain a uniform temperature.

The blades should be suspended from the holes in the narrow end of the blades to prevent contacting oven surfaces and giving uniform heating. The blades should not be stacked on top of each other.

Please include in your process sheet the time taken. The time should be from removal from rinse bath (at the end of plating process) to inclusion in oven at desired temperature. If blades are not plated within the desired time, please contact LIGO Contract officer.

2.7 Age Hardening Bake

Prior to aging, soak the springs in a bath of iso-propanol and either ultrasonically or manually agitate for 2 minutes. Handle the springs only with latex gloves and expose them as little as possible to the environment.

³ Standard Specification for Autocatalytic (Electroless) Nickel-Phosphorus Coatings on Metals, ASTM Designation: B 733-97

⁴ Standard Guide for Post-Coating Treatments of Steel for Reducing the Risk of Hydrogen Embrittlement, ASTM B850-98 (2009)

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The springs must be mounted in a "comb" or "wire rack with pins" fixture. The fixture should be made from stainless steel, other materials should be approved by LIGO staff.. The fixture is used to maintain the shape of the blades during aging and should expose most of the blades surface area. The design of this fixture should be discussed and approved with LIGO staff prior to proceeding. The fixture must be electrocleaned and baked out at 500 degrees C for 4 hours prior to initial use.

The age hardening bake must occur in a clean, non-shedding oven with stainless steel surfaces, or in a clean stainless steel box insert within the oven. The oven (or stainless steel box if one is used) must be continuously purged with heated Argon gas at a rate of about 10 liters/min through oil-free plumbing lines and valves. A vacuum oven (1 millibar (1×10^{-3} bar)) is also acceptable for age hardening. However, an inspection of such an oven must be carried out by LIGO approved staff prior to use.

Measure the post heat treatment hardness at several locations on each blade spring. Care should be taken when making measurements, especially on the thin (< 0.2 inch, or < 5 mm) blades, and if questions arise on settings please contact LIGO staff. If measurements are taken at the clamp regions please confirm with LIGO staff the acceptable locations, since the upset/dimple created could interfere with proper clamping. Details of clamping will be provided at this time if not already received with package. Provide these measurements in certification documentation to LIGO.

2.7.1 Thin Blade Springs

For suspension assembly blade springs (see section 2.2):

Age harden at 815 F (435 C) for 100 hours in an inert atmosphere and air cool.

After aging the hardness should be 48 to 52 Rockwell C.

2.7.2 Thick Blade Springs

For seismic isolation assembly blade springs (see section 2.2):

Age harden at 900 F +/- 10 (482 C) at temperature for 6 hours in inert atmosphere then cool at air temperature.

After aging the hardness should be 50 to 55 Rockwell C.

2.8 Post-Hardening Dimensional Check

Perform a final dimensional check on all dimensions, including, but not limited to the thickness at various positions along the length, the radius and the height. If the dimensions are not within the tolerances called out on the drawing, forward this information to LIGO for review. Provide a summary of these final dimensional checks with a certification statement of compliance with this specification.

3 Alternative

In the process outlined above nickel plating is performed before aging. However, it should be noted that plating after age hardening is also acceptable, but only with the addition of a 275 deg C for 24 hr bake in air, used to drive off any unbound phosphorous⁵. This additional bake step should be performed after the hydrogen embrittlement prevention bake (section 2.6) at the end of the nickel plating process. Alternatively, if this bake can be accomplished within 1 hour of plating it also serves the purpose of preventing hydrogen embrittlement.

The additional bake, outlined above, must occur in a clean, non-shedding oven with stainless steel surfaces, or in a clean stainless steel box insert within the oven. The oven (or stainless steel box if one is used) must be continuously purged with HEPA and carbon filtered air, at a rate of about 10 liters/min through oil-free plumbing lines and valves, depending on size of oven. A closed loop oven with circulating air is also acceptable for this step, meaning an oven where the heated air circulates in from the top and bottom and out through the sides continuously to maintain a uniform temperature.

The blades should be suspended from the holes in the narrow end of the blades to prevent contacting oven surfaces and giving uniform heating. The blades should not be stacked on top of each other.

Prior to baking to remove unbound phosphorous, soak the springs in a bath of iso-propanol and either ultrasonically or manually agitate for 2 minutes. Handle the springs only with latex gloves and expose them as little as possible to the environment.

4 Internal Steps ⁶

The following steps will be performed by LIGO staff after receipt of the blade springs: -

1. Blade spring response characterization – deflection/flatness under load, internal mode frequencies, etc.
2. Cleaning and baking (200 deg C for 48 hours) for UHV service, as per [LIGO-E960022-v6](#), including outgassing measurements - not under load.
3. If required for noise performance then perform a Creep bake (120 deg C for a week) - blades should remain under load.

⁵ Internal LIGO reference - [LIGO-L0900024-v1](#) The VRB response to nickel-phosphorous plating issues.

⁶ This section was updated following an exchange of e-mails titled "Re: Maraging steel clean and bake p.s. - further tweak" and sent on 5th January 2010.



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.

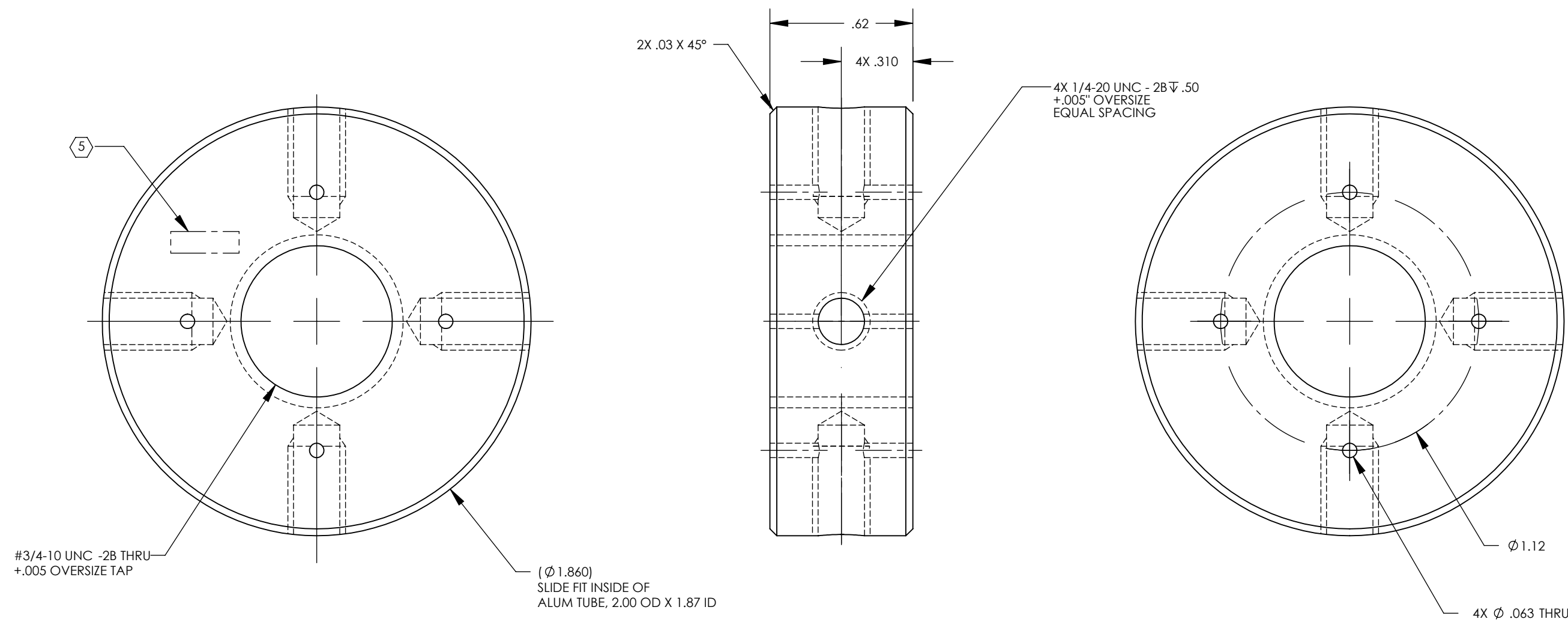
NOTES CONTINUED:

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 = 0.136 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 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	20 JUL 2010	E1000191	



D1000684_AdlIGO_AOS_SLC Tube Lower Mounting Plate, PART PDM REV: X-008, DRAWING PDM REV: X-011

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME	
DIMENSIONS ARE IN INCHES TOLERANCES: .XX \pm .01 .XXX \pm .005 ANGULAR \pm 1.0°				1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES 0.005" TO 0.015". 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.		SLIC TUBE LOWER MTG PLATE	
MATERIAL 6061-T6 Al		FINISH 63 μ inch		NEXT ASSY D1001007, D1001095		DESIGNER N. NGUYEN 01 JUN 2010 DRAFTER TQ. NGUYEN 20 JUL 2010 CHECKER M. SMITH 01 NOV 2010 APPROVAL D. COYNE 10 NOV 2010	
				SYSTEM ADVANCED LIGO SUB-SYSTEM AOS		SIZE DWG. NO. B D1000684 REV. v1	
				SCALE: 2:1		PROJECTION: SHEET 1 OF 1	

8

7

6

5

4

3

2

1

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 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: DXXXXX-VY, TYPE-XX, S/N XXX

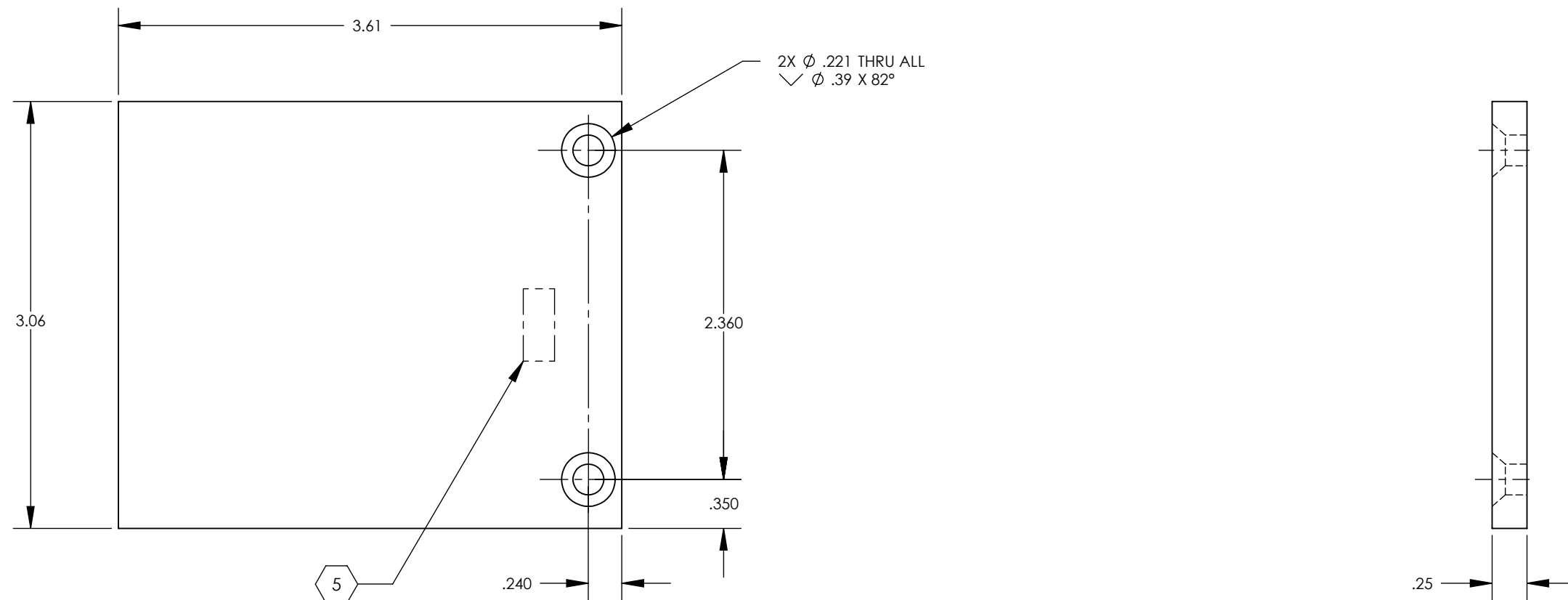
6. APPROXIMATE WEIGHT=0.89 LB.

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

8. PART 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.

REV.	DATE	DCN #	DRAWING TREE #
v1	07 JUN 2010	E1000191	



D1000909_AdlLIGO_AOS_SLC 4-Way Copper Plate, PART PDM REV: X-011, DRAWING PDM REV: X-023

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES
 TOLERANCES:
 .XX ± .01
 .XXX ± .005
 ANGULAR ± 1.0°

1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.

MATERIAL 99.999% COPPER FINISH 63 μinch

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SYSTEM ADVANCED LIGO SUB-SYSTEM AOS

NEXT ASSY D1000863, D1002564

PART NAME			SLC COPPER PLATE		
DESIGNER	N.Nguyen	01 Jun 2010	SIZE	DWG. NO.	REV.
DRAFTER	TQ. NGUYEN	25 MAY 2010	B	D1000909	v1
CHECKER	M. SMITH	30 JUN 2010	SCALE:	1:1	PROJECTION:
APPROVAL	D. COYNE	10 SEP 2010	SHEET 1 OF 1		

8

7

6

5

4

3

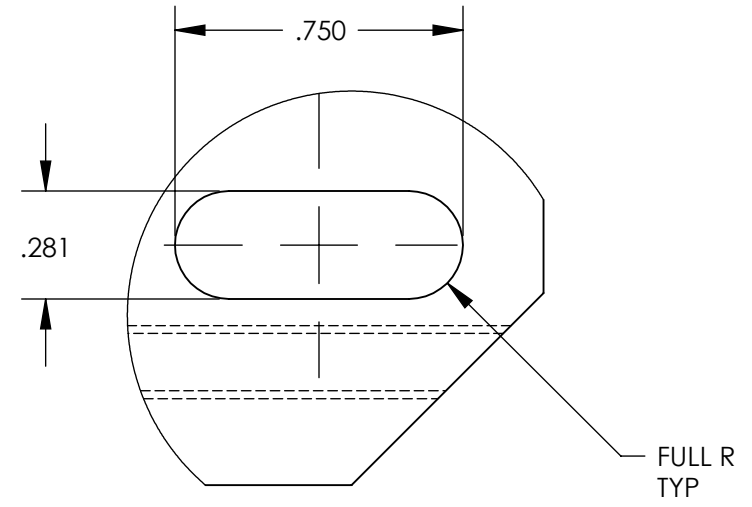
2

1

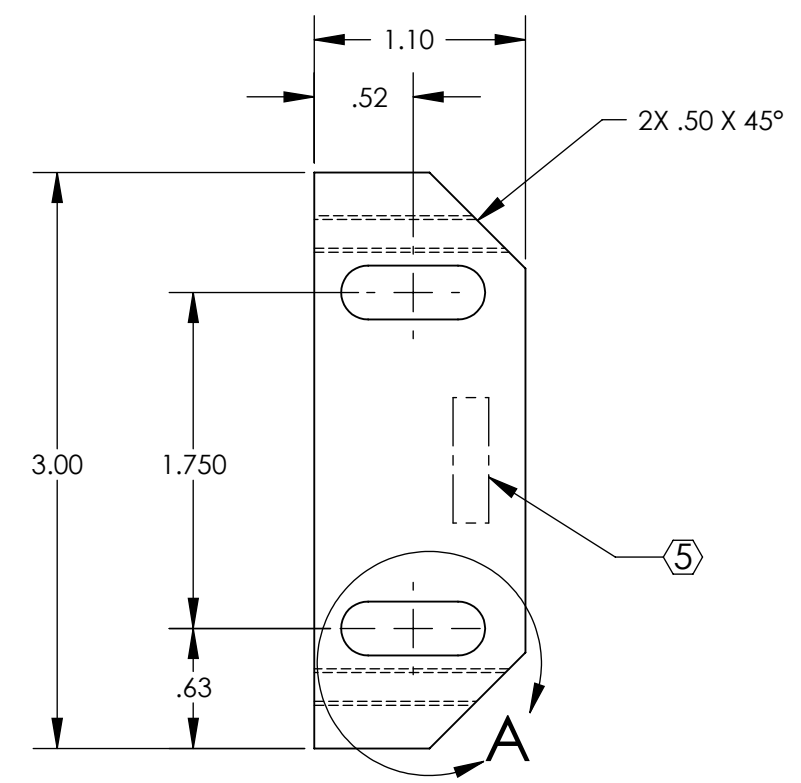
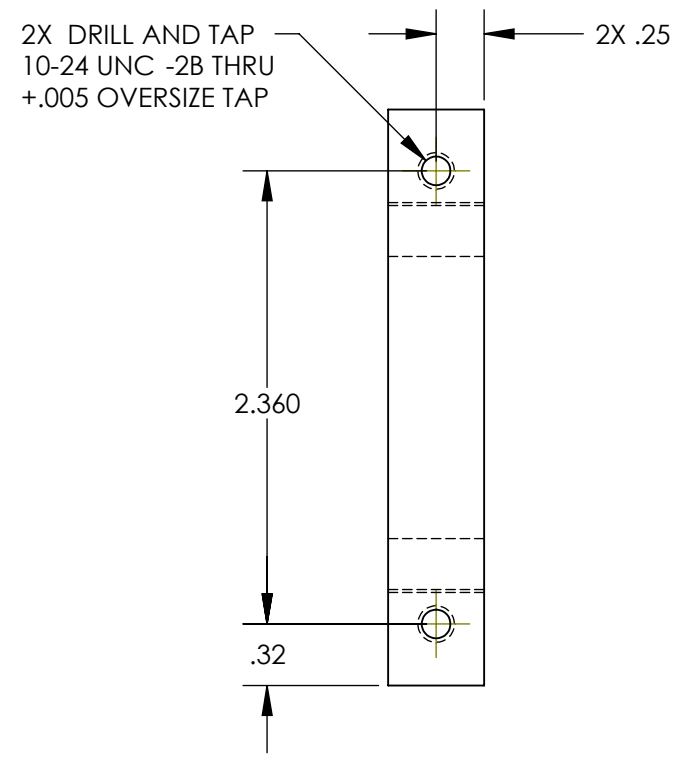
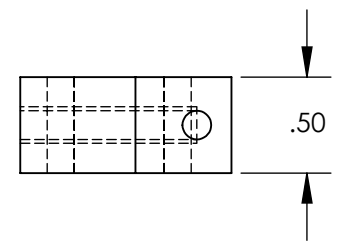
NOTES: UNLESS OTHERWISE SPECIFIED

1. INTERPRET DRAWING PER ASME Y14.5-1994.
2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".
3. DO NOT SCALE FROM DRAWING.
4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.
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 =0.127 LB.
7. MACHINE ALL SURFACES TO REMOVE OXIDES AND MILL FINISH, USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED. REFER TO LIGO-E0900364.
8. PART 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.

REV.	DATE	DCN #	DRAWING TREE #
v1	07 JUN 2010	E1000191	



DETAIL A
SCALE 2 : 1
2X



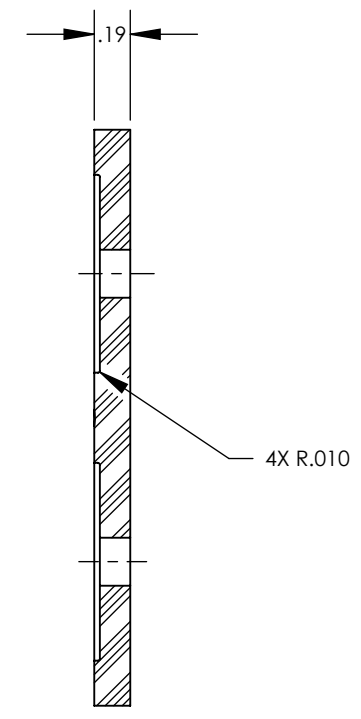
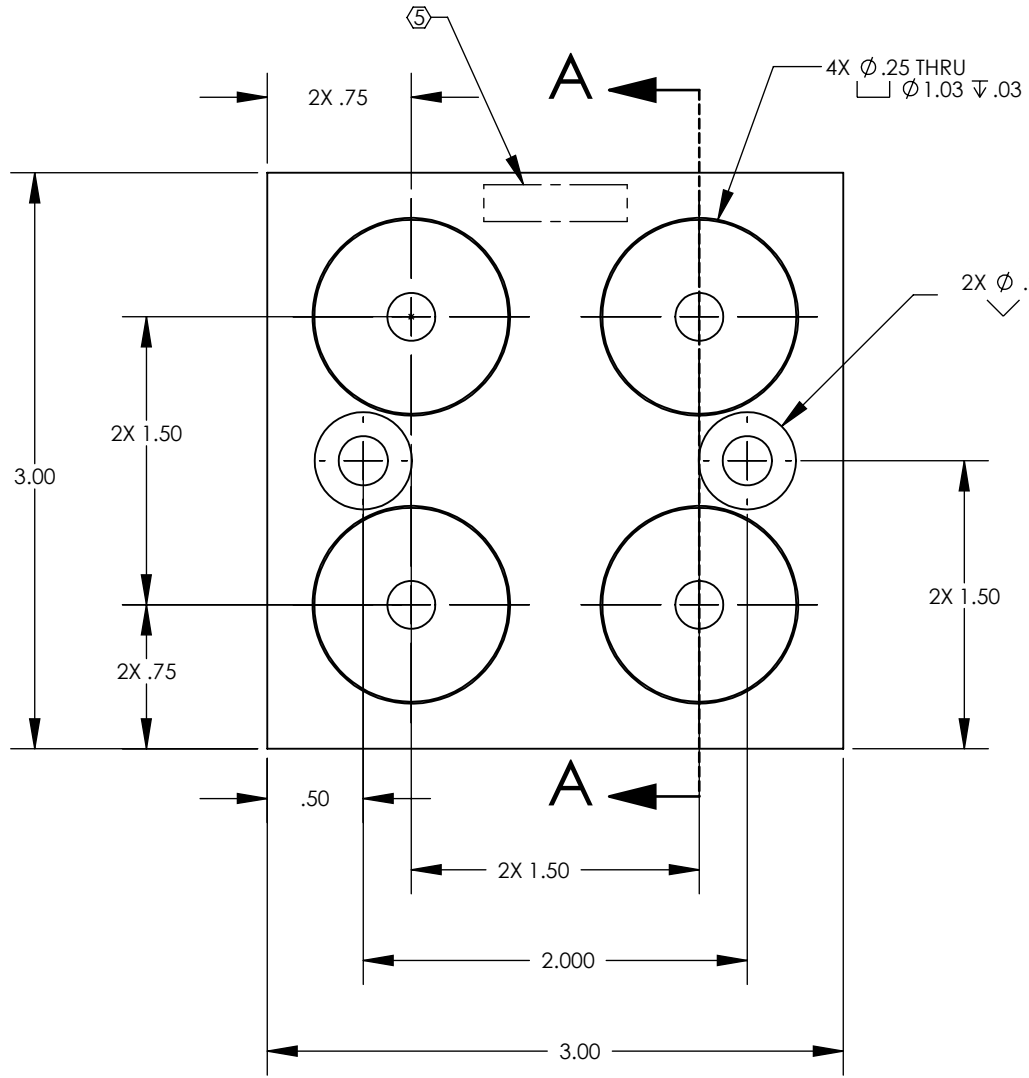
D1000929_AdlLIGO_AOS_SLC Copper Support Plate, PART PDM REV: X-006, DRAWING PDM REV: X-013

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME	
DIMENSIONS ARE IN INCHES				ADVANCED LIGO		SLC COPPER SUPPORT PLATE	
TOLERANCES: .XX ± .01 .XXX ± .005				SUB-SYSTEM AOS		DESIGNER	N.Nguyen 01 Jun 2010
ANGULAR ± 1.0°				NEXT ASSY D100863,D1002564		DRAFTER	TQ. NGUYEN 19 MAY 2010
MATERIAL	6061-T6 Al	FINISH	63 μinch	CHECKER	M. SMITH 30 JUN 2010	SIZE	DWG. NO. B D1000929
				APPROVAL	D. COYNE 10 SEP 2010	REV.	v1
				SCALE: 1:1		PROJECTION: SHEET 1 OF 1	

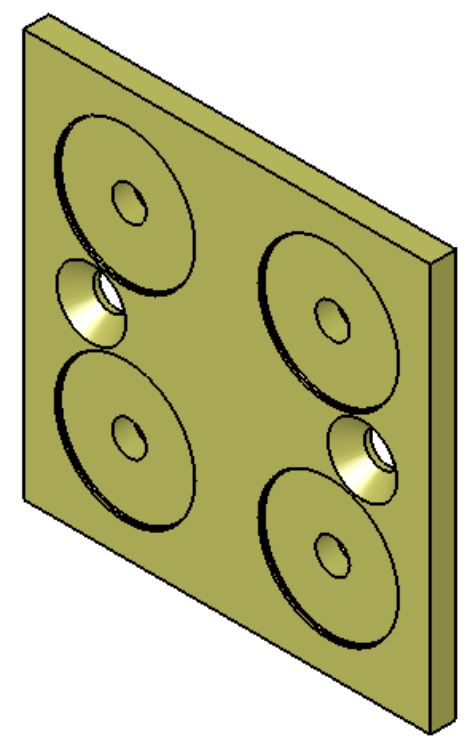
NOTES CONTINUED:
 5. SCRIBE, ENGRAVE (A VIBRATORY TOOL MAY BE USED), LASER MARK OR MECHANICALLY STAMP (NO INKS OR DYES) DRAWING PART NUMBER, REVISION (AND VARIANT OR "TYPE" IF APPLICABLE) ON NOTED SURFACE OF PART FOLLOWED ON THE NEXT LINE WITH A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 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. MACHINE ALL SURFACES TO REMOVE OXIDES AND MILL FINISH, USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED. REFER TO LIGO-E0900364
- 7. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.
- 8. ALL MATERIAL IS TO BE VIRGIN MATERIAL (i.e. NOT WELD REPAIRS, PLUGS OR RECYCLED MATERIAL). NO REPAIRS SHALL BE MADE UNLESS APPROVED IN ADVANCE, AND IN WRITING BY LIGO. REFER TO LIGO-E0900364.

REV.	DATE	DCN #	DRAWING TREE #
v1	07 JUN 2010	E1000285	



SECTION A-A



D1000930_AdlIGO_AOS_SLC Magnet Holder Steel Plate, PART PDM REV: X-012, DRAWING PDM REV: X-018

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)	
1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES .005" TO .015" 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LOGO E0900237	
DIMENSIONS ARE IN INCHES TOLERANCES: .XX ± .01 .XXX ± .005 ANGULAR ± 1.0°	MATERIAL: 416 SSSL FINISH: 63 μinch

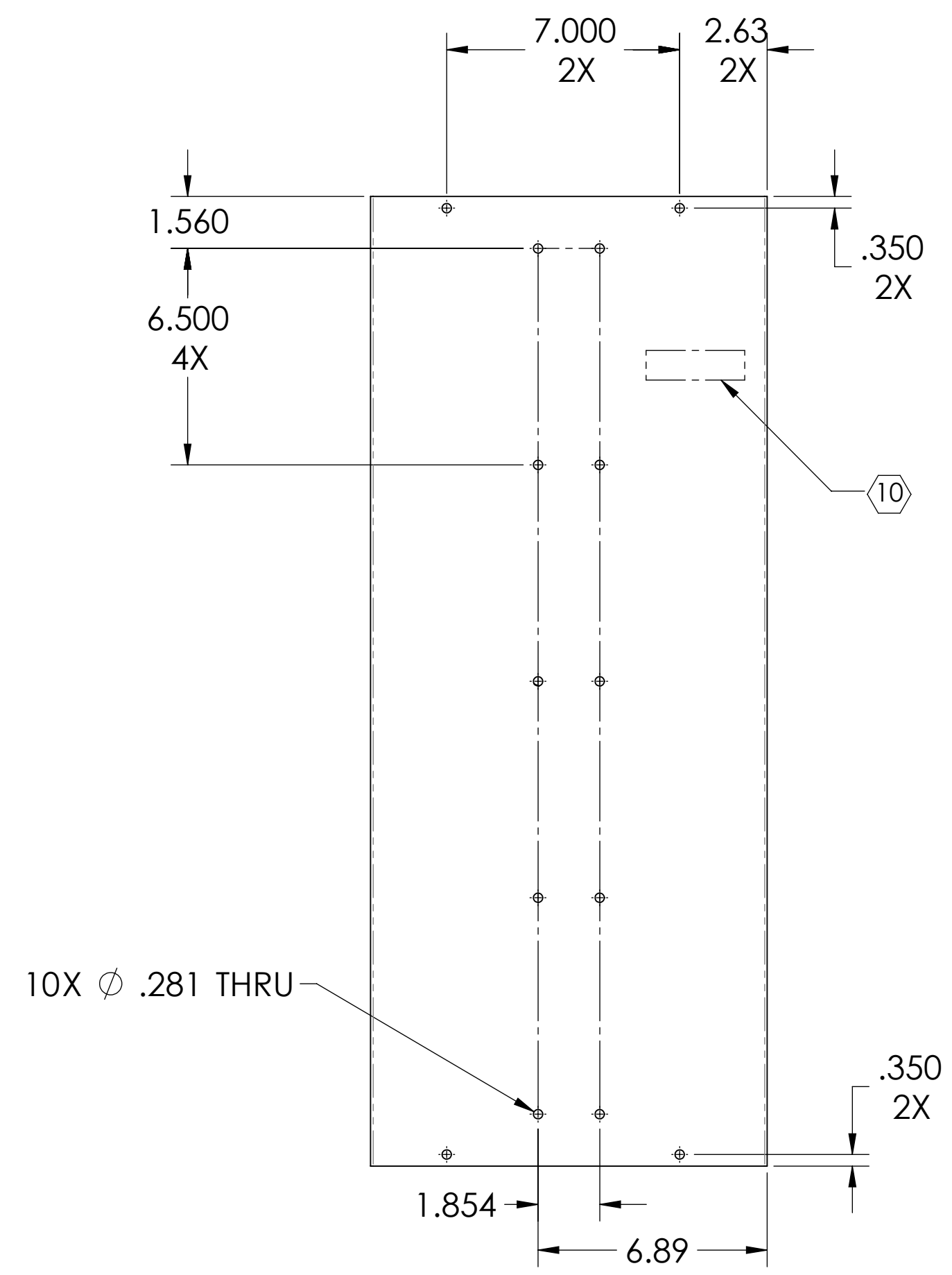
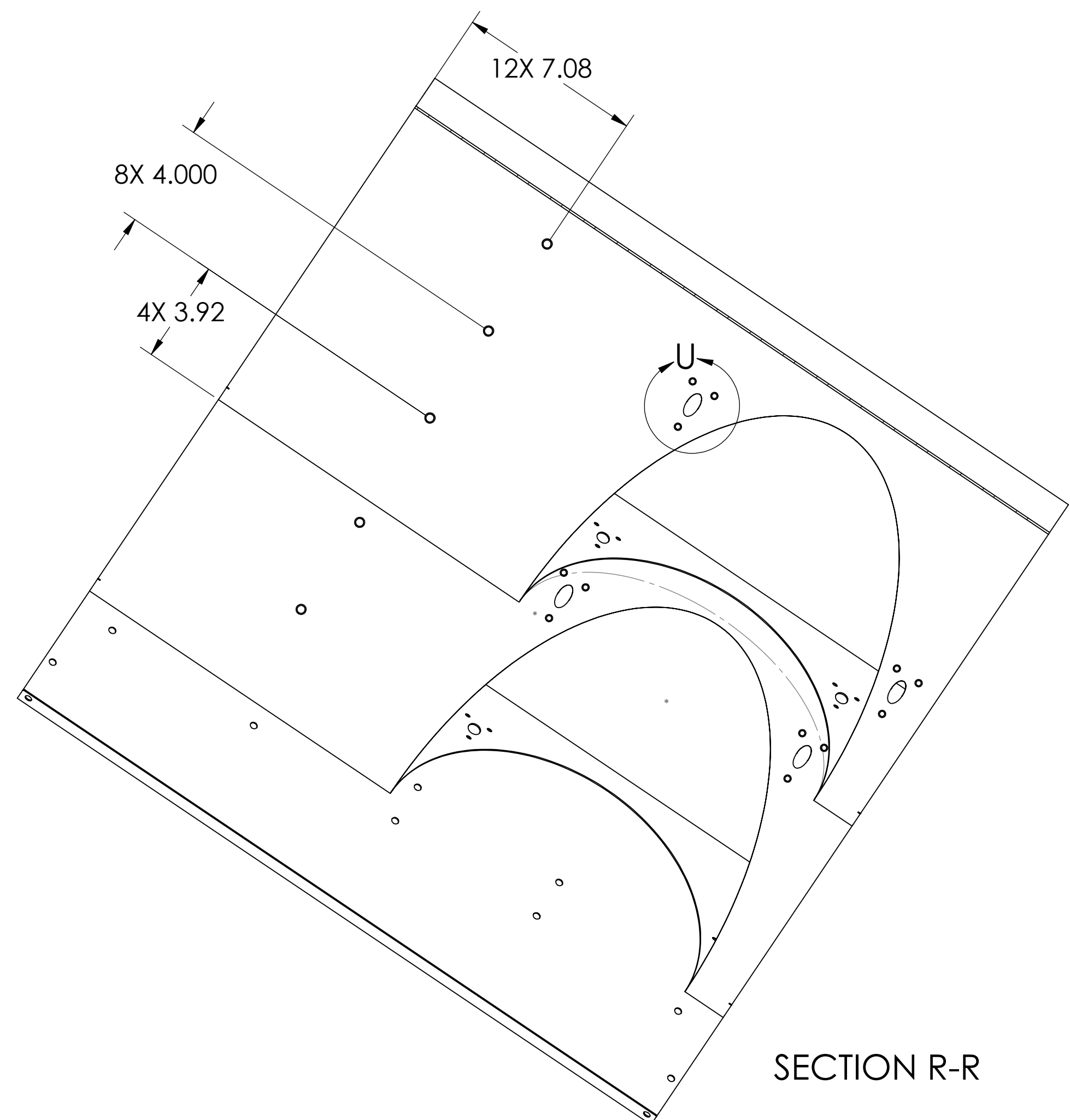
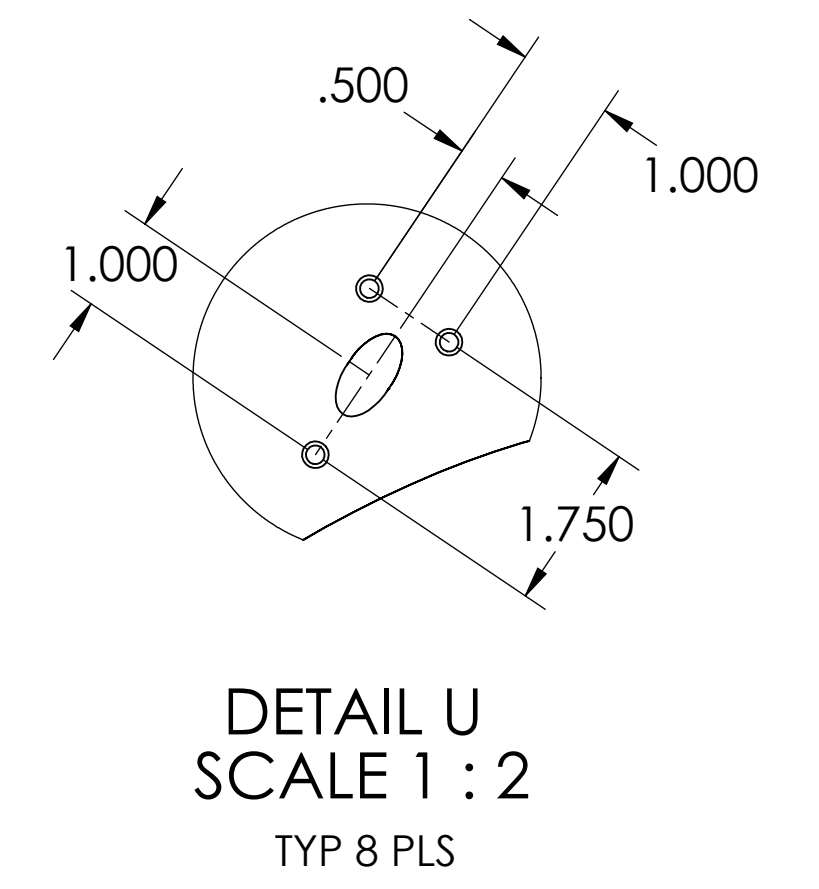
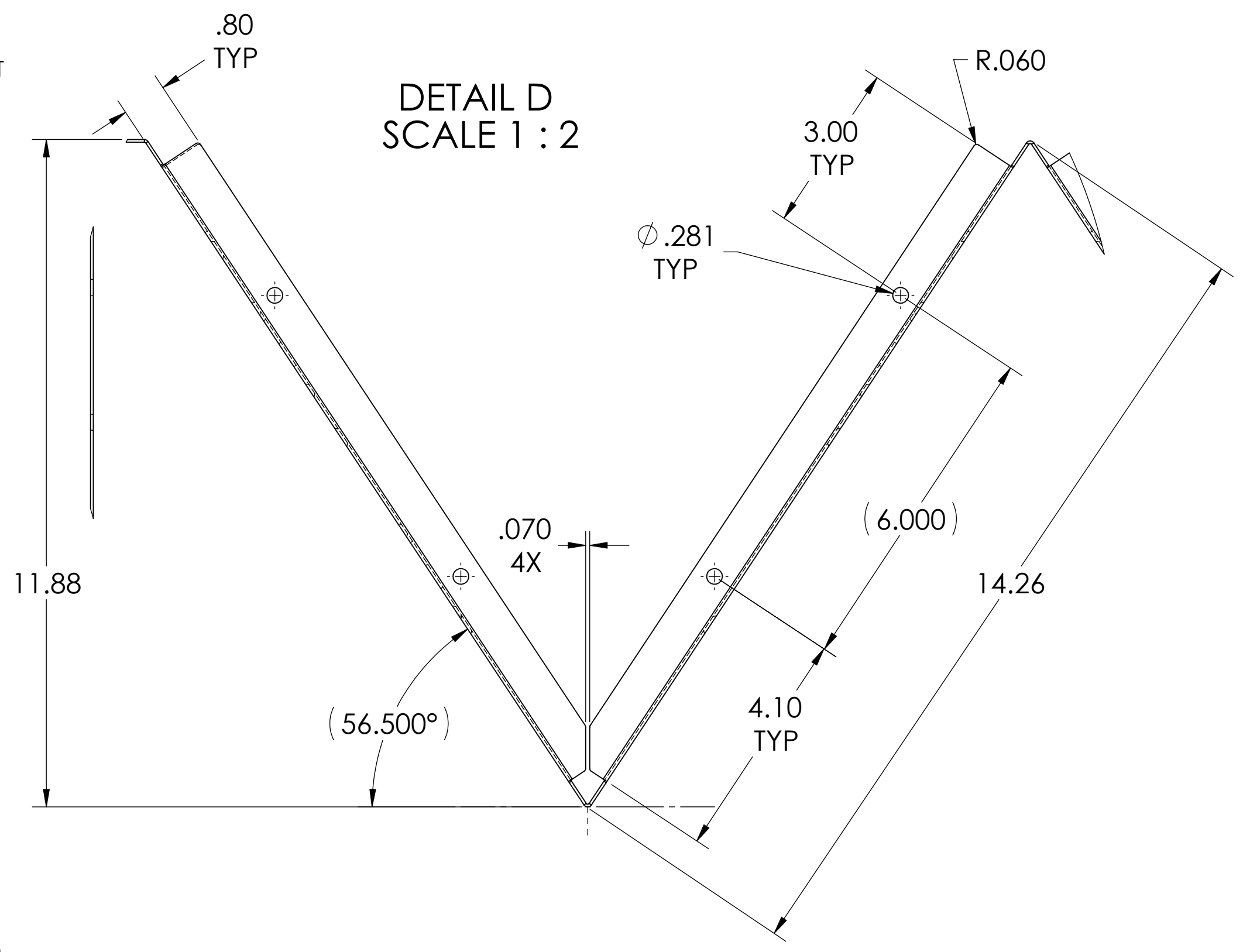
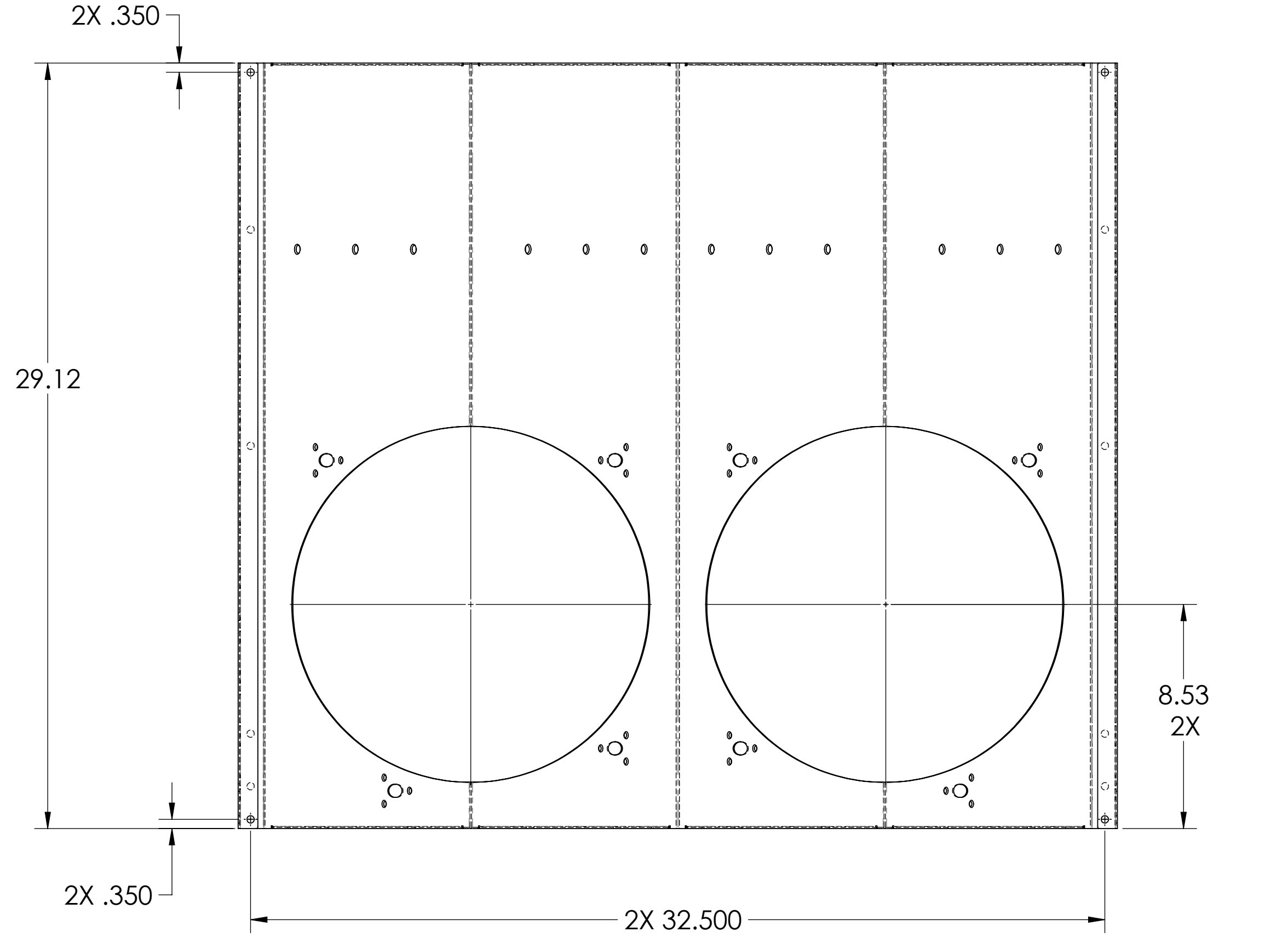
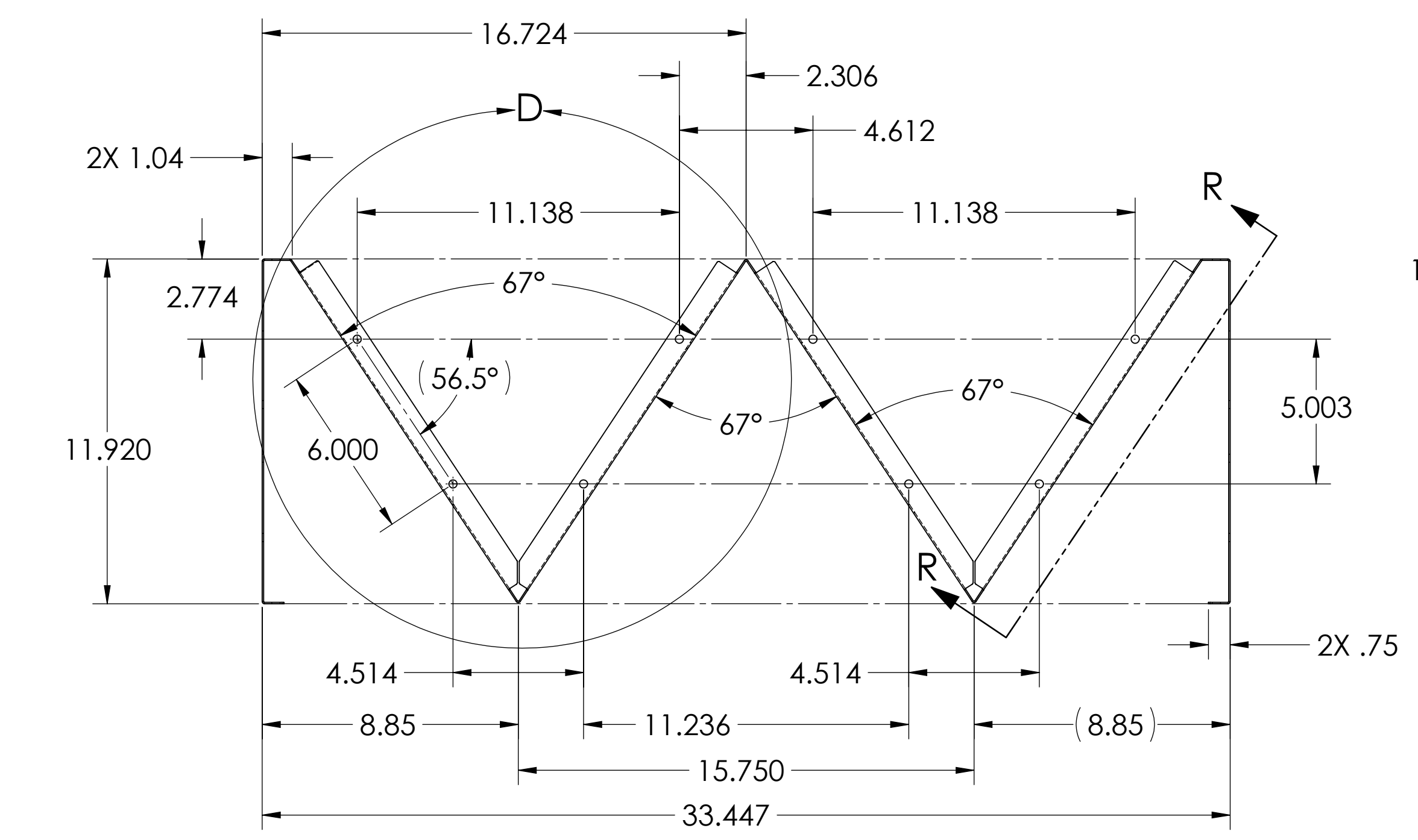
CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME SLC MAGNET HOLDER STEEL PLATE	
SYSTEM ADVANCED LIGO	SUB-SYSTEM AOS	DESIGNER N. NGUYEN	DATE 01 JUN 2010
DRAFTER TQ. NGUYEN	DATE 19 MAY 2010	SIZE B	DWG. NO. D1000930
CHECKER M. SMITH	DATE 30 JUN 2010	APPROVAL D. COYNE	REV. v1
NEXT ASSY D1001007		SCALE: 1:1	PROJECTION:
			SHEET 1 OF 1

D1000973_AudiGO_AOS_SLC_ARM_Cavity_Baffle_Skin_PART_FDM_REV_X-012_DRAWING_FDM_REV_X-026

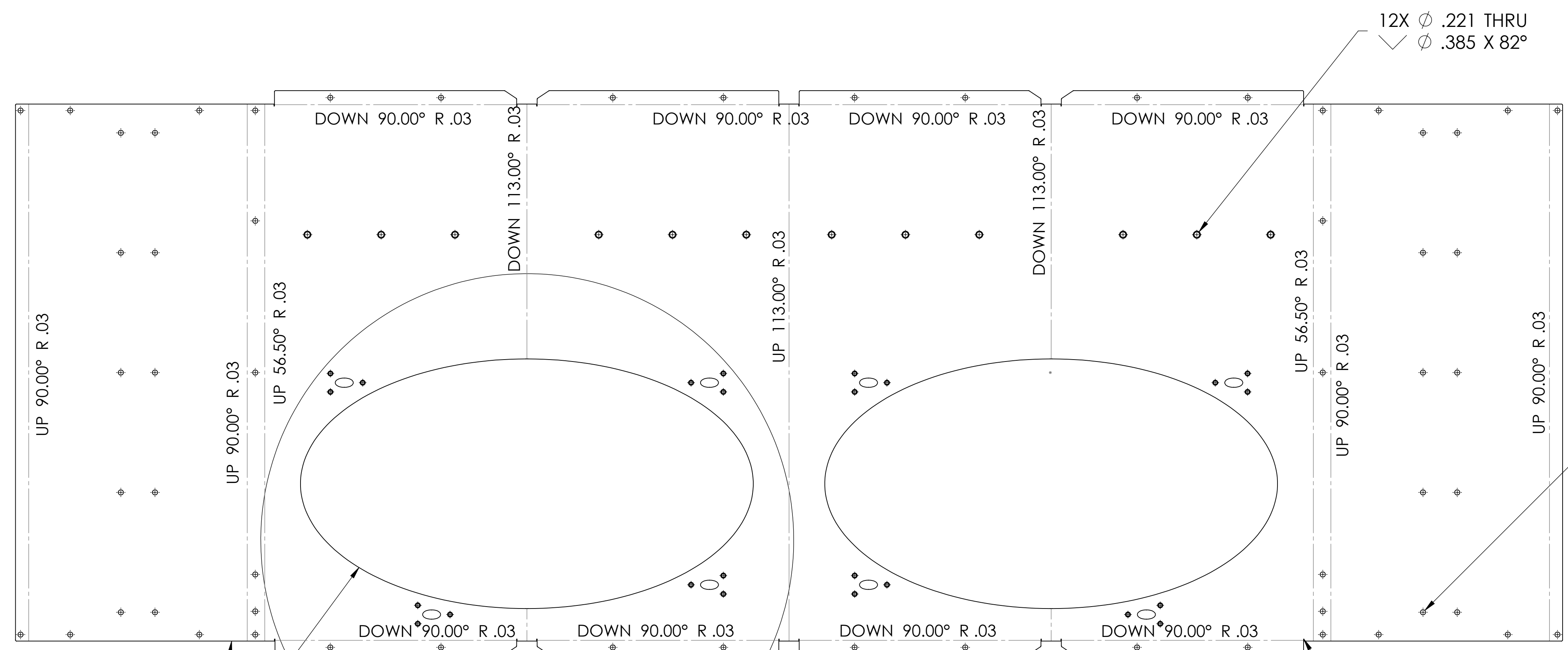
- 5. MAT'L: 18 GA ENAMELING STEEL -A424 TYPE I OR III.
- 6. ALL EDGES TO BE SMOOTH AND FREE OFF BURRS.
- 7. FINISH: PART WILL BE PORCELAIN COATED IN ACCORDANCE WITH LIGO SPECIFICATION E1000083
- 8. ALL HOLE AREAS SHALL BE MASKED WITHIN .63 DIA PRIOR PORCELAIN COATED. BOTH SIDES
- 9. SEE CAD FILE # D1000973 TO GENERATE ELLIPSE CURVES

10. ENGRAVE OR MECHANICALLY STAMP DRAWING PART NUMBER, REVISION AND A THREE DIGIT SERIAL NUMBER. SERIAL NUMBER START AT 001 FOR THE FIRST ARTICAL AND PROCEED CONSECUTIVELY. USE .156 HIGH X .020 DEEP CHARACTERS. EXAMPLE: DXXXXXX-v1 S/N XXX

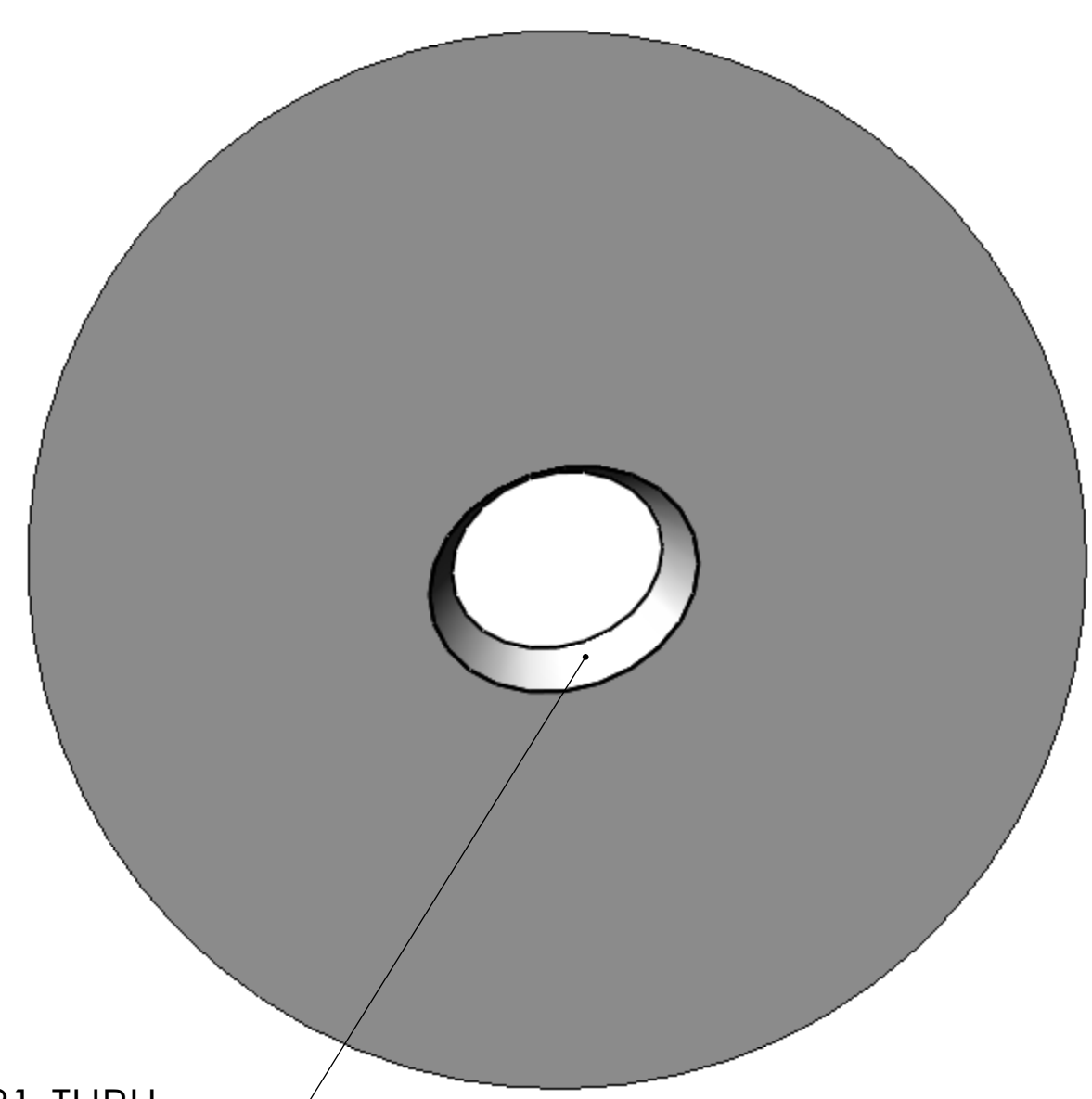
REV.	DATE	DCN #	DRAWING TREE #
v1	02 JUL 2010	E1000285	



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY				PART NAME			
1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES, R.02 MIN. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.				ADVANCED LIGO				ARM CAVITY BAFFLE SKIN			
DIMENSIONS ARE IN INCHES TOLERANCES: .XX ± .02 .XXX ± .010 ANGULAR ± 1.0°				MATERIAL: 18 GA Enamel Steel A424 Type I FINISH: SEE NOTE 7				DESIGNER: N.Nguyen 20 May 2010 DRAFTER: TG. NGUYEN 27 MAY 2010 CHECKER: M. SMITH 10 NOV 2010 APPROVAL: D. COYNE 20 NOV 2010			
				SYSTEM: ADVANCED LIGO SUB-SYSTEM: AOS NEXT ASSY: D1000977				SIZE: D DWG. NO.: D1000973 SCALE: 1:4 PROJECTION:			
								REV. v1 SHEET 1 OF 3			



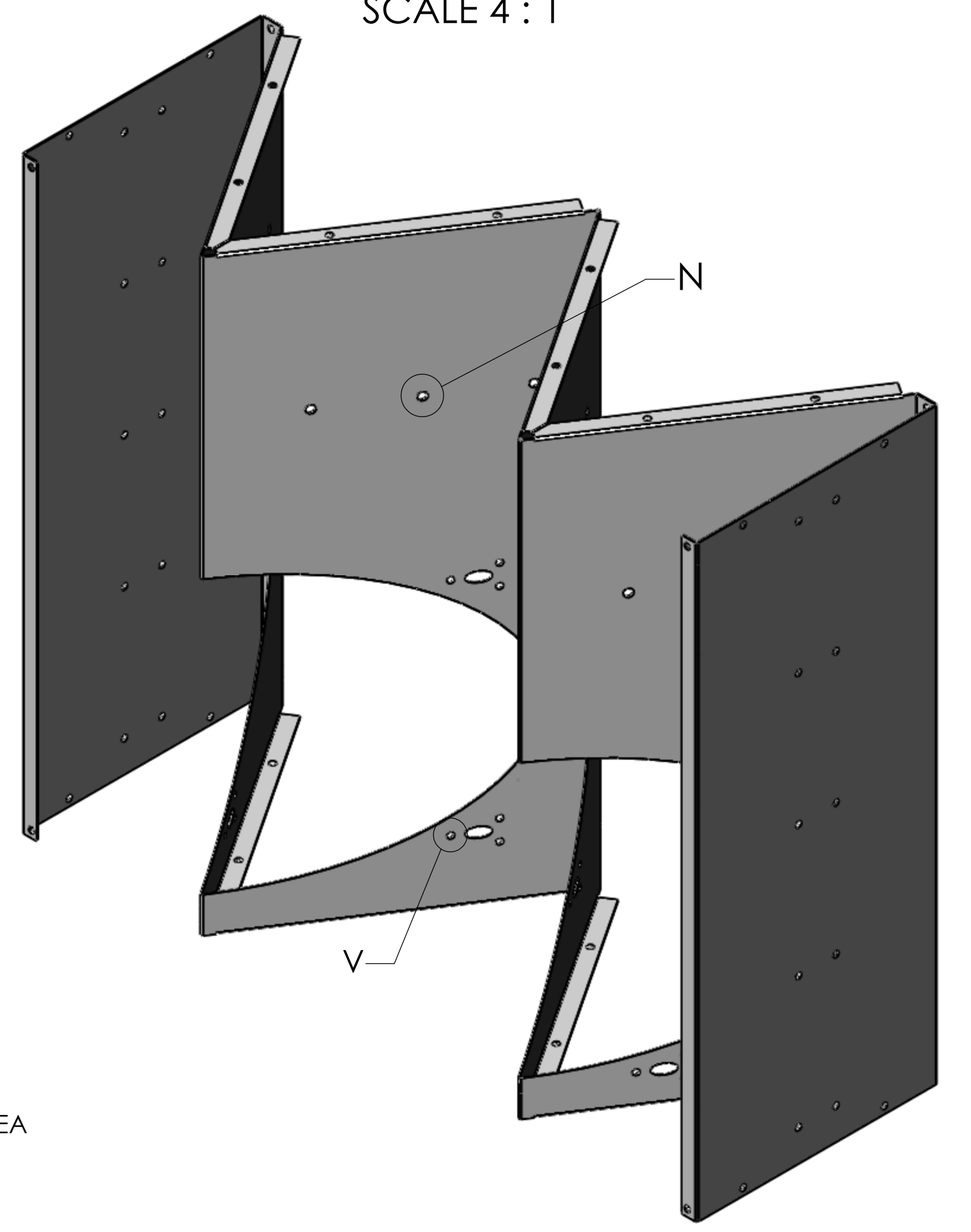
12X ϕ .221 THRU
 \checkmark ϕ .385 X 82°



60X ϕ .281 THRU

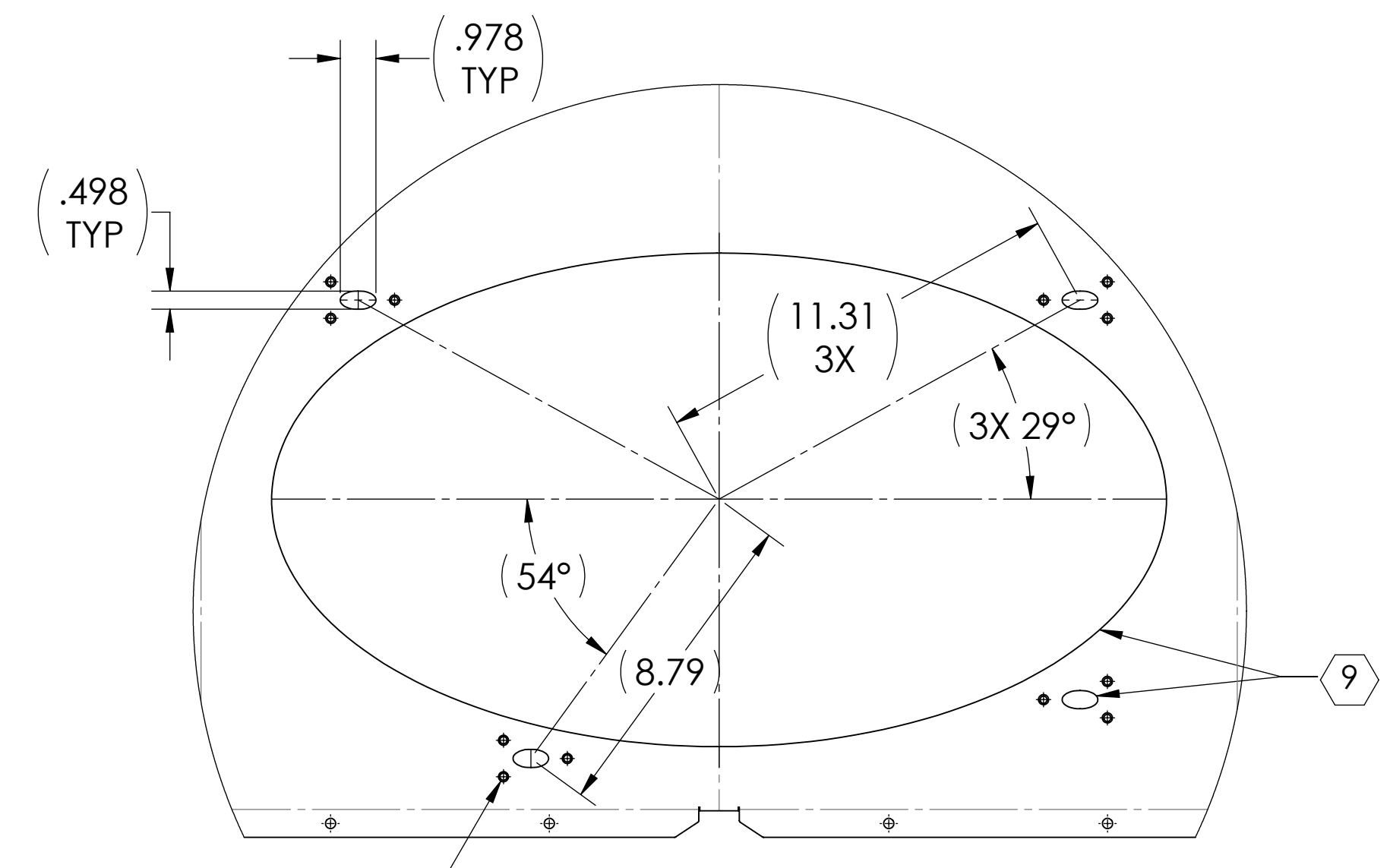
MASK THIS COUNTERSINK AREA AND WITHIN .63 DIA OF OPPOSITE SIDE. PRIOR PORCELAINIZING. 12X

DETAIL N
 SCALE 4 : 1



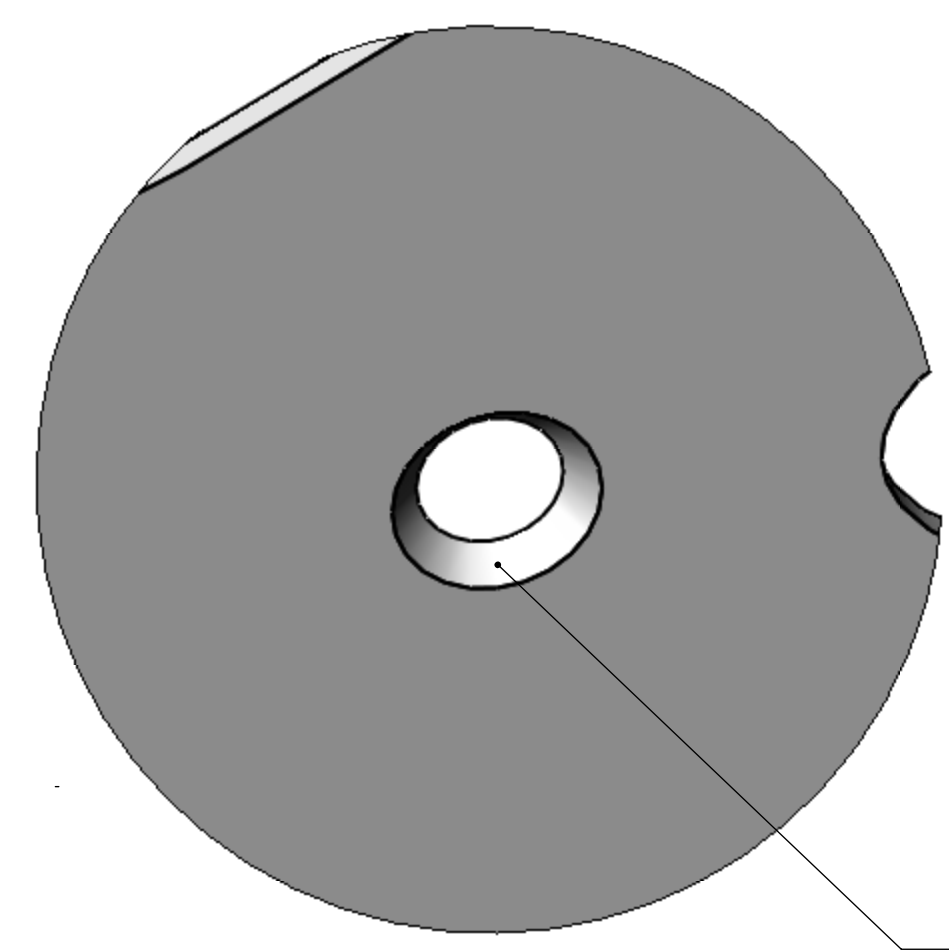
ALL EDGES TO BE SMOOTH AND FREE OF BURRS

BEND RELIEF
 OPTIONAL
 TYP



24X ϕ .170 THRU
 \checkmark ϕ .279 X 82°

DETAIL M
 TYP 2 PLS



MASK THIS COUNTERSINK AREA PRIOR PORCELAINIZING 24X

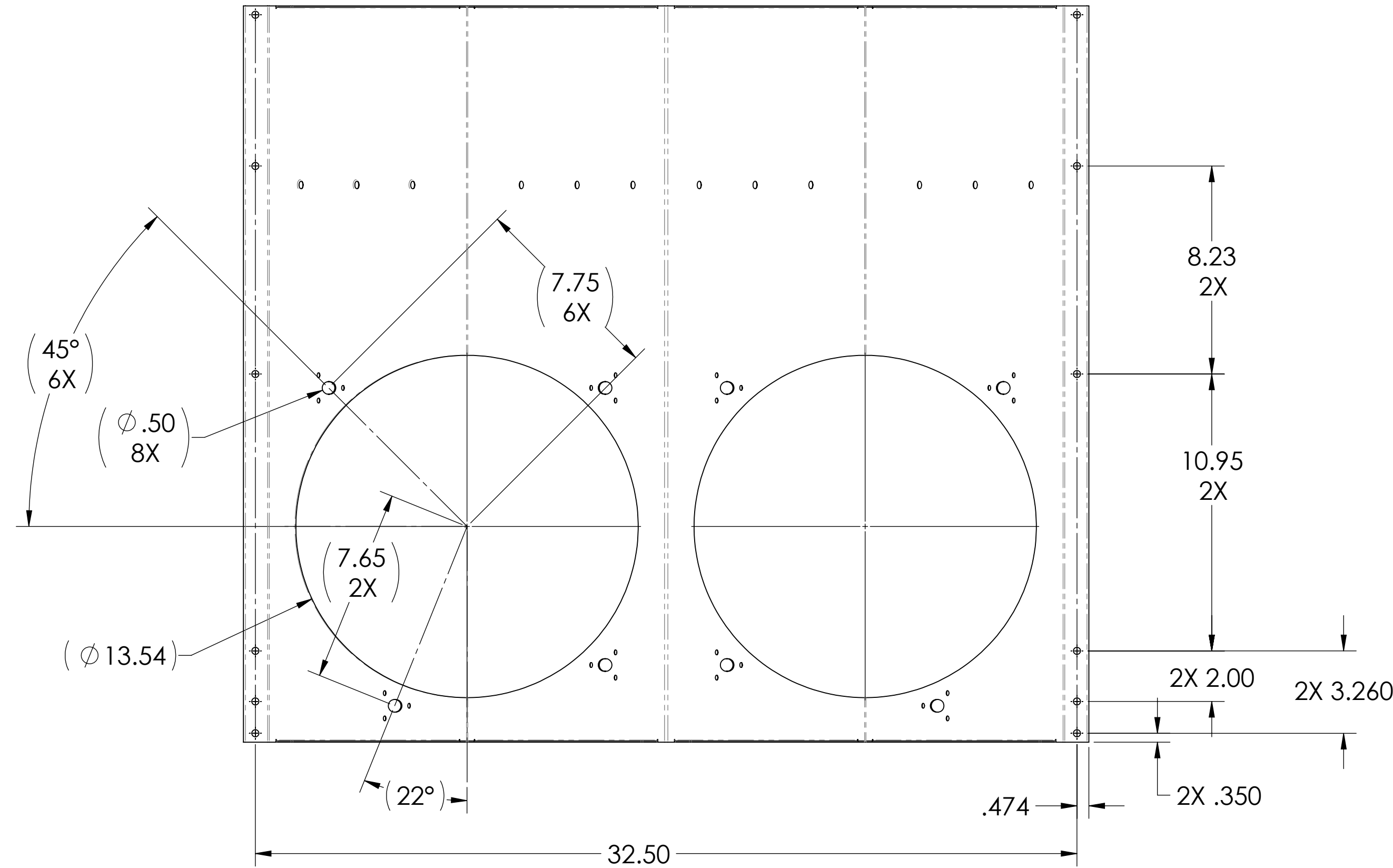
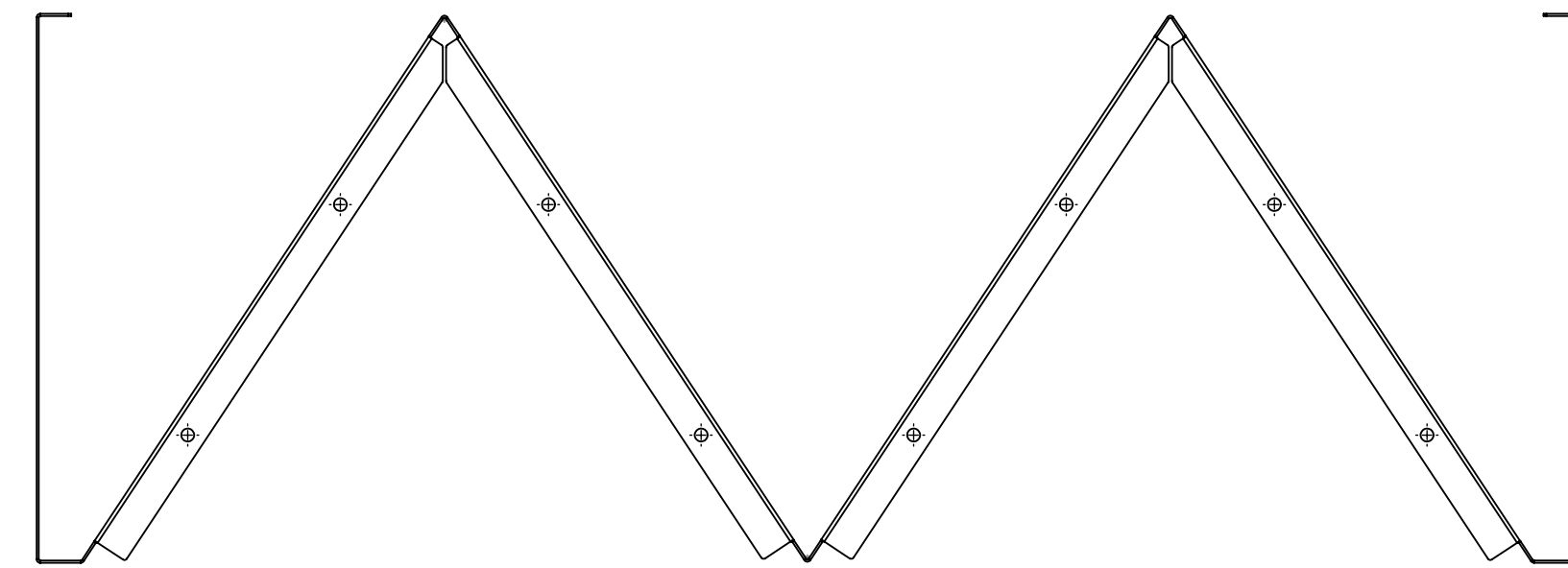
DETAIL V
 SCALE 4 : 1

CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		REV.
SIZE DWG. NO.	D1000973	v1
SCALE: 1:4	PROJECTION:	SHEET 2 OF 3

D1000973_AduLIGO_ACS_SLC_ARM_Cavity_Baffle_Sim_PART_PDM_REV_X-010_DRAWING_PDM_REV_X-026

8 7 6 5 4 3 2 1

H
G
F
E
D
C
B
A



LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY
 SIZE DWG. NO. REV.
D **D1000973** v1
 SCALE: 1:4 PROJECTION: SHEET 3 OF 3

8 7 6 5 4 3 2 1

H
G
F
E
D
C
B
A

D:\000973_AduLIGO_ACS_SLC_ARM_Cavity_Bottle_Sign_PART_PDM_REV.X-010_DRAWING_PDM_REV.X-026

NOTES CONTINUED:

5. FINISH: PART WILL BE PORCELAIN COATED IN ACCORDANCE WITH LIGO SPECIFICATION E1000083

6. DIMENSIONS APPLY BEFORE COATING

7. PART TO BE SMOOTH AND FREE OF BURRS.

8. ALL MOUNTING HOLE AREAS SHALL BE MASKED WITHIN .63 ± .03 DIA PRIOR PORCELAIN COATING, BOTH SIDES.

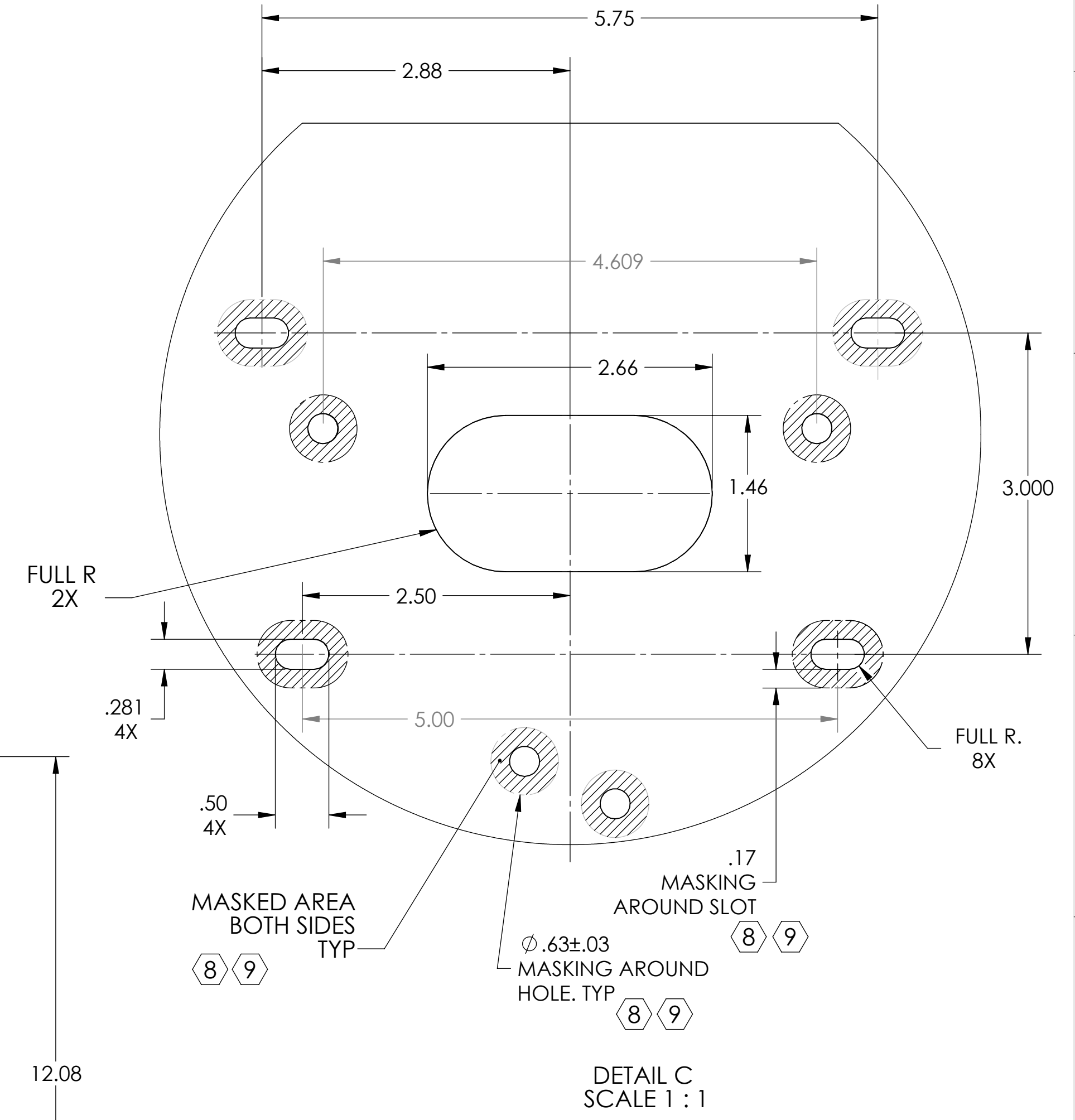
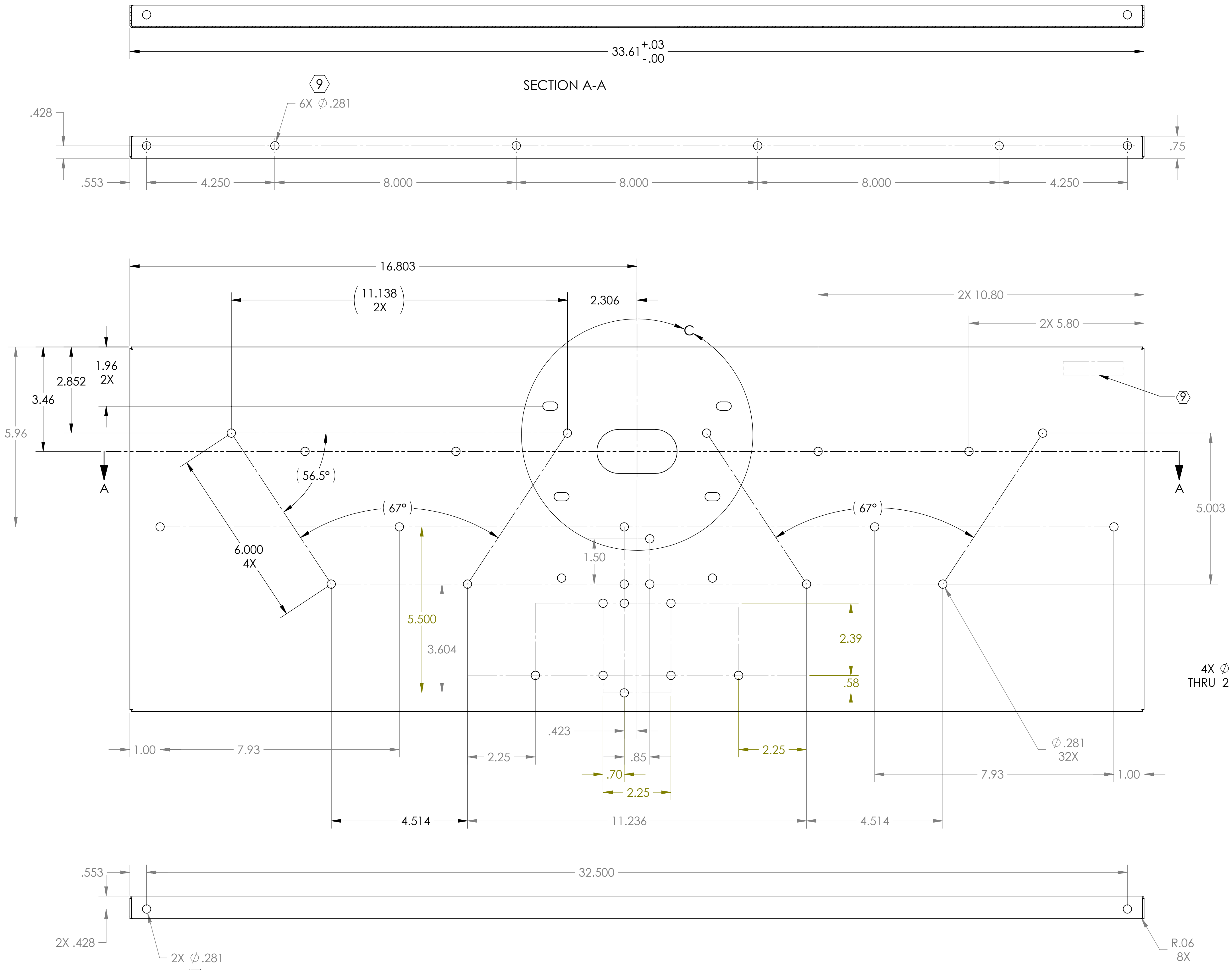
9. ENGRAVE OR MECHANICALLY STAMP DRAWING PART NUMBER, REVISION AND A THREE DIGIT SERIAL NUMBER. SERIAL NUMBER START AT 001 FOR THE FIRST ARTICAL AND PROCEED CONSECUTIVELY. USE .156 HIGH X .020 DEEP CHARACTERS. EXAMPLE: DXXXXXX-v1 S/N XXX

10. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364 (SECTION 4.1, 4.4, 4.6, 4.7 & 4.8)

11. ALL MATERIAL IS TO BE VIRGIN MATERIAL (i.e. NOT WELD REPAIRS OR PLUGS UNLESS APPROVED IN ADVANCE IN WRITING BY LIGO, REFER TO LIGO-E0900364.

12. 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 SHOULD BE MADE WITH VIRGIN MATERIAL. SPECIAL CIRCUMSTANCES CAN BE REVIEWED IF / WHEN BROUGHT TO THE ATTENTION OF LIGO CONTRACTING OFFICER'S REPRESENTATIVE (COR) THROUGH A MATERIAL REVIEW BOARD (MRB) PROCESS. REFER TO LIGO-E0900364.

REV.	DATE	DCN #	DRAWING TREE #
v1	15 JUN 2010	E1000285	

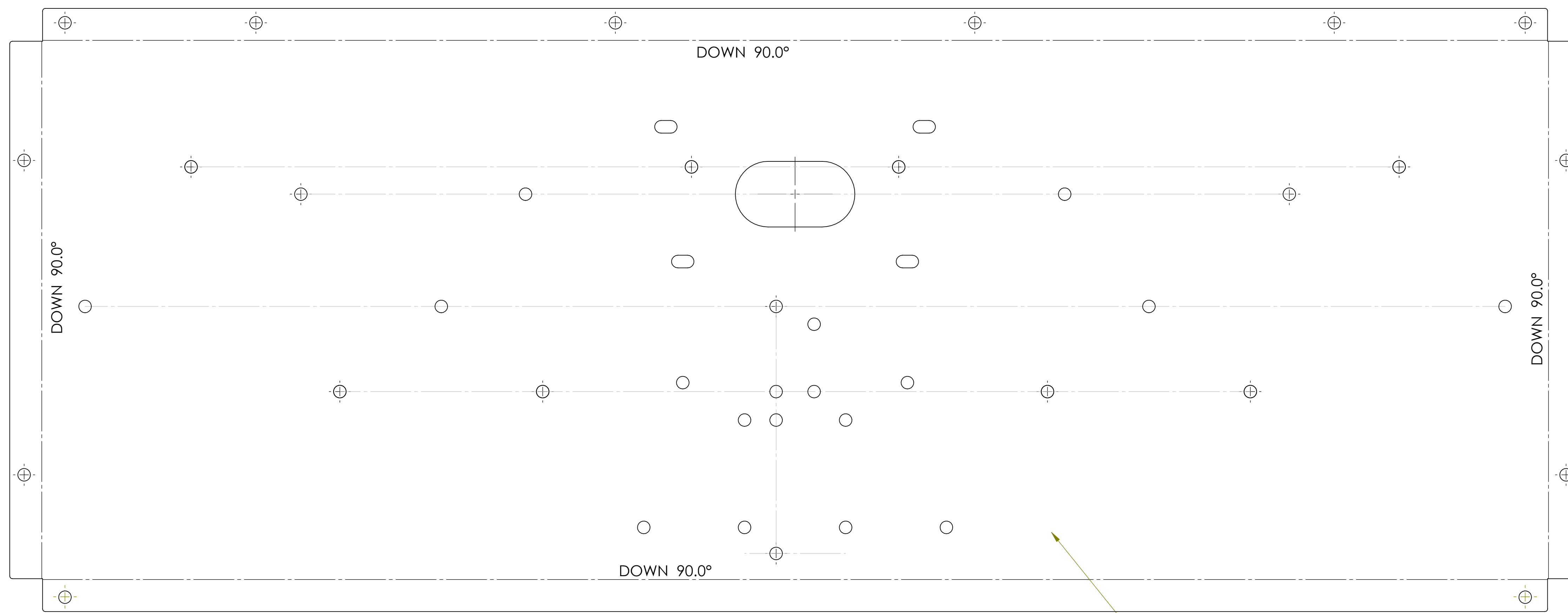


NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)	
1. INTERPRET DRAWING PER ASME Y14.5-1994.	
2. REMOVE ALL SHARP EDGES, R.02.	
3. DO NOT SCALE FROM DRAWING.	
4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.	
DIMENSIONS ARE IN INCHES	
TOLERANCES: .XX ± .02 .XXX ± .015	
ANGULAR ± 1.0°	
MATERIAL 18 GA Enamel A424 Type I	FINISH (8) (9)

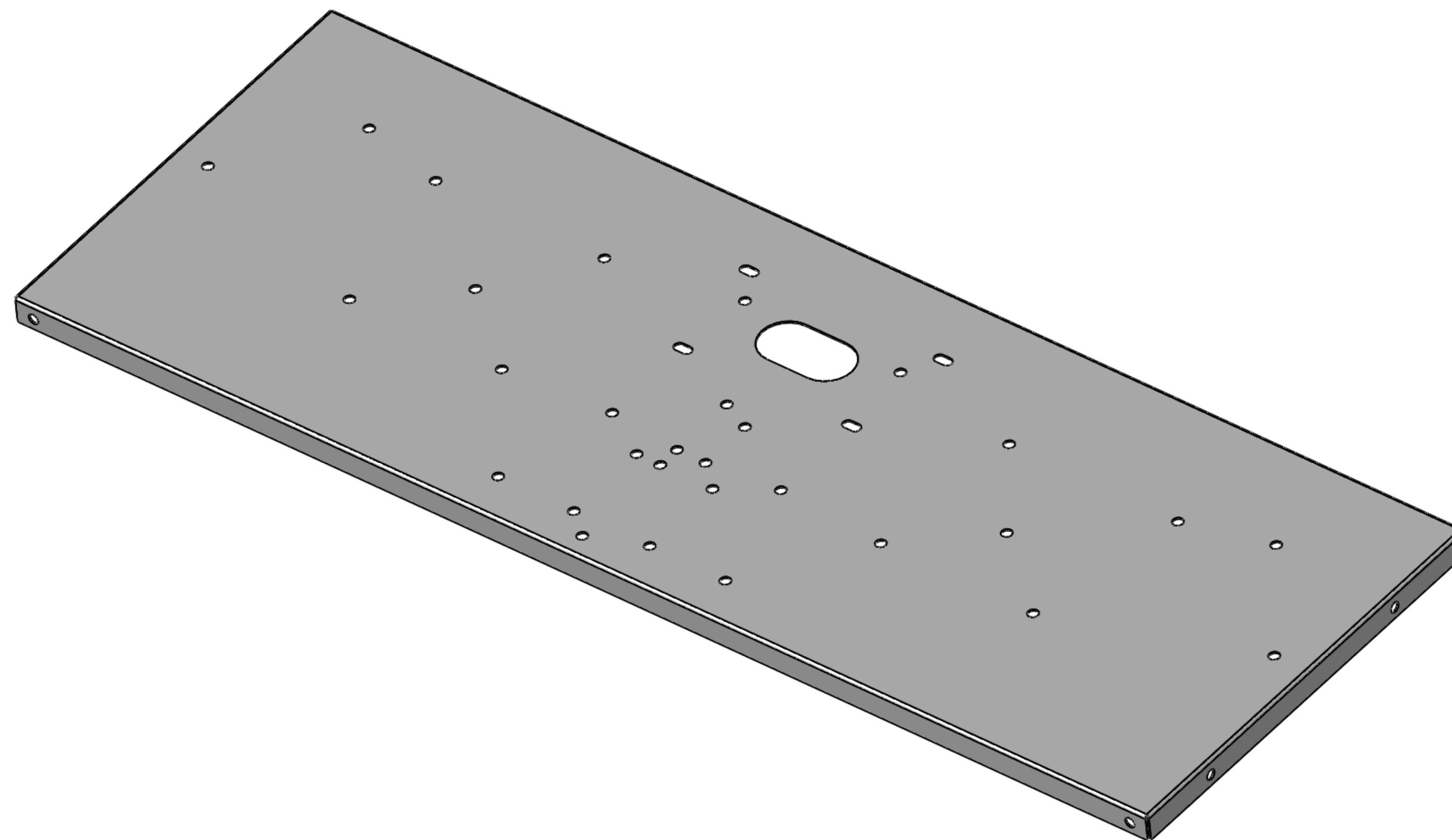
CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
SYSTEM ADVANCED LIGO	SUB-SYSTEM AOS
NEXT ASSY D1000977	

PART NAME				SIZE		DWG. NO.		REV.
ARM CAVITY BAFFLE TOP SKIN				D		D1000974		v1
DESIGNER	N.Nguyen	01 Jun 2010	CHECKER	M. SMITH	10 NOV 2010	APPROVAL	D. COYNE	20 NOV 2010
SCALE: 1:2		PROJECTION:		SHEET 1 OF 2				

D:\000974_Adi\GO_AOS_31C_ARM_Cavity_Baffle_Top_Skin_PART.PDM.REV.X-046_DRAWING.PDM.REV.X-021



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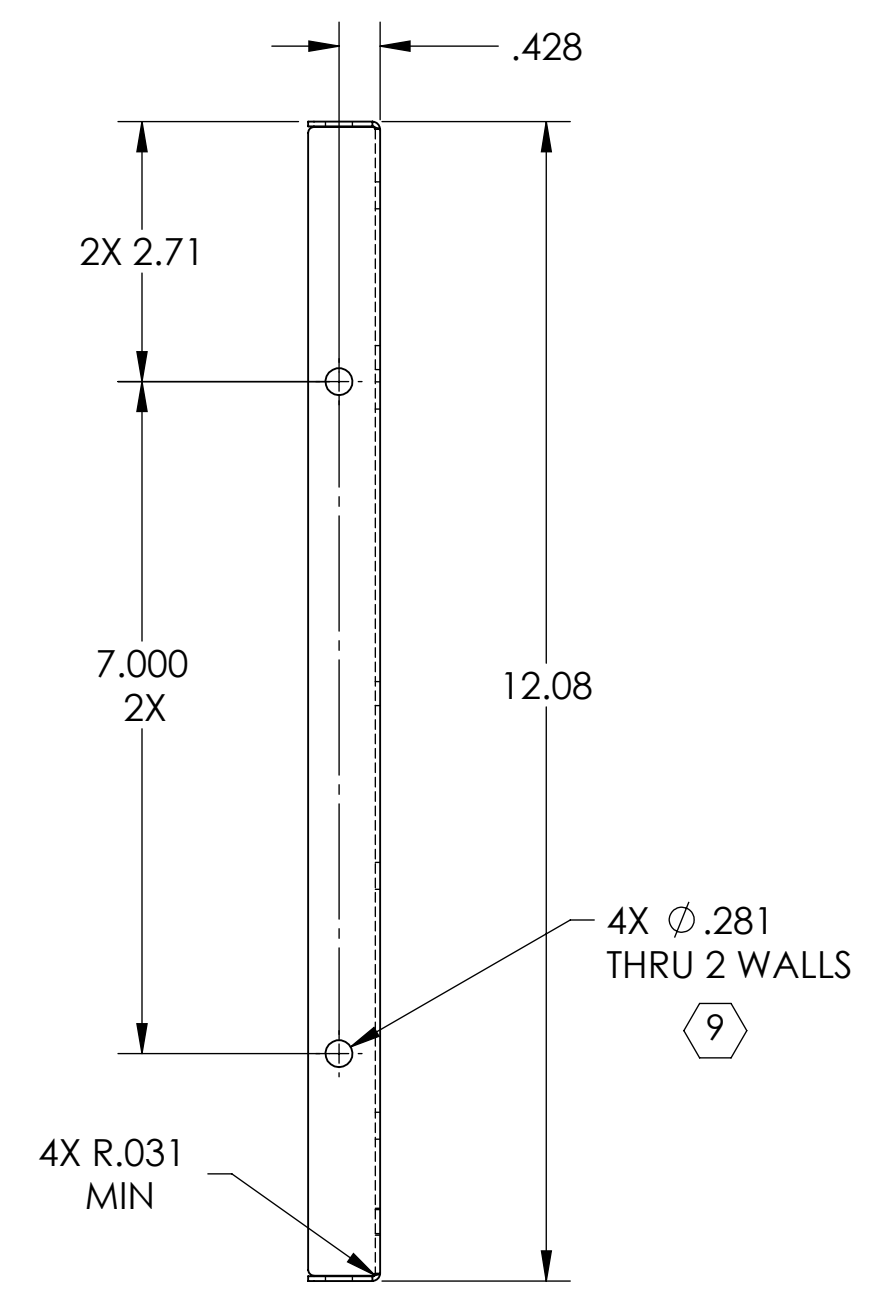
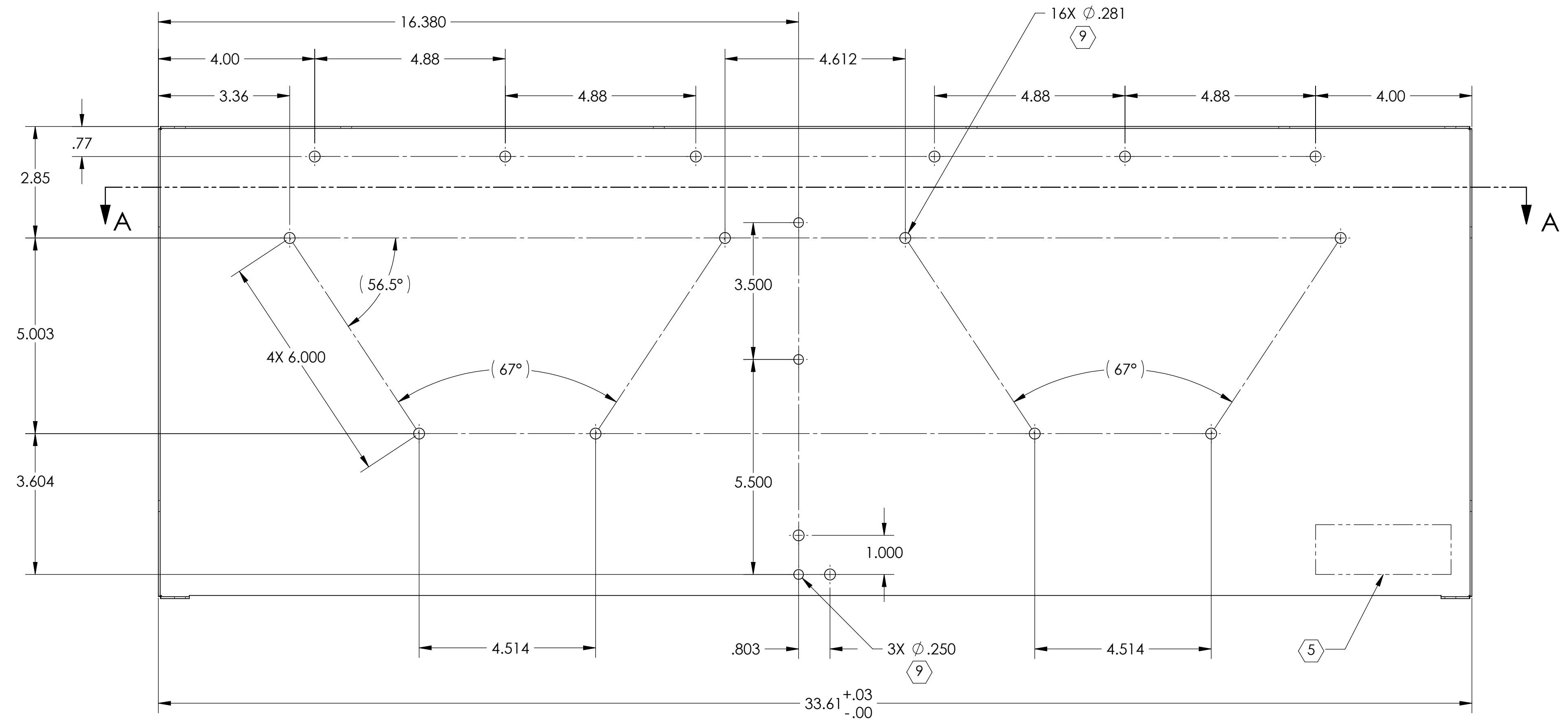
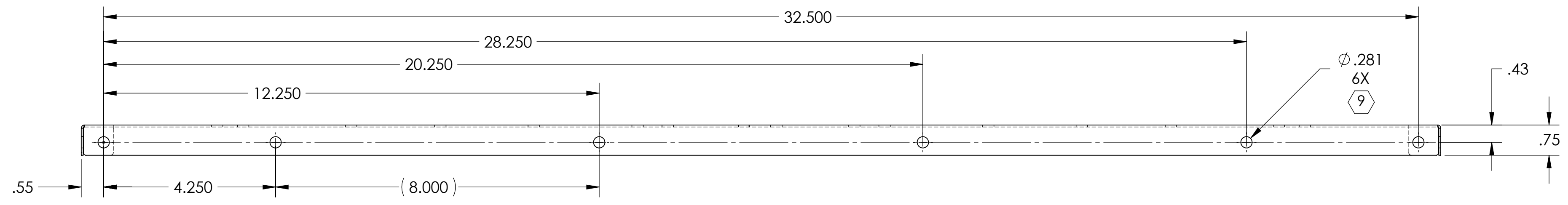
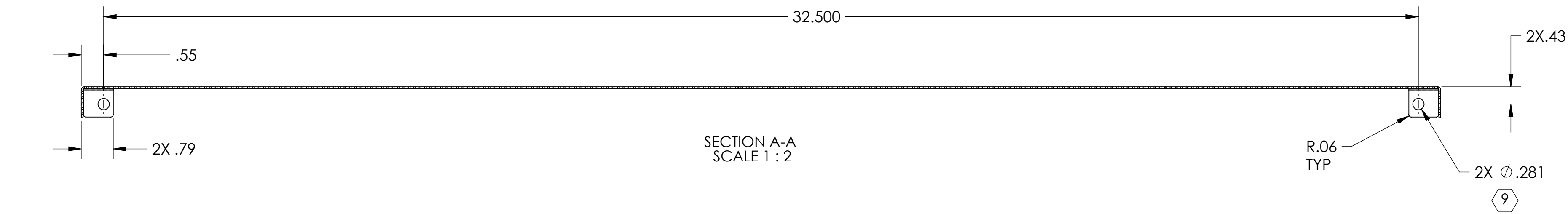


LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		
SIZE	DWG. NO.	REV.
D	D1000974	v1
SCALE: 1:2	PROJECTION:	SHEET 2 OF 2

D1000974_AduLIGO_AOS_SLC_ARM_Covily_Bottle_Top_Skin_PART_PDM_REV_X.046_DRAWING_PDM_REV_X.021

- NOTES CONTINUED:**
- ⑤ MECHANICALLY STAMP (NO INKS OR DYES) PART NUMBER, REVISION AND SERIAL NUMBER .020 DEEP WITH MINIMUM CHARACTER HEIGHT .156 APPROXIMATELY WHERE SHOWN. SERIAL NUMBER WILL START AT 001 AND PROCEED CONSECUTIVELY.
EXAMPLE: D100XXXX-V1
S/N 001
 - 6. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPEC E0900364.
 - 7. ALL MATERIAL IS TO BE VIGIN MATERIAL (I.E. NO WELD REPAIRS OR PLUGS) UNLESS APPROVED IN ADVANCE, IN WRITING, BY LIGO PER SPECIFICATION E0900364.
 - 8. SURFACE FINISH TO BE AS-PROCESSED FROM MILL/SUPPLIER, FREE FROM SCRATCHES OR GOUGES.
 - ⑥ PART WILL BE PORCELAIN COATED PER LIGO SPECIFICATION E1000083 AFTER FABRICATION. THE INDICATED HOLES WILL BE MASKED PRIOR TO PORCELAIN COATING TO APPROXIMATELY 2.5-3X HOLE DIAMETER CENTERED ON BOTH SIDES OF THE HOLE.
 - 10. DIMENSIONS APPLY BEFORE PORCELAIN COATING UNLESS SPECIFIED.
 - 11. BEND RADIUS: UNLESS OTHERWISE NOTED, THE BEND RADIUS SHOULD BE THE MINIMUM REQUIRED TO FORM WITHOUT CRACKING OR REQUIRING ADDITION WORK WHEN FORMING. IN PARTICULAR IF SHEET METAL IS TO BE PORCELAIN COATED, THE BEND RADIUS SHALL BE A MINIMUM OF .12" OUTSIDE RADIUS OF BEND UNLESS OTHERWISE NOTED.

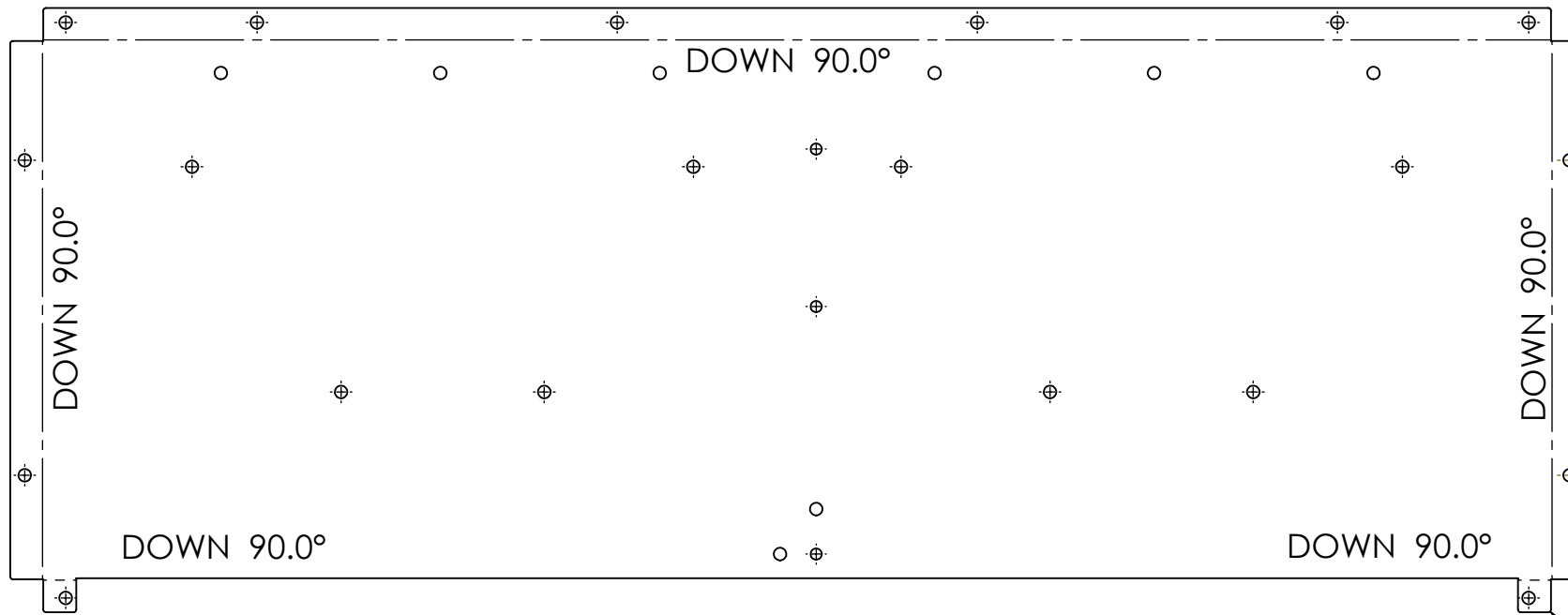
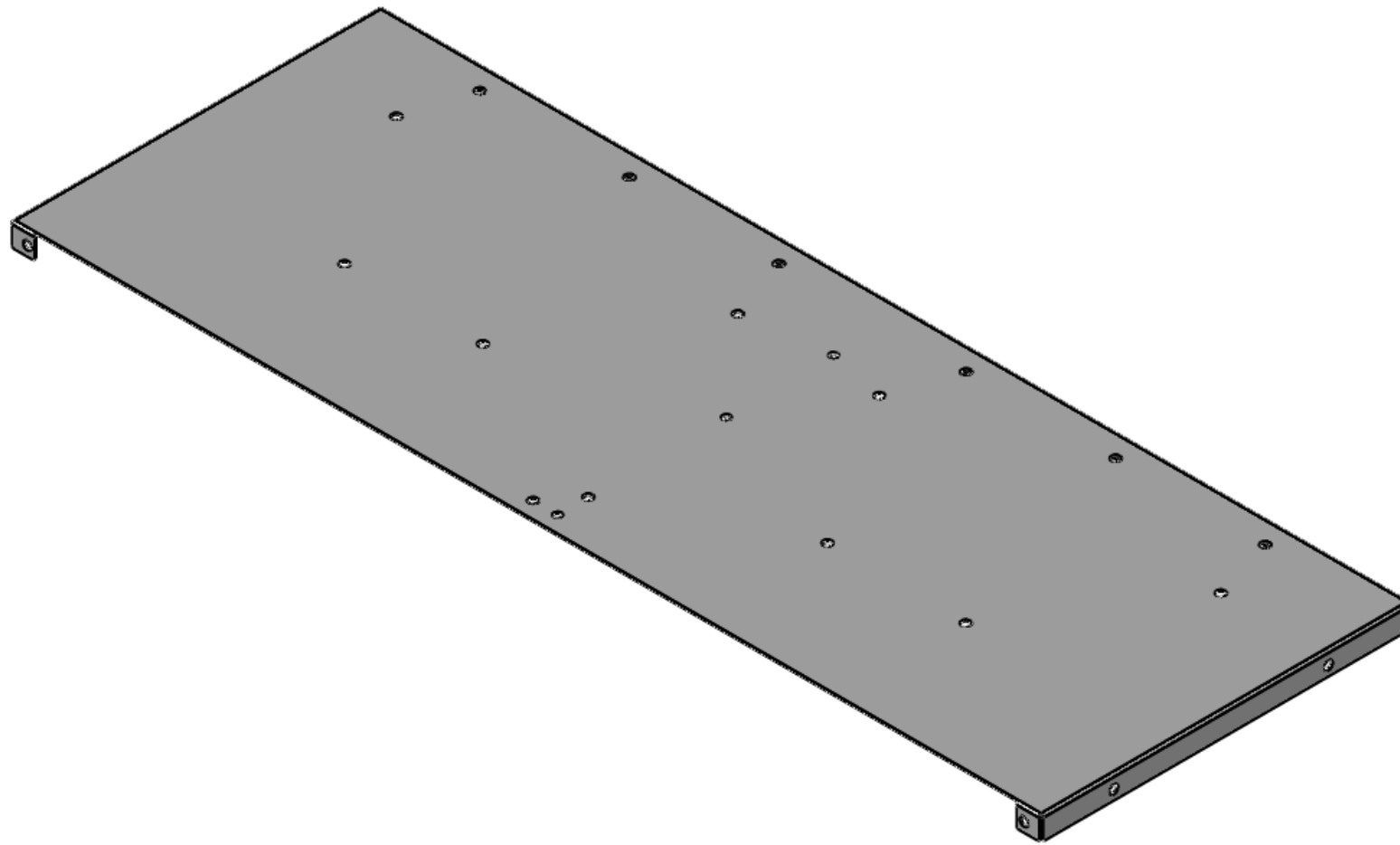
REV.	DATE	DCN #	DRAWING TREE #
v1	10 AUG 2010	E1000285	



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)		LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME	
DIMENSIONS ARE IN INCHES TOLERANCES: .XX ± .02 .XXX ± .010 ANGULAR ± 1.0°		1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES AND BURRS AND ROUND EDGES APPROXIMATELY R.02. 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE PER LIGO DOCUMENT E0900237.		ARM CAVITY BAFFLE BTM SKIN	
MATERIAL 18 GA Enamel Steel A424 Type 1		FINISH 9		DESIGNER N.Nguyen 01 Jun 2010	
NEXT ASSY D1000977		SUB-SYSTEM AOS		SIZE DWG. NO. D D1000975	
		CHECKER M. SMITH 10 NOV 2010		REV. v1	
		APPROVAL D. COYNE 20 NOV 2010		SCALE: 1:4 PROJECTION:	
				SHEET 1 OF 2	

D1000975_AulIGO_AOS_3LC_ARM Cavity Baffle Bottom Skin_PART PDM REV: X:024 DRAWING PDM REV: X:020

D1000975_AdLIGO_AOS_SLC_ARM_Cavity Baffle Bottom Skin, PART PDM REV: X-024, DRAWING PDM REV: X-020



10X R.060

 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
SIZE B	DWG. NO. D1000975
SCALE: 1:4	REV. v1
PROJECTION: 	SHEET 2 OF 2

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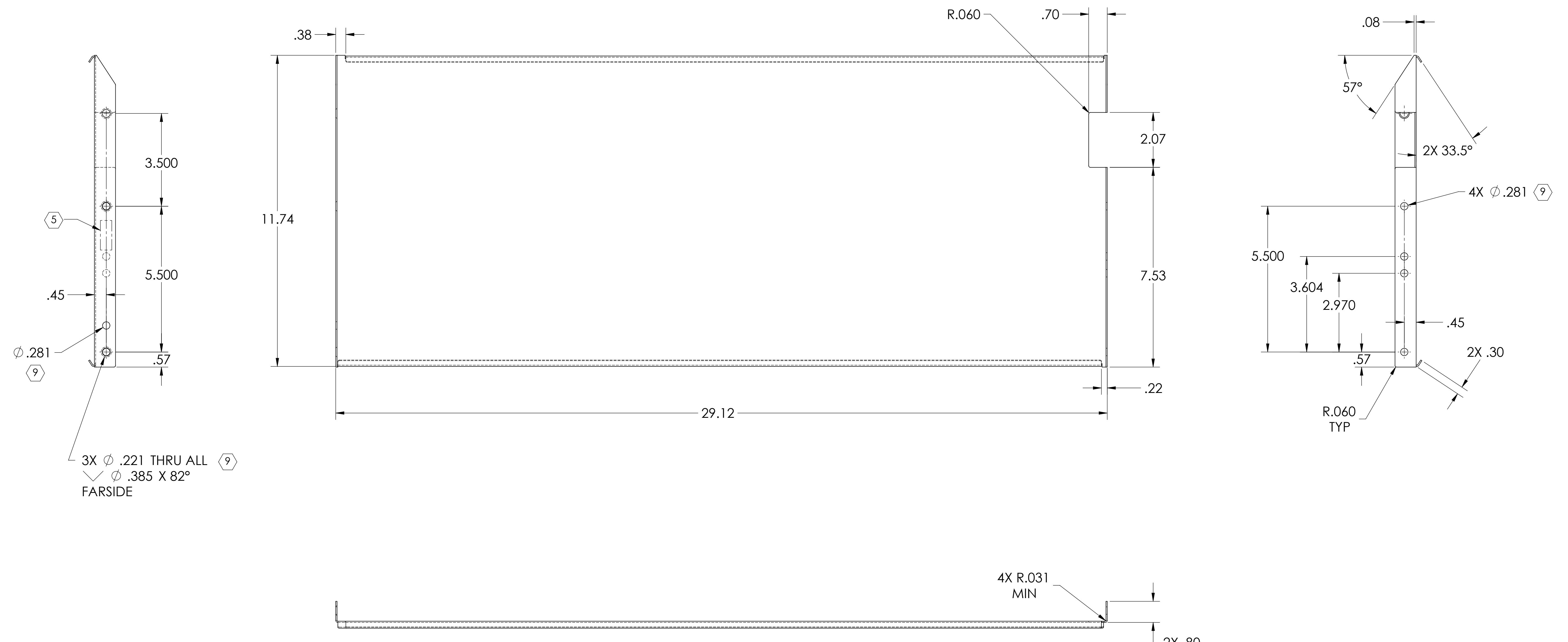
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REV.	DATE	DCN #	DRAWING TREE #
v1	08 JUN 2010	E1000285	

- NOTES: UNLESS OTHERWISE SPECIFIED**
1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES AND BURRS AND ROUND EDGES APPROXIMATELY R.02.
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINE FLUIDS MUST BE FULLY SYNTHETIC, FULL WATER SOLUBLE AND FREE OF SULFUR, SILICONE AND CHLORINE PER LIGO DOCUMENT E0900237.
 5. MECHANICALLY STAMP (NO INKS OR DYES) PART NUMBER, REVISION AND SERIAL NUMBER .020 DEEP WITH MINIMUM CHARACTER HEIGHT .156 APPROXIMATELY WHERE SHOWN. SERIAL NUMBER WILL START AT 001 AND PROCEED CONSECUTIVELY. EXAMPLE: D100XXXX-V1 S/N 001
 6. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPEC E0900364.
 7. ALL MATERIAL IS TO BE VIRGIN MATERIAL (I.E. NO WELD REPAIRS OR PLUGS) UNLESS APPROVED IN ADVANCE, IN WRITING, BY LIGO PER SPECIFICATION E0900364.
 8. SURFACE FINISH TO BE AS-PROCESSED FROM MILL/SUPPLIER, FREE FROM SCRATCHES OR GOUGES.
 9. PART WILL BE PORCELAIN COATED PER LIGO SPECIFICATION E1000083 AFTER FABRICATION. THE INDICATED HOLES WILL BE MASKED PRIOR TO PORCELAIN COATING TO APPROXIMATELY 2.5-3X HOLE DIAMETER CENTERED ON BOTH SIDES OF THE HOLE.
 10. DIMENSIONS APPLY BEFORE PORCELAIN COATING UNLESS SPECIFIED.
 11. BEND RADIUS: UNLESS OTHERWISE NOTED, THE BEND RADIUS SHOULD BE THE MINIMUM REQUIRED TO FORM WITHOUT CRACKING OR REQUIRING ADDITIONAL WORK WHEN FORMING. IN PARTICULAR IF SHEET METAL IS TO BE PORCELAIN COATED, THE BEND RADIUS SHALL BE MINIMUM OF .12" OUTSIDE RADIUS OF BEND UNLESS OTHERWISE NOTED.



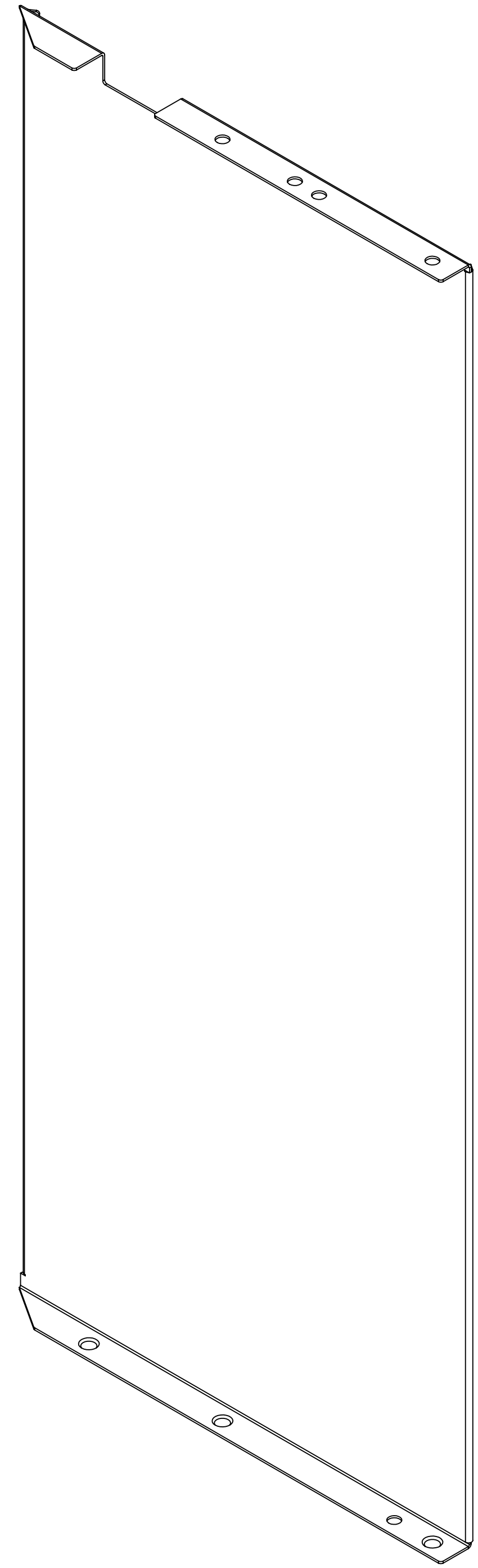
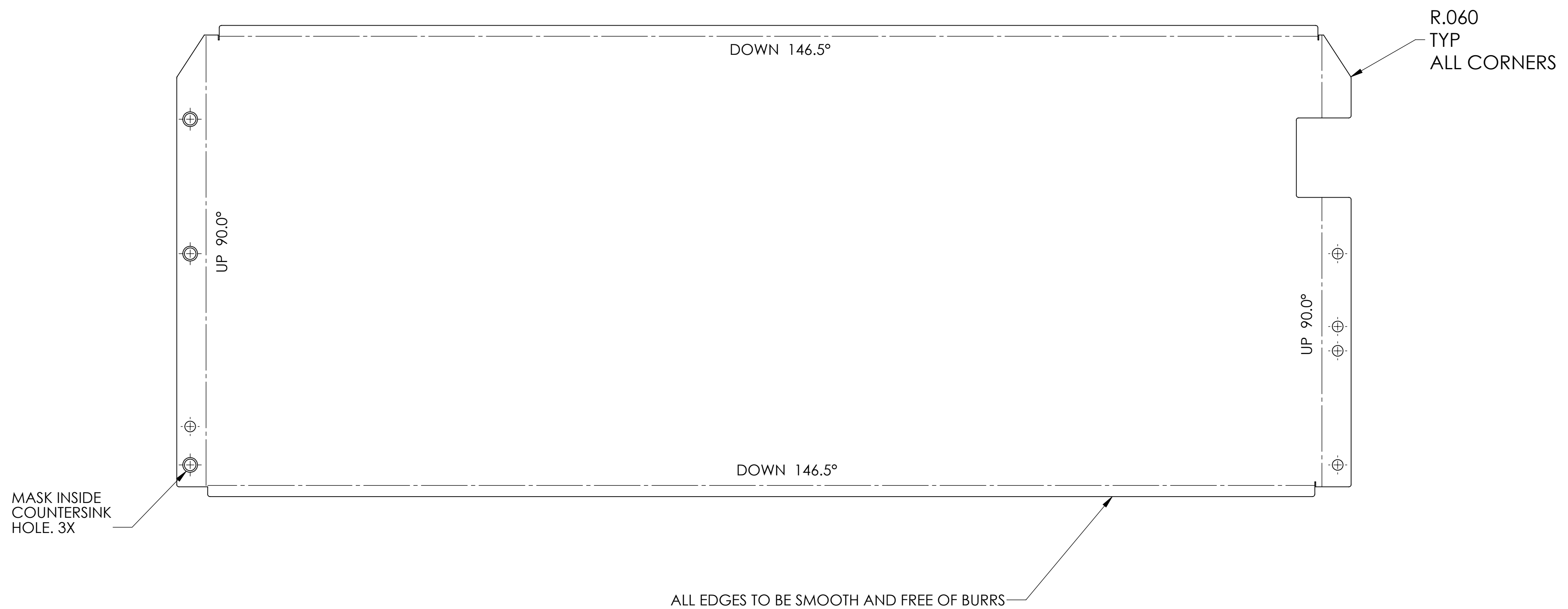
D1000976_AduLIGO_AOS_31C_ARM_Cavity_Baffle_Center_Skin_PART_PDM_REV_X-006_DRAWING_PDM_REV_X-008

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY				PART NAME																													
DIMENSIONS ARE IN INCHES				<table border="1"> <tr> <td>SYSTEM</td> <td colspan="2">ADVANCED LIGO</td> <td colspan="2">SUB-SYSTEM</td> <td>AOS</td> </tr> <tr> <td>MATERIAL</td> <td colspan="2">18GA Enamel Steel A424 type 1</td> <td colspan="2">FINISH</td> <td>9</td> </tr> <tr> <td colspan="4">TOLERANCES: .XX ± .02 .XXX ± .010</td> <td colspan="2">NEXT ASSY</td> <td>D1000977</td> </tr> <tr> <td colspan="4">ANGULAR ± 1.0°</td> <td colspan="2"></td> <td></td> </tr> </table>				SYSTEM	ADVANCED LIGO		SUB-SYSTEM		AOS	MATERIAL	18GA Enamel Steel A424 type 1		FINISH		9	TOLERANCES: .XX ± .02 .XXX ± .010				NEXT ASSY		D1000977	ANGULAR ± 1.0°							ARM CAVITY BAFFLE CTR SKIN			
SYSTEM	ADVANCED LIGO		SUB-SYSTEM					AOS																													
MATERIAL	18GA Enamel Steel A424 type 1		FINISH		9																																
TOLERANCES: .XX ± .02 .XXX ± .010				NEXT ASSY		D1000977																															
ANGULAR ± 1.0°																																					
				DESIGNER		N.Nguyen	02 Jun 2010		SIZE		DWG. NO.	REV.																									
				DRAFTER		TG. NGUYEN	28 MAY 2010		D		D1000976		v1																								
				CHECKER		M. SMITH	10 AUG 2010		SCALE: 1:2		PROJECTION:		SHEET 1 OF 2																								
				APPROVAL		D. COYNE	20 AUG 2010																														

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LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		REV.
SIZE	DWG. NO.	v1
D	D1000976	
SCALE: 1:2	PROJECTION:	SHEET 2 OF 2

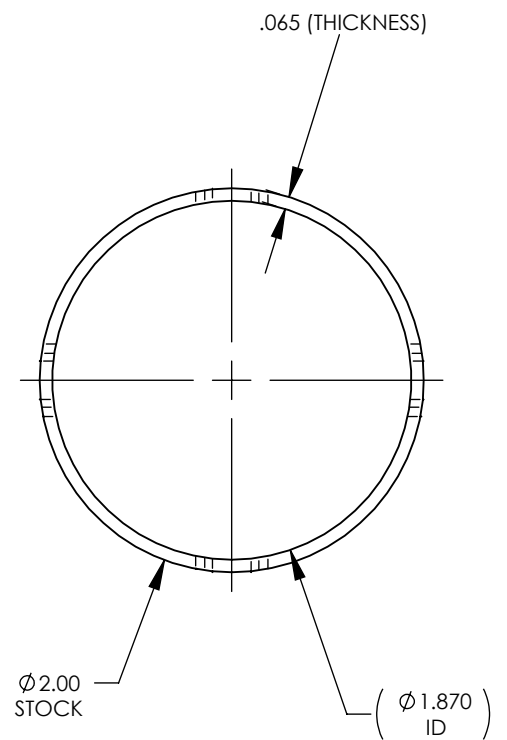
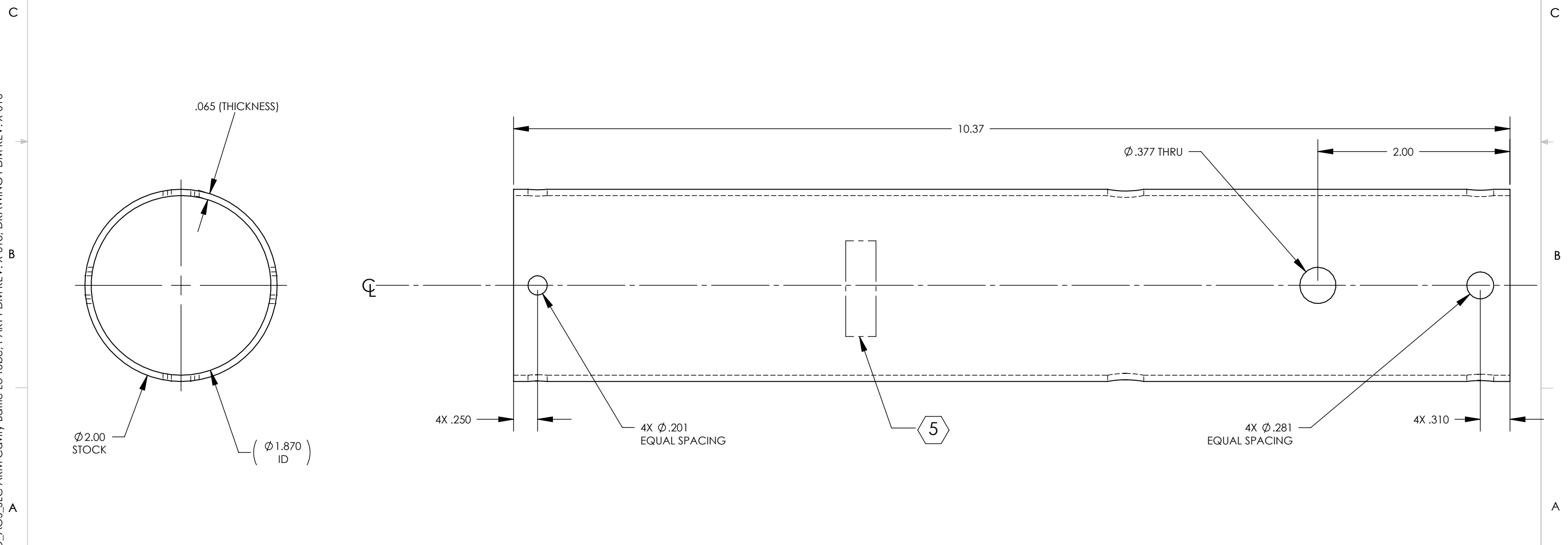
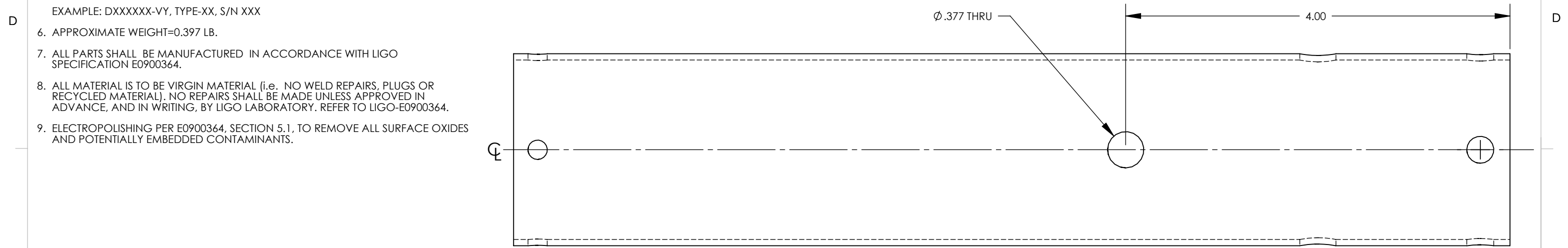
D:\000976_Adu\GO_ACS_SLC_ARM_Cavity_Baffle_Center_Sin_PART_PDM_REV_X:006_DRAWING_PDM_REV_X:008

D1001009_AdlIGO_AOS_SLC_ARM Cavity Baffle Lo Tube, PART PDM REV: X-018, DRAWING PDM REV: X-016

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 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: DXXXXX-VY, TYPE-XX, S/N XXX
- 6. APPROXIMATE WEIGHT=0.397 LB.
 - 7. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.
 - 8. 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.
 - 9. ELECTROPOLISHING PER E0900364, SECTION 5.1, TO REMOVE ALL SURFACE OXIDES AND POTENTIALLY EMBEDDED CONTAMINANTS.

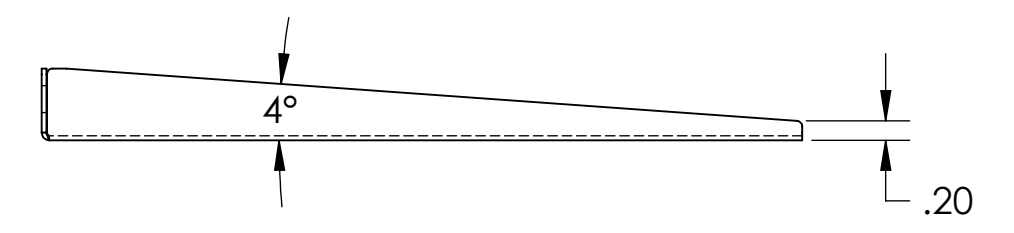
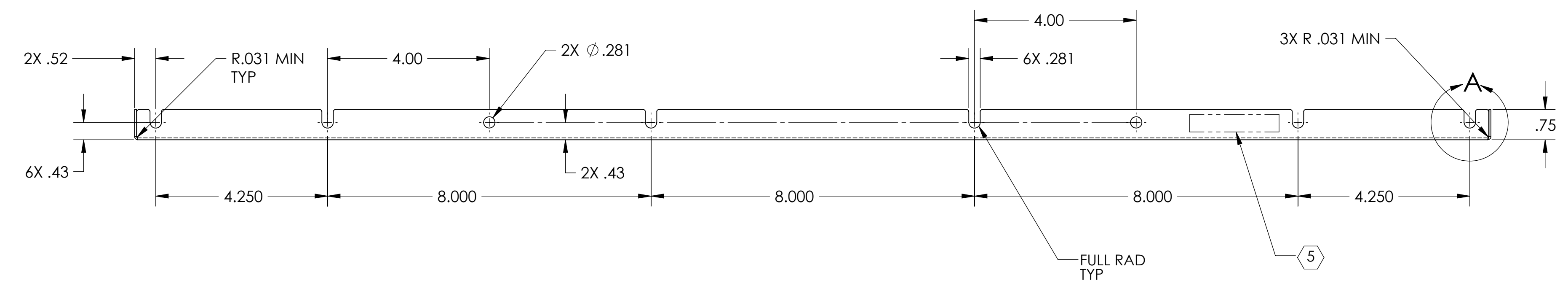
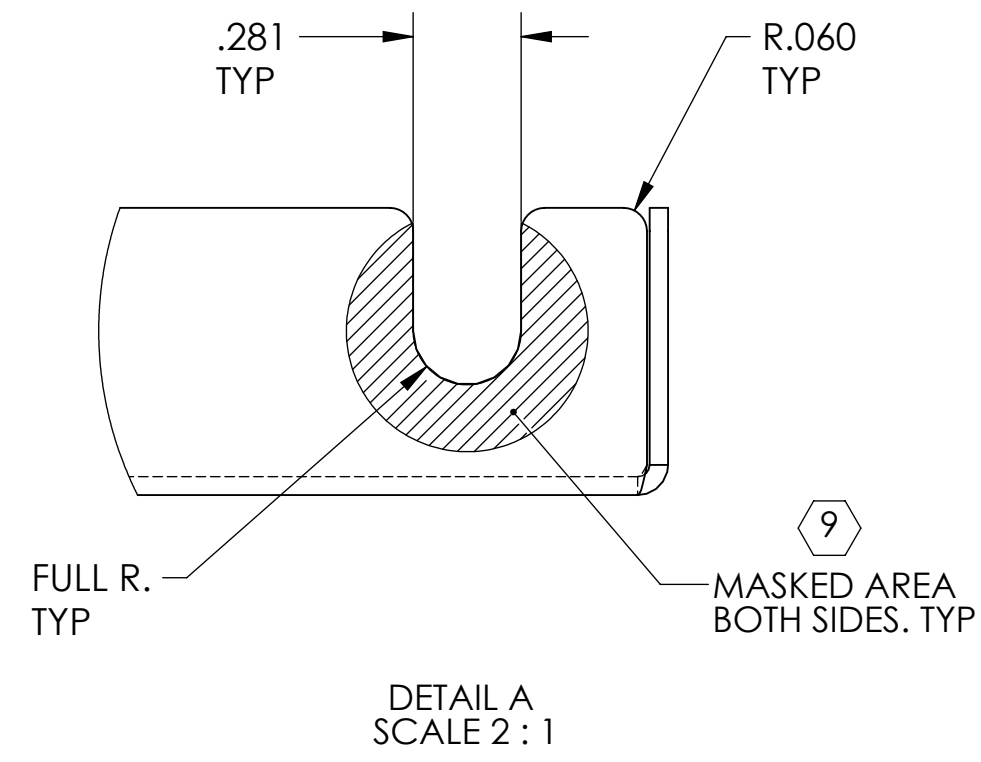
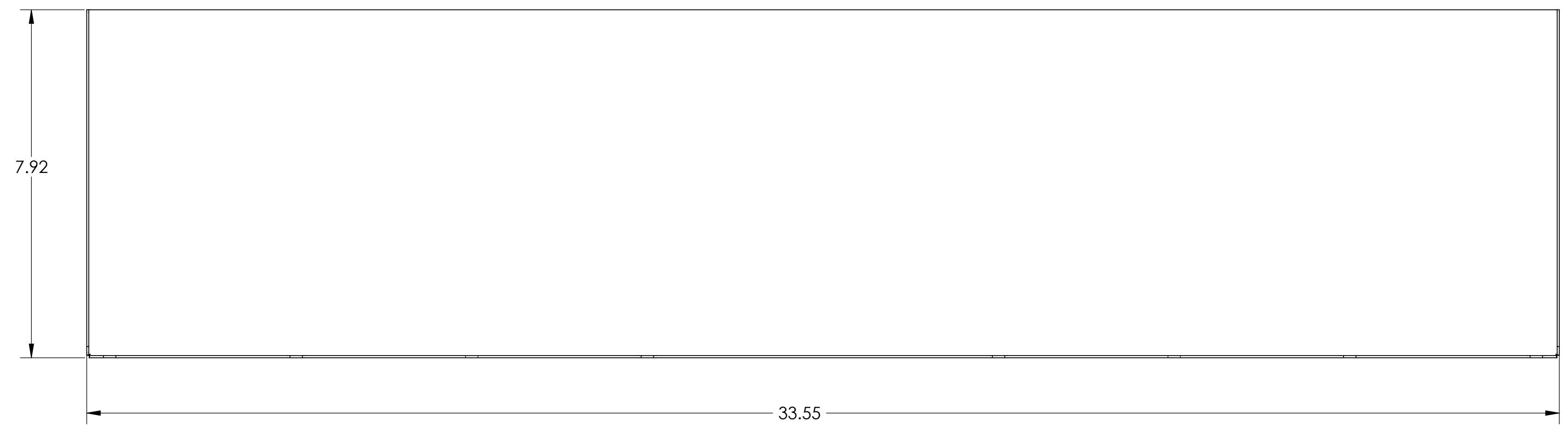
REV.	DATE	DCN #	DRAWING TREE #
v1	20 AUG 2010	E1000285	



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME	
DIMENSIONS ARE IN INCHES TOLERANCES: .XX ± .03 .XXX ± .010 ANGULAR ± 1.0°				1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES 0.005" TO 0.015". 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.		ARM CAVITY BAFFLE LO TUBE	
MATERIAL 6061-T6 Al		FINISH 63 μinch		NEXT ASSY D1001007		DESIGNER N.Nguyen 10 AUG 2010 DRAFTER TQ. NGUYEN 25 MAY 2010 CHECKER M. SMITH 20 AUG 2010 APPROVAL D. COYNE 30 AUG 2010	
				SYSTEM ADVANCED LIGO SUB-SYSTEM AOS		SIZE DWG. NO. B D1001009 REV. v1	
				SCALE: 1:1		PROJECTION: SHEET 1 OF 1	

- NOTES: UNLESS OTHERWISE SPECIFIED**
1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES AND BURRS AND ROUND EDGES APPROXIMATELY R.02.
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINE FLUIDS MUST BE FULLY SYNTHETIC, FULL WATER SOLUBLE AND FREE OF SULFUR, SILICONE AND CHLORINE PER LIGO DOCUMENT E0900237.
 5. MECHANICALLY STAMP (NO INKS OR DYES) PART NUMBER, REVISION AND SERIAL NUMBER .020 DEEP WITH MINIMUM CHARACTER HEIGHT .156 APPROXIMATELY WHERE SHOWN. SERIAL NUMBER WILL START AT 001 AND PROCEED CONSECUTIVELY. EXAMPLE: D100XXX-V1 S/N 001
 6. PART SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPEC E0900364.
 7. ALL MATERIAL IS TO BE VIRGIN MATERIAL (I.E. NO WELD REPAIRS OR PLUGS) UNLESS APPROVED IN ADVANCE, IN WRITING, BY LIGO PER SPECIFICATION E0900364.
 8. SURFACE FINISH TO BE AS-PROCESSED FROM MILL/SUPPLIER, FREE FROM SCRATCHES OR GOUGES.
 9. PART WILL BE PORCELAIN COATED PER LIGO SPECIFICATION E1000083 AFTER FABRICATION. THE INDICATED HOLES WILL BE MASKED PRIOR TO PORCELAIN COATING TO APPROXIMATELY 2.5-3X HOLE DIAMETER CENTERED ON BOTH SIDES OF THE HOLE.
 10. DIMENSIONS APPLY BEFORE PORCELAIN COATING UNLESS SPECIFIED.
 11. BEND RADIUS: UNLESS OTHERWISE NOTED, THE BEND RADIUS SHOULD BE THE MINIMUM REQUIRED TO FORM WITHOUT CRACKING OR REQUIRING ADDITIONAL WORK WHEN FORMING. IN PARTICULAR IF SHEET METAL IS TO BE PORCELAIN COATED, THE BEND RADIUS SHALL BE MINIMUM OF .12" OUTSIDE RADIUS OF BEND UNLESS OTHERWISE NOTED.

REV.	DATE	DCN #	DRAWING TREE #
v1	10 AUG 2010	E1000285	



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME							
DIMENSIONS ARE IN INCHES						ARM CAVITY BAFFLE UP LEAF							
TOLERANCES: .XX ± .02 .XXX ± .010						SYSTEM	SUB-SYSTEM	DESIGNER	DATE	SIZE	DWG. NO.	REV.	
ANGULAR ± 0.5°				MATERIAL	FINISH	ADVANCED LIGO	AOS	D	D1001026	v1			
				NEXT ASSY		D1000977		APPROVAL	D. Coyne	20 NOV 2010	SCALE: 1:4	PROJECTION:	SHEET 1 OF 2

D1001026_A03_SLC_ARM_Cavity_Baffle_Upper_Leaf_PRT_PDM_REV_X012_DRAWING_PDM_REV_X008

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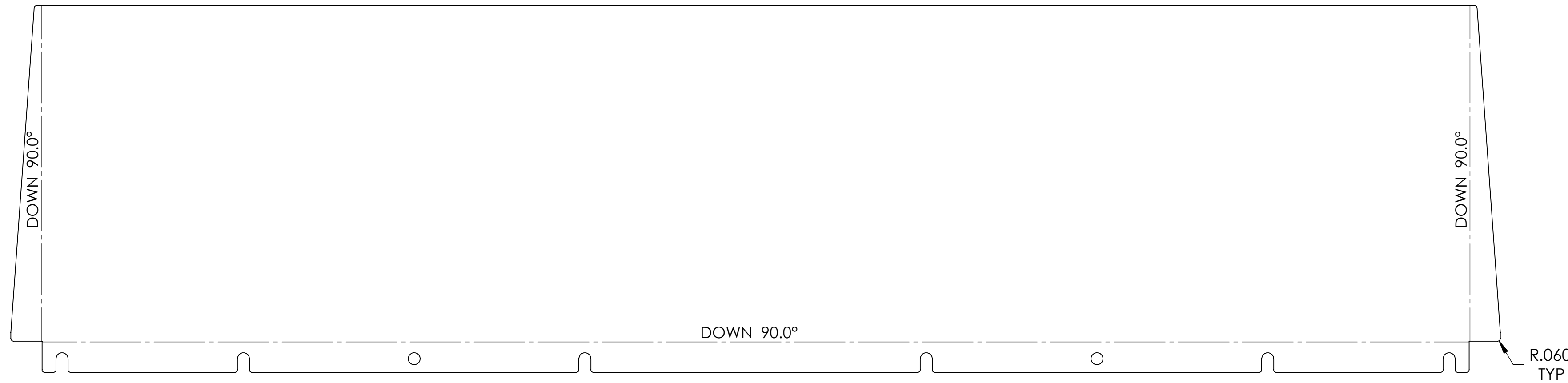
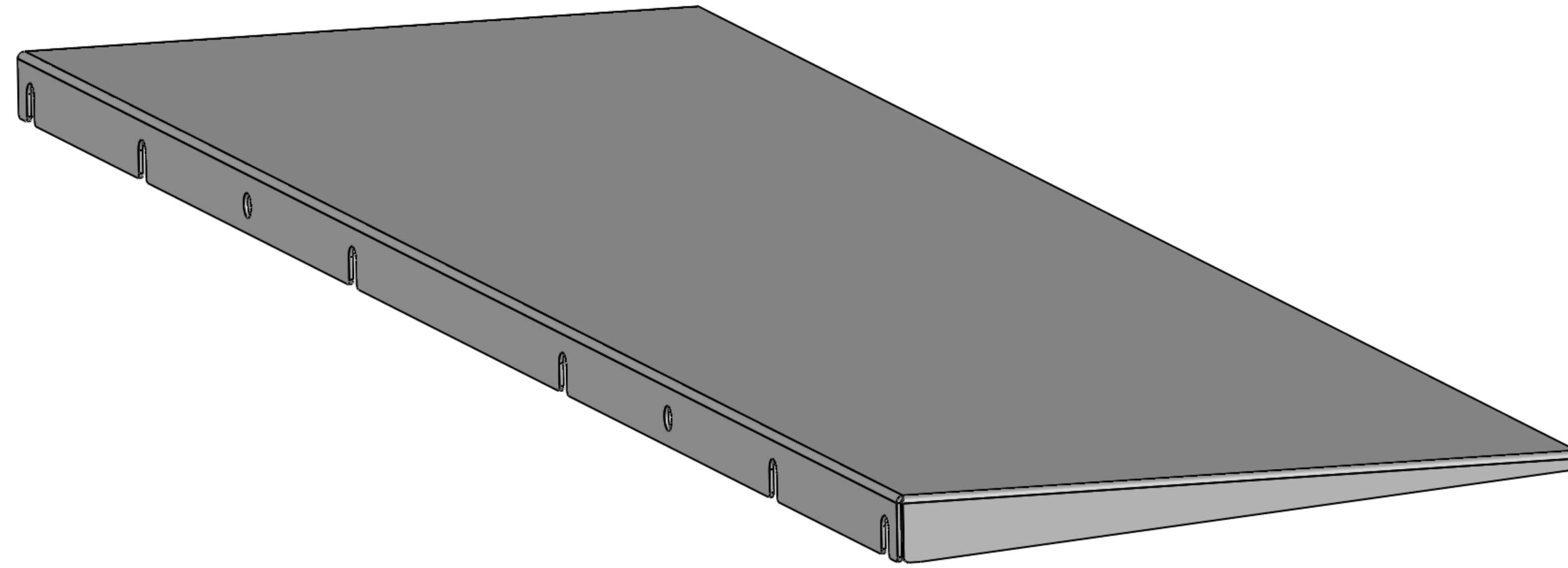
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		CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
SIZE	DWG. NO.	REV.	
D	D1001026	v1	
SCALE: 1:1	PROJECTION:	SHEET 2 OF 2	

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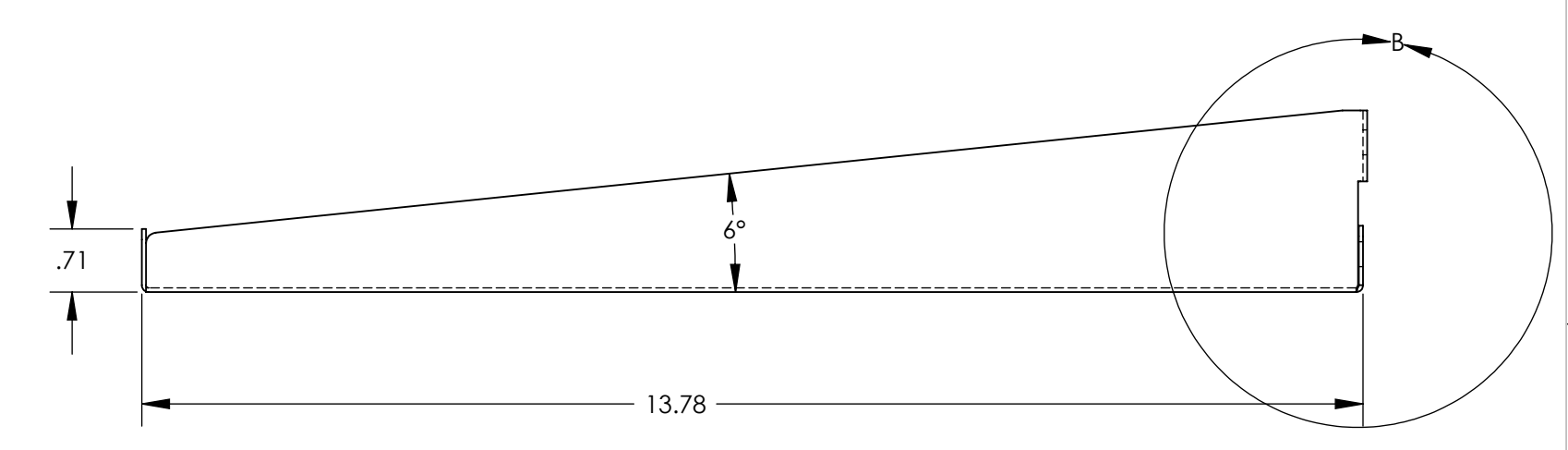
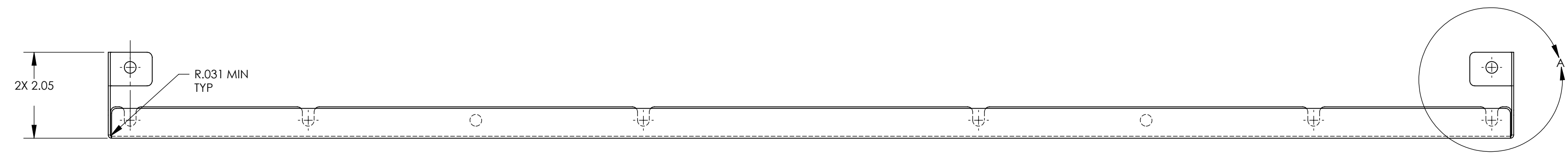
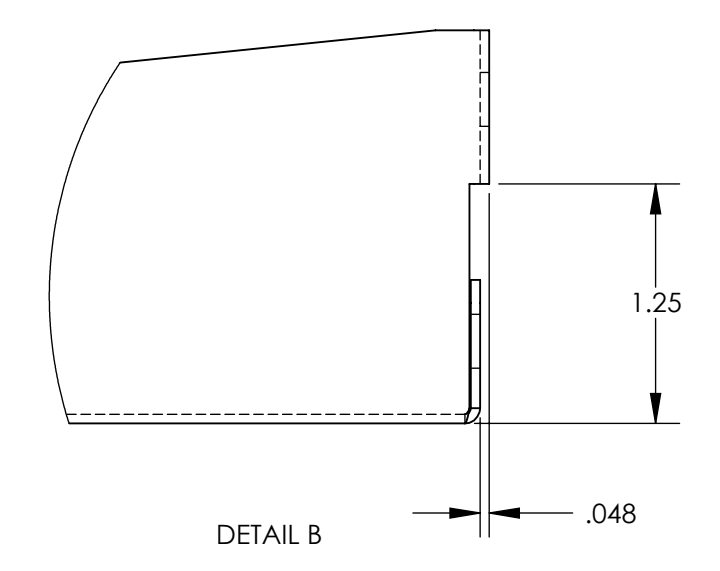
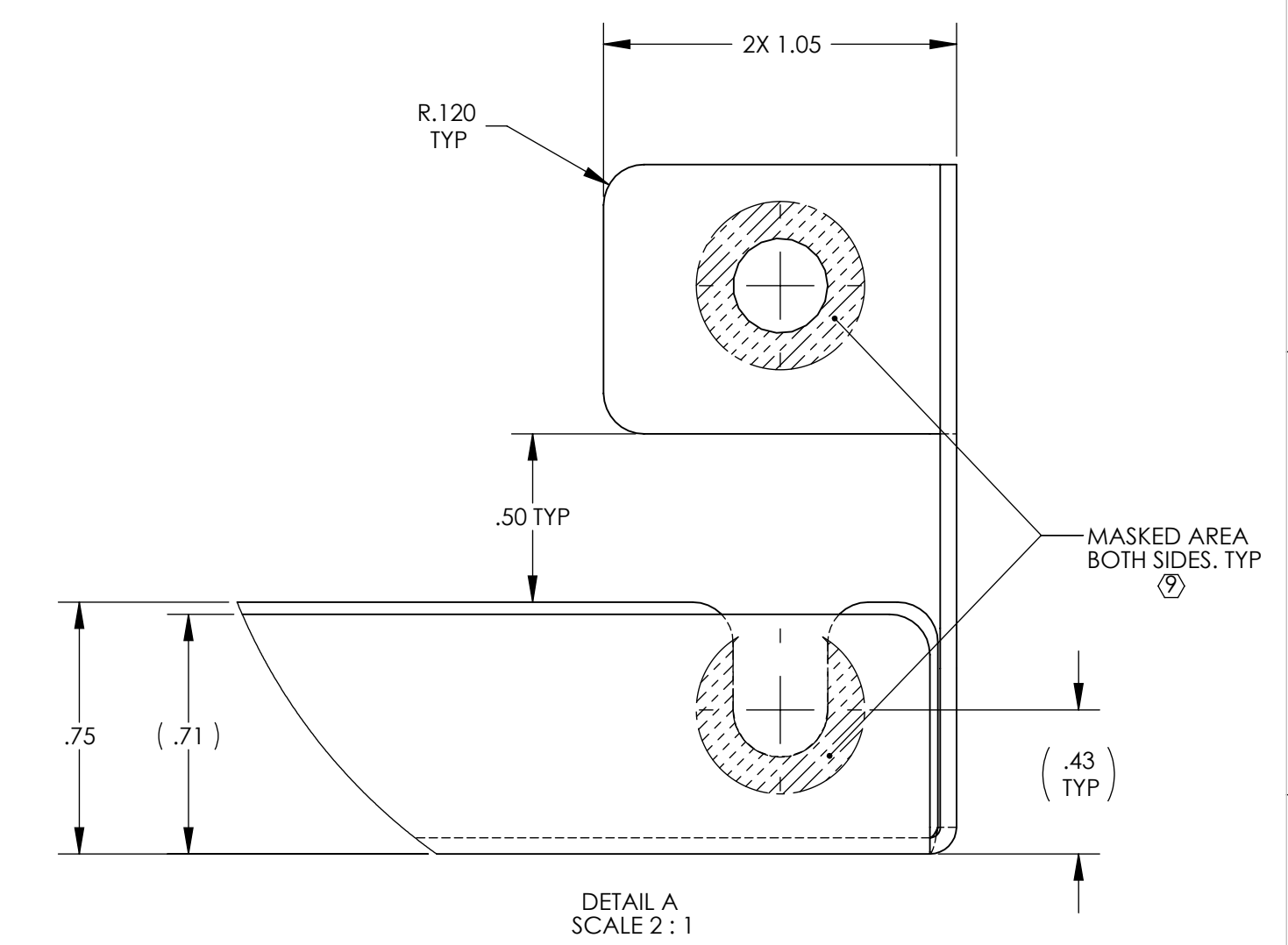
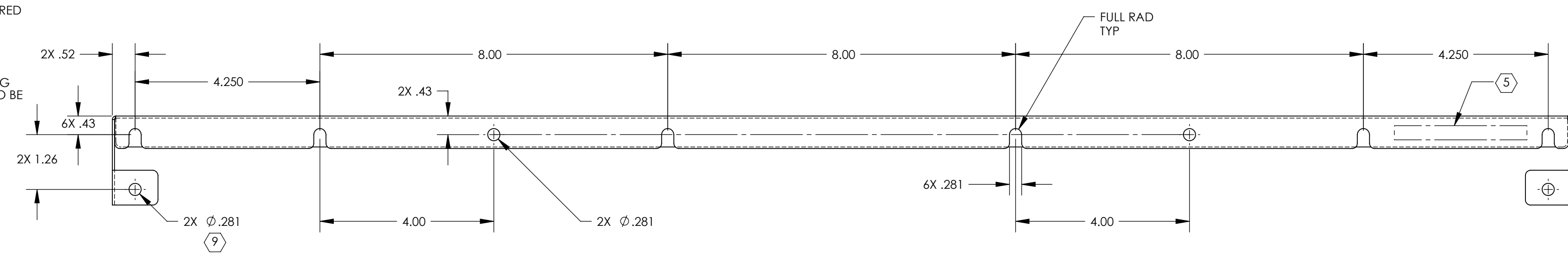
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- NOTES: UNLESS OTHERWISE SPECIFIED**
1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES AND BURRS AND ROUND EDGES APPROXIMATELY R.02.
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINE FLUIDS MUST BE FULLY SYNTHETIC, FULL WATER SOLUBLE AND FREE OF SULFUR, SILICONE AND CHLORINE PER LIGO DOCUMENT E0900237.
 5. MECHANICALLY STAMP (NO INKS OR DYES) PART NUMBER, REVISION AND SERIAL NUMBER .020 DEEP WITH MINIMUM CHARACTER HEIGHT .156 APPROXIMATELY WHERE SHOWN. SERIAL NUMBER WILL START AT 001 AND PROCEED CONSECUTIVELY. EXAMPLE: D100XXXX=V1 S/N 001
 6. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPEC E0900364.
 7. ALL MATERIAL IS TO BE VIRGIN MATERIAL (I.E. NO WELD REPAIRS OR PLUGS) UNLESS APPROVED IN ADVANCE, IN WRITING, BY LIGO PER SPECIFICATION E0900364.
 8. SURFACE FINISH TO BE AS-PROCESSED FROM MILL/SUPPLIER, FREE FROM SCRATCHES OR GOUGES.
 9. PART WILL BE PORCELAIN COATED PER LIGO SPECIFICATION E1000083 AFTER FABRICATION. THE INDICATED HOLES WILL BE MASKED PRIOR TO PORCELAIN COATING TO APPROXIMATELY 2.5-3X HOLE DIAMETER CENTERED ON BOTH SIDES OF THE HOLE.
 10. DIMENSIONS APPLY BEFORE PORCELAIN COATING UNLESS SPECIFIED.
 11. BEND RADIUS: UNLESS OTHERWISE NOTED, THE BEND RADIUS SHOULD BE THE MINIMUM REQUIRED TO FORM WITHOUT CRACKING OR REQUIRING ADDITIONAL WORK WHEN FORMING. IN PARTICULAR IF SHEET METAL IS TO BE PORCELAIN COATED, THE BEND RADIUS SHALL BE MINIMUM OF .12" OUTSIDE RADIUS OF BEND UNLESS OTHERWISE NOTED.

REV.	DATE	DCN #	DRAWING TREE #
v1	31 AUG 2010	E1000285	



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME													
DIMENSIONS ARE IN INCHES TOLERANCES: .XX ± .02 .XXX ± .010 ANGULAR ± 0.5°				MATERIAL 18 GA Enamel Steel A424 Type I		FINISH 8 9		SYSTEM ADVANCED LIGO		SUB-SYSTEM AOS		DESIGNER N.Nguyen 01 Jun 2010		SIZE D		DWG. NO. D1001027		REV. v1	
								NEXT ASSY D1000977		APPROVAL D. COYNE 20 NOV 2010		SCALE: 1:1		PROJECTION:		SHEET 1 OF 2			

D1001027_AudiGO_AOS_31C_ARM_Cavity_Baffle_Lower_Leaf_PRT_PDM_REV_X020_DRAWING_PDM_REV_X023

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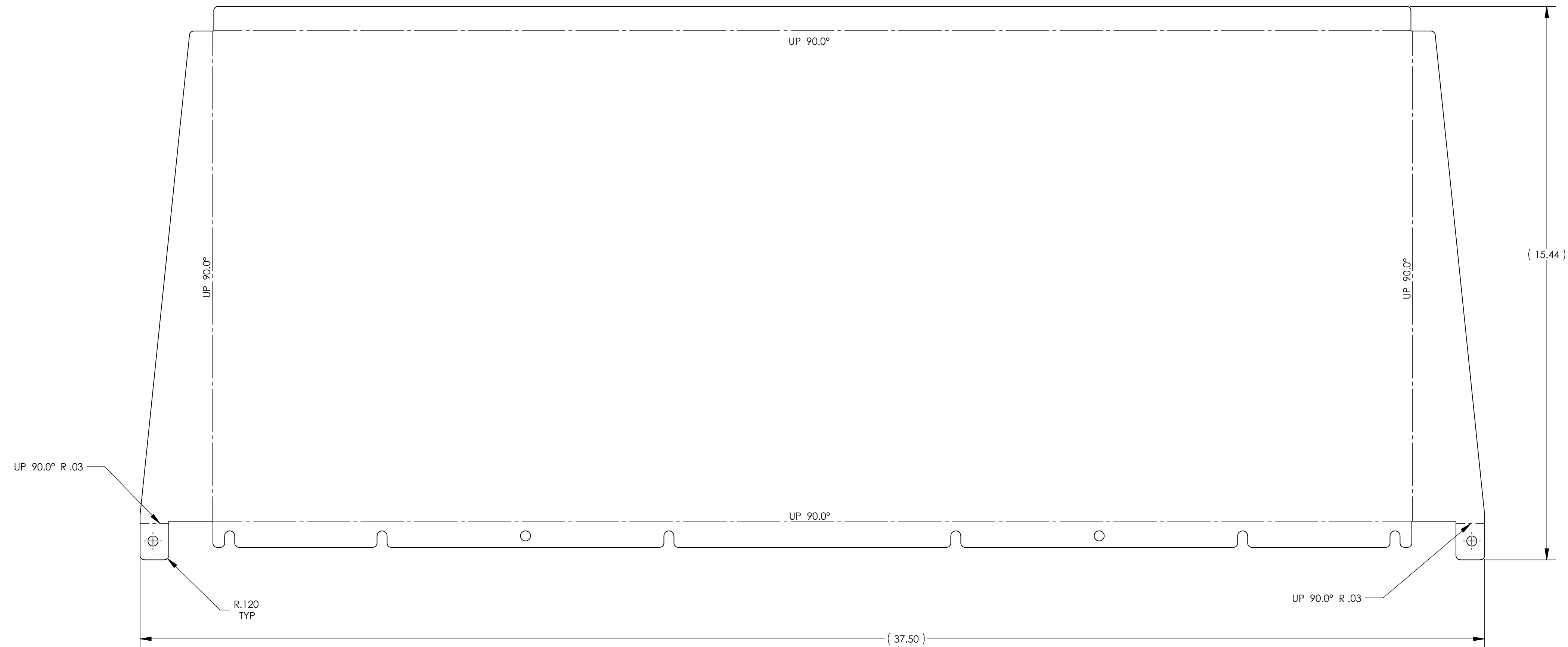
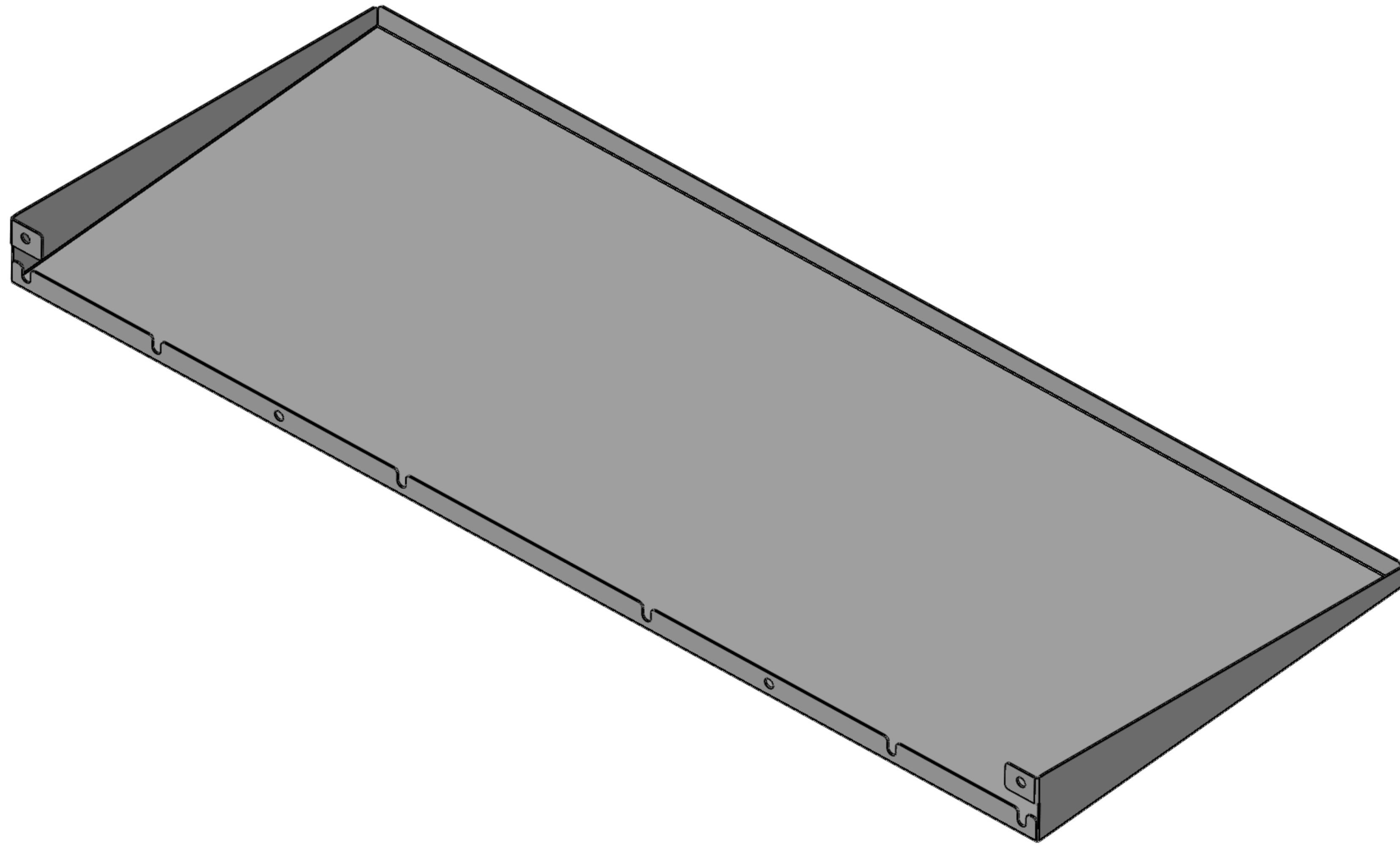
E

D

C

B

A



LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		REV.
SIZE	DWG. NO.	REV.
D	D1001027	v1
SCALE: 1:1	PROJECTION:	SHEET 2 OF 2

8

7

6

5

4

3

2

1

D:\001027_Adu\GO_AQS_S\IC_ARM_Cavity_Baffle_Lower_Left_PART.PDM.REV.X020.DRAWING.PDM.REV.X023

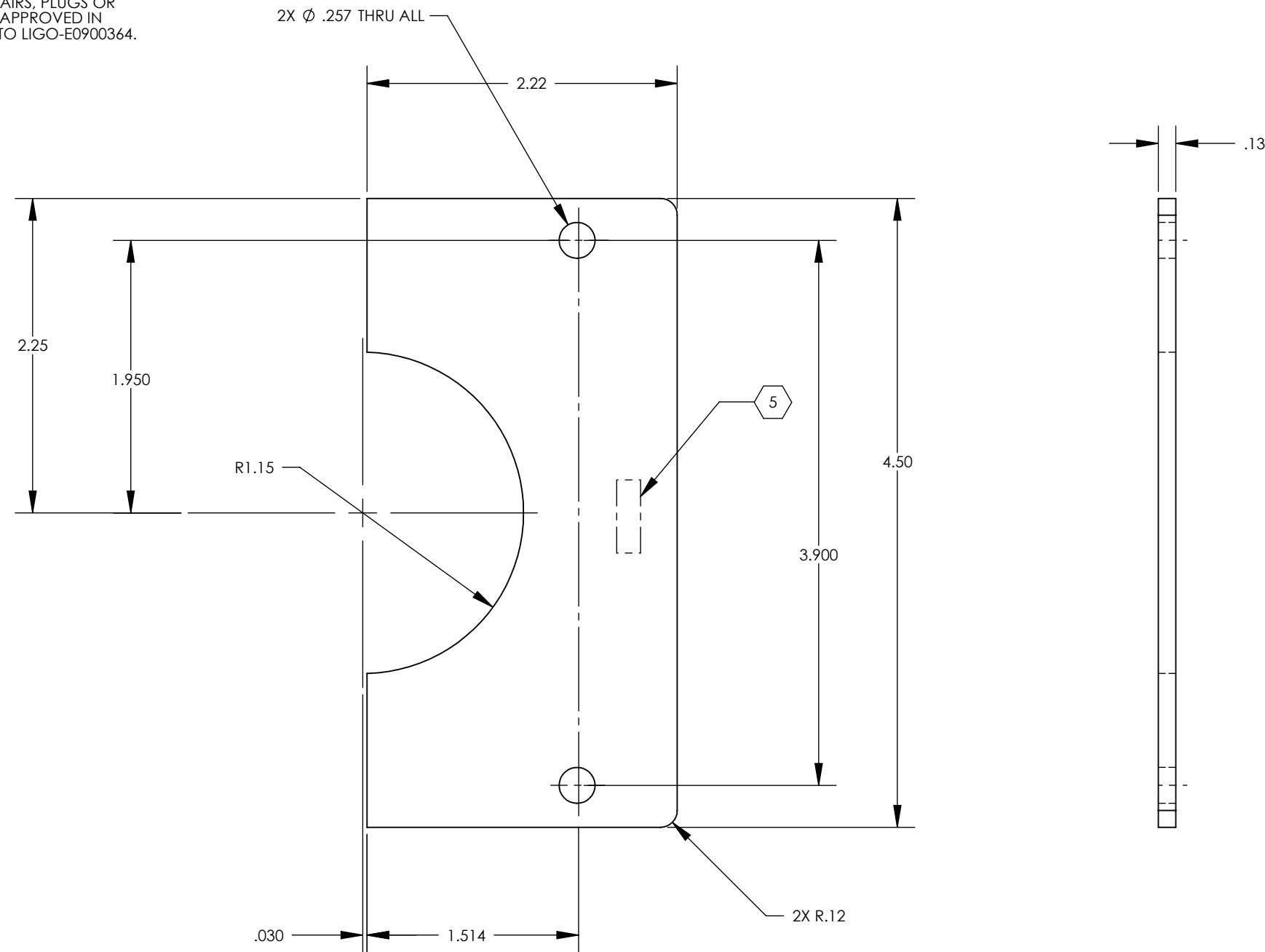
NOTES CONTINUED:

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 = 0.096 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 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	07 JUN 2010	E1000285	



D1001120_AdlLIGO_AOS_SLC Earthquake Stop Ring, PART PDM REV: X-012, DRAWING PDM REV: X-021

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

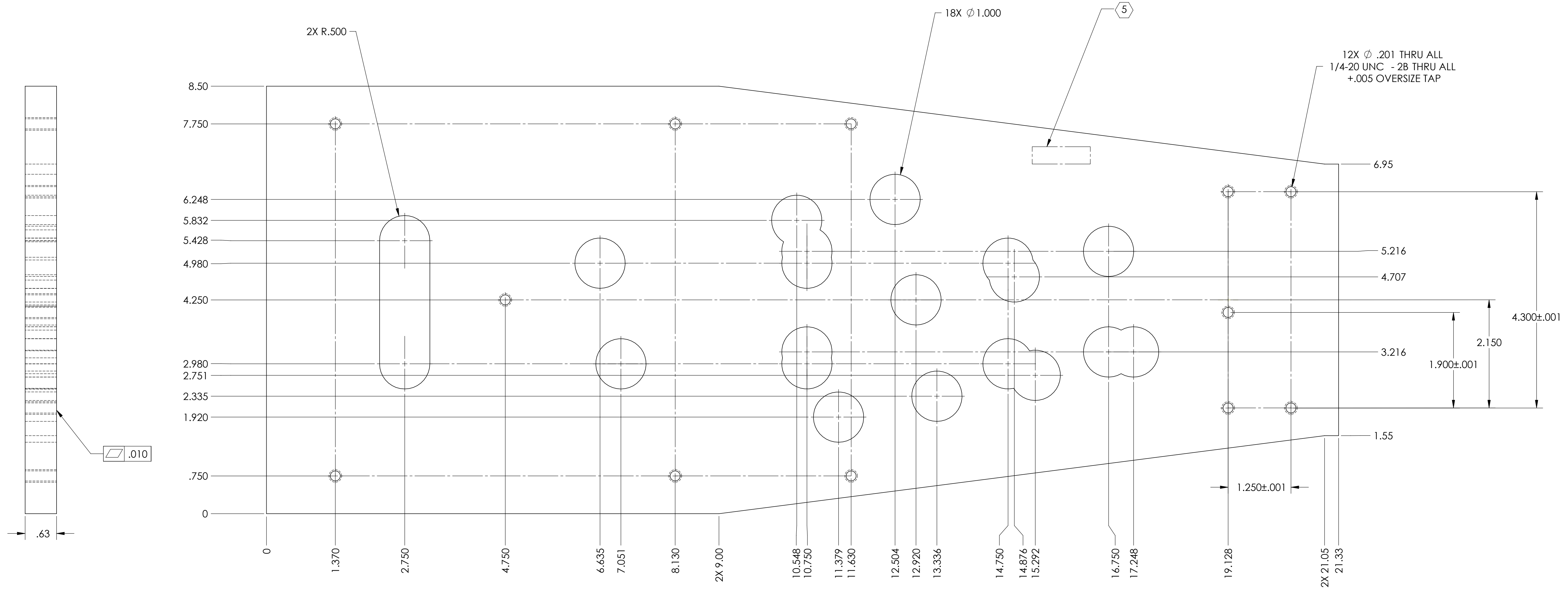
DIMENSIONS ARE IN INCHES	
TOLERANCES: .XX ± .01 .XXX ± .005	
ANGULAR ± 1.0°	
1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES .005" to 0.015" 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.	
MATERIAL	6061-T6 Al
FINISH	63 μinch

CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME		SLC EARTHQUAKE STOP RING	
SYSTEM	ADVANCED LIGO	SUB-SYSTEM	AOS	DESIGNER	N.Nguyen 01 Jun 20
NEXT ASSY	D1000863, D1002564	CHECKER	M. SMITH 30 JUN 2010	SIZE	DWG. NO. B D1001120
APPROVAL	D. COYNE 10 SEP 2010	REVISION	v1	SCALE	1:1
				PROJECTION:	
				SHEET	1 OF 1

NOTES CONTINUED:
 5. SCRIBE, ENGRAVE, 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. A VIBRATORY TOOL MAY BE USED. EXAMPLE: DXXXXXX-VY, TYPE-XX, S/N XXX

- 6. APPROXIMATE WEIGHT = 26.25 LB.
- 7. MACHINE ALL SURFACES TO REMOVE OXIDES AND MILL FINISH. USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED.
- 8. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.
- 9. ALL MATERIAL IS TO BE VIRGIN MATERIAL (i.e. NOT WELD REPAIRS OR PLUGS UNLESS APPROVED IN ADVANCE IN WRITING BY LIGO, REFER TO LIGO-E0900364.

REV.	DATE	DCN #	DRAWING TREE #
v1	10 SEP 2010	E1000285	



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME	
DIMENSIONS ARE IN INCHES TOLERANCES: .XX ± .01 .XXX ± .005 ANGULAR ± 1.0°				1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES .005 TO .015". 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE.		SLC ACB INTERFACE MTG PLATE	
MATERIAL 304 SSSL		FINISH 63 μinch		SYSTEM ADVANCED LIGO		SUB-SYSTEM AOS	
NEXT ASSY D1001005				DESIGNER N.Nguyen 07 SEP 2010		SIZE D	
APPROVAL D. COYNE 15 NOV 2010				CHECKER M. SMITH 01 NOV 2010		DWG. NO. D1001138	
SCALE: 1:2				PROJECTION:		REV. v1	
				SHEET 1 OF 1			

D1001138_AduLIGO_AOS_SLC ACB Interface Mounting Plate PART PDM REV: X-035 DRAWING PDM REV: X-019

NOTES CONTINUED:

5. SCRIBE, ENGRAVE, OR MECHANICALLY STAMP (NO DYES OR INKS) A UNIQUE THREE DIGIT NUMBER & REVISION NUMBER ON EACH PART. SERIAL NUMBERS START 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY. BAG AND TAG PARTS WITH THEIR DRAWING PART NUMBER, REVISION, VARIANT OR "TYPE" (IF APPLICABLE), AND QUANTITY. IF PARTS ARE TOO SMALL TO SCRIBE, BAGGING AND TAGGING ALONE IS SUFFICIENT.
 EXAMPLE (PART): 001-v1
 EXAMPLE (TAG): DXXXXXX-VY, TYPE-XX, QTY: TBD

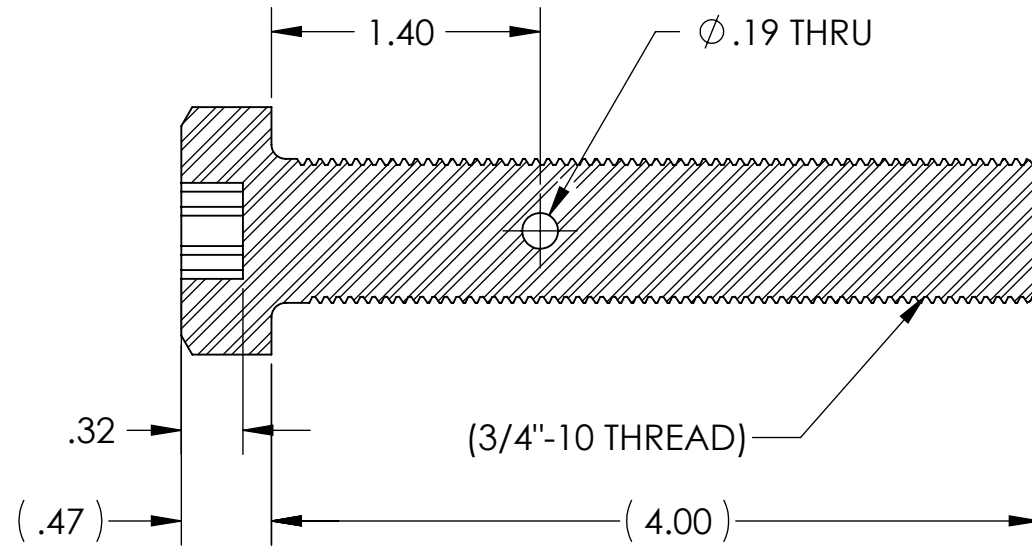
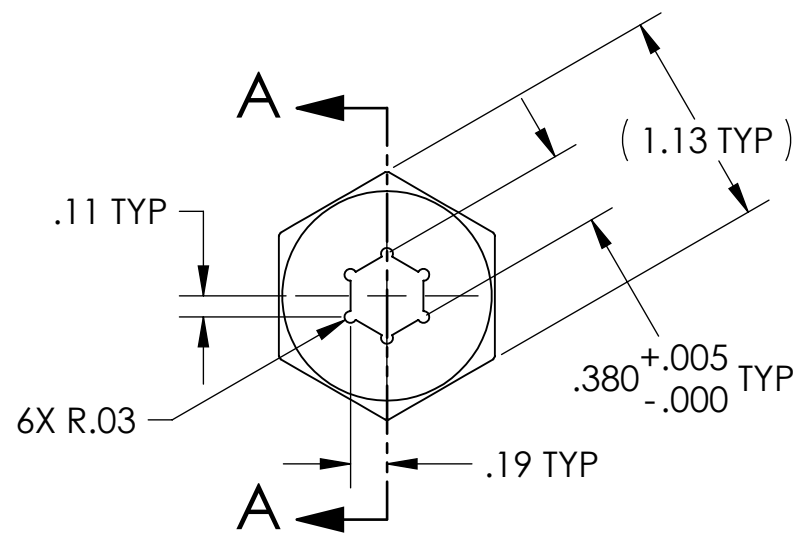
6. APPROXIMATE WEIGHT = 0.590 LB.

D 7. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.

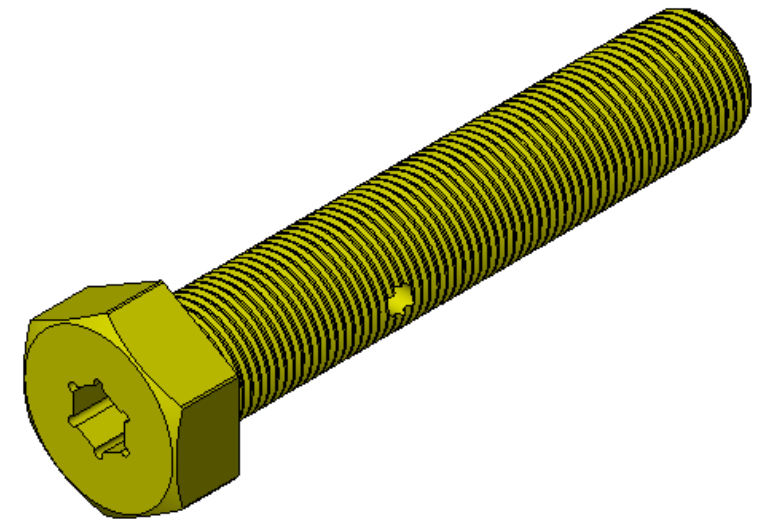
8. ALL MATERIAL IS TO BE VIRGIN MATERIAL (i.e. NO WELD REPAIRS, PLUGS OR RECYCLED MATERIAL). NO REPAIRS SHALL BE MADE UNLESS APPROVED IN ADVANCE, AND IN WRITING, BY LIGO LABORATORY. REFER TO LIGO-E0900364.

9. PART TO BE MADE FROM MC MASTER CARR P/N 92240A849.

REV.	DATE	DCN #	DRAWING TREE #
v1	19 OCT 2010	E1000285	-
-	-	-	-
-	-	-	-



SECTION A-A



D1001186_AdlLIGO_AOS_Screw .75-10x4.0_92240A849, PART PDM REV: X-008, DRAWING PDM REV: X-013

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES
 TOLERANCES:
 .XX ± .01
 .XXX ± .005
 ANGULAR ± 0.5°

1. INTERPRET DRAWING PER ASME Y14.5-1994.
2. REMOVE ALL SHARP EDGES 0.005" TO 0.0015".
3. DO NOT SCALE FROM DRAWING.
4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.

MATERIAL 18-8 SSSL FINISH 63 μinch

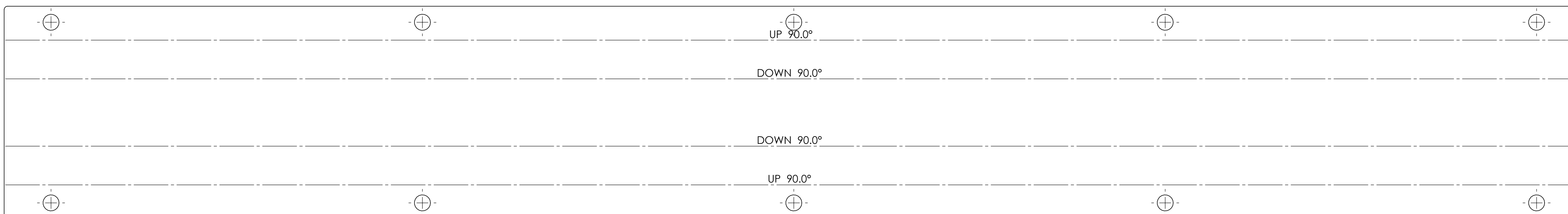
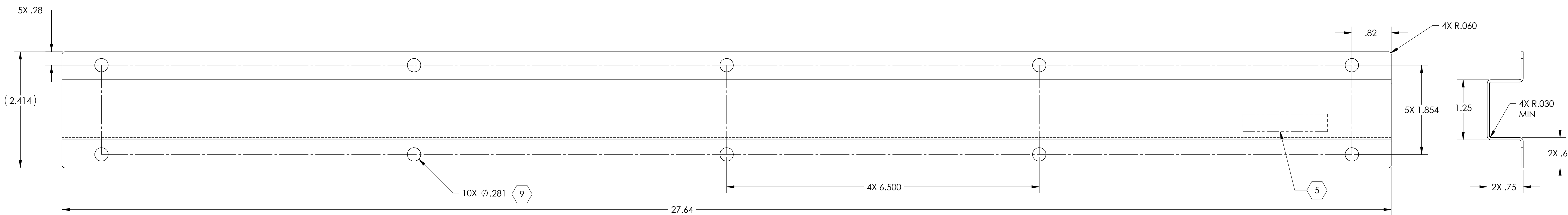
LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SYSTEM ADVANCED LIGO SUB-SYSTEM AOS
 NEXT ASSY D0901376

DESIGNER			PART NAME		
N. NGUYEN	10 Sep 2010	SIZE	SCREW HEX HD #3/4-10 X 4 MODIFIED		
TQ. NGUYEN	18 OCT 2010	DWG. NO.	D1001186		
M. SMITH	15 NOV 2010	REV.	v1		
D. COYNE	20 NOV 2010	SCALE: 1:1	PROJECTION:		
APPROVAL			SHEET 1 OF 1		

- NOTES: UNLESS OTHERWISE SPECIFIED**
1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES AND BURRS AND ROUND EDGES APPROXIMATELY R.02.
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINE FLUIDS MUST BE FULLY SYNTHETIC, FULL WATER SOLUBLE AND FREE OF SULFUR, SILICONE AND CHLORINE PER LIGO DOCUMENT E0900237.
 5. MECHANICALLY STAMP (NO INKS OR DYES) PART NUMBER, REVISION AND SERIAL NUMBER .020 DEEP WITH MINIMUM CHARACTER HEIGHT .156 APPROXIMATELY WHERE SHOWN. SERIAL NUMBER WILL START AT 001 AND PROCEED CONSECUTIVELY. EXAMPLE: D100XXX=V1 S/N 001
 6. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPEC E0900364.
 7. ALL MATERIAL IS TO BE VIRGIN MATERIAL (I.E. NO WELD REPAIRS OR PLUGS) UNLESS APPROVED IN ADVANCE, IN WRITING, BY LIGO PER SPECIFICATION E0900364.
 8. SURFACE FINISH TO BE AS-PROCESSED FROM MILL/SUPPLIER, FREE FROM SCRATCHES OR GOUGES.
 9. PART WILL BE PORCELAIN COATED PER LIGO SPECIFICATION E1000083 AFTER FABRICATION. THE INDICATED HOLES WILL BE MASKED PRIOR TO PORCELAIN COATING TO APPROXIMATELY 2.5-3X HOLE DIAMETER CENTERED ON BOTH SIDES OF THE HOLE.
 10. DIMENSIONS APPLY BEFORE PORCELAIN COATING UNLESS SPECIFIED.
 11. BEND RADIUS: UNLESS OTHERWISE NOTED, THE BEND RADIUS SHOULD BE THE MINIMUM REQUIRED TO FORM WITHOUT CRACKING OR REQUIRING ADDITIONAL WORK WHEN FORMING. IN PARTICULAR IF SHEET METAL IS TO BE PORCELAIN COATED, THE BEND RADIUS SHALL BE MINIMUM OF .12" OUTSIDE RADIUS OF BEND UNLESS OTHERWISE NOTED.

REV.	DATE	DCN #	DRAWING TREE #
v1	10 JUN 2010	D1000285	-
-	-	-	-
-	-	-	-

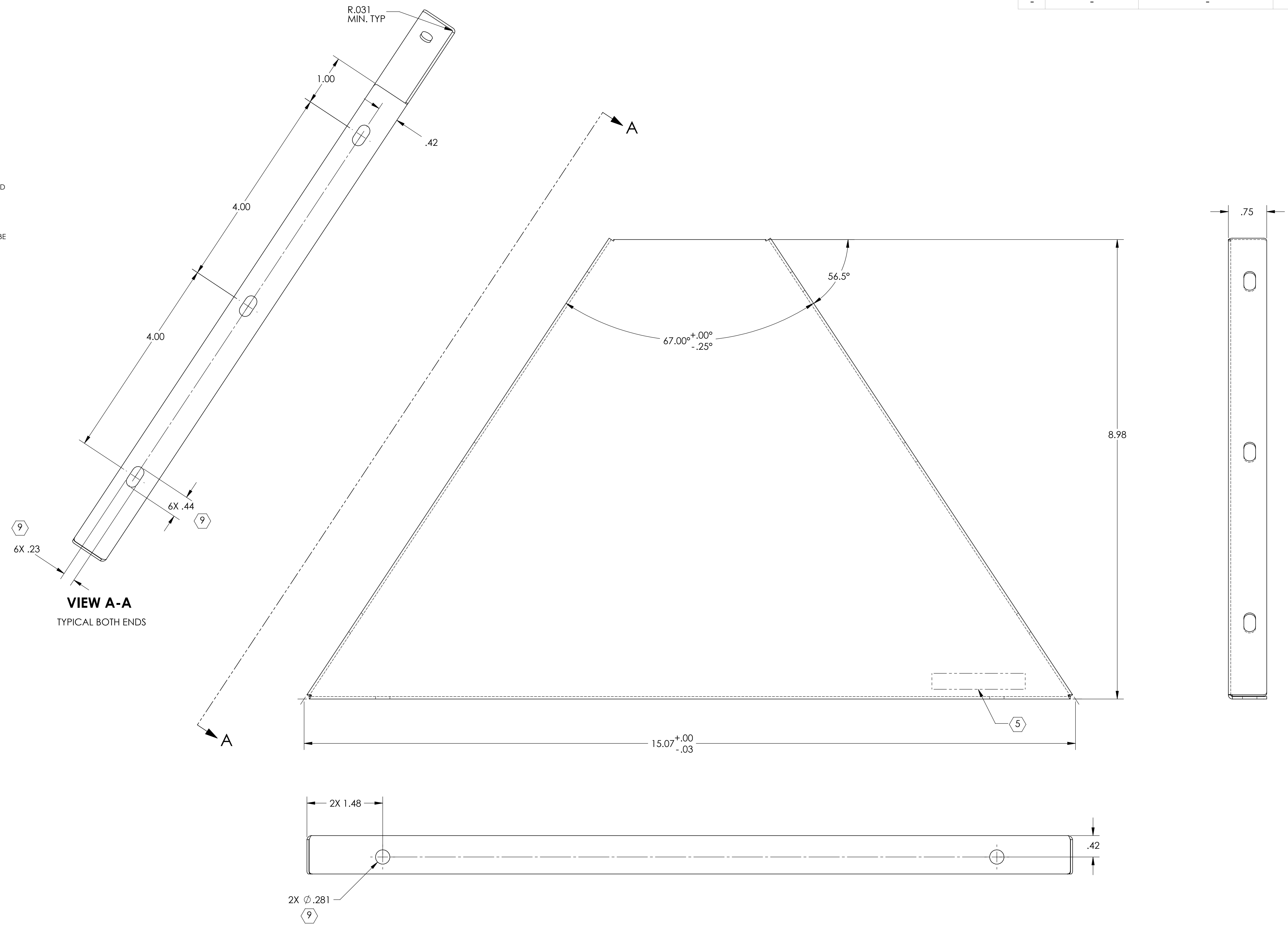


NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME						
DIMENSIONS ARE IN INCHES						ACB SIDE REINFORCING HATSECTION						
TOLERANCES: .XX ± .02 .XXX ± .010 ANGULAR ± 1.0°						SYSTEM ADVANCED LIGO	SUB-SYSTEM AOS	DESIGNER N.Nguyen	DATE 01 Jul @010	SIZE D	DWG. NO. D1001363	REV. v1
MATERIAL 18GA Enamel Steel A424 Type 1				FINISH 		NEXT ASSY D1000977		CHECKER M. SMITH	DATE 10 NOV 2010	SCALE: 1:1	PROJECTION:	SHEET 1 OF 1

D1001363_AcdlGO_AOS_3LC_ARM Beffle Side Reinforcing Hatsection, PART PDM REV: X-013, DRAWING PDM REV: X-013

- NOTES: UNLESS OTHERWISE SPECIFIED**
1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES AND BURRS AND ROUND EDGES APPROXIMATELY R.02.
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINE FLUIDS MUST BE FULLY SYNTHETIC, FULL WATER SOLUBLE AND FREE OF SULFUR, SILICONE AND CHLORINE PER LIGO DOCUMENT E0900237.
 5. MECHANICALLY STAMP (NO INKS OR DYES) PART NUMBER, REVISION AND SERIAL NUMBER .020 DEEP WITH MINIMUM CHARACTER HEIGHT .156 APPROXIMATELY WHERE SHOWN. SERIAL NUMBER WILL START AT 001 AND PROCEED CONSECUTIVELY. EXAMPLE: D100XXX=V1 S/N 001
 6. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPEC E0900364.
 7. ALL MATERIAL IS TO BE VIRGIN MATERIAL (I.E. NO WELD REPAIRS OR PLUGS) UNLESS APPROVED IN ADVANCE, IN WRITING, BY LIGO PER SPECIFICATION E0900364.
 8. SURFACE FINISH TO BE AS-PROCESSED FROM MILL/SUPPLIER, FREE FROM SCRATCHES OR GOUGES.
 9. PART WILL BE PORCELAIN COATED PER LIGO SPECIFICATION E1000083 AFTER FABRICATION. THE INDICATED HOLES WILL BE MASKED PRIOR TO PORCELAIN COATING TO APPROXIMATELY 2.5-3X HOLE DIAMETER CENTERED ON BOTH SIDES OF THE HOLE.
 10. DIMENSIONS APPLY BEFORE PORCELAIN COATING UNLESS SPECIFIED.
 11. BEND RADIUS: UNLESS OTHERWISE NOTED, THE BEND RADIUS SHOULD BE THE MINIMUM REQUIRED TO FORM WITHOUT CRACKING OR REQUIRING ADDITIONAL WORK WHEN FORMING. IN PARTICULAR IF SHEET METAL IS TO BE PORCELAIN COATED, THE BEND RADIUS SHALL BE MINIMUM OF .12" OUTSIDE RADIUS OF BEND UNLESS OTHERWISE NOTED.

REV.	DATE	DCN #	DRAWING TREE #
v1	16 JUN 2010	E1000285	-
-	-	-	-
-	-	-	-



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES

TOLERANCES:
 .XX ± .02
 .XXX ± .010

ANGULAR ± 1.0°

MATERIAL
 18 GA Enamel Steel A424 Type I

FINISH
 (8) (9)

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SYSTEM
 ADVANCED LIGO

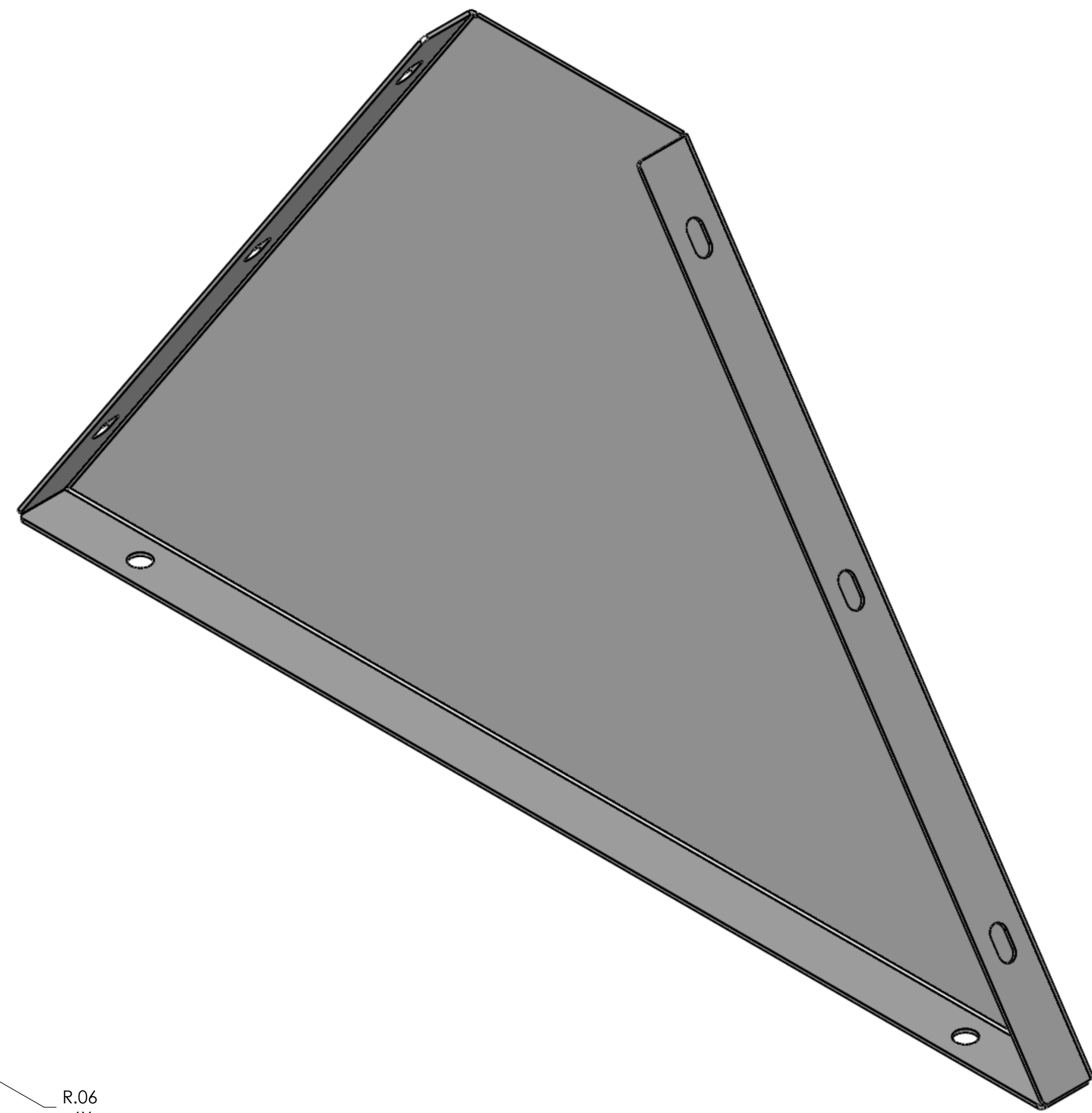
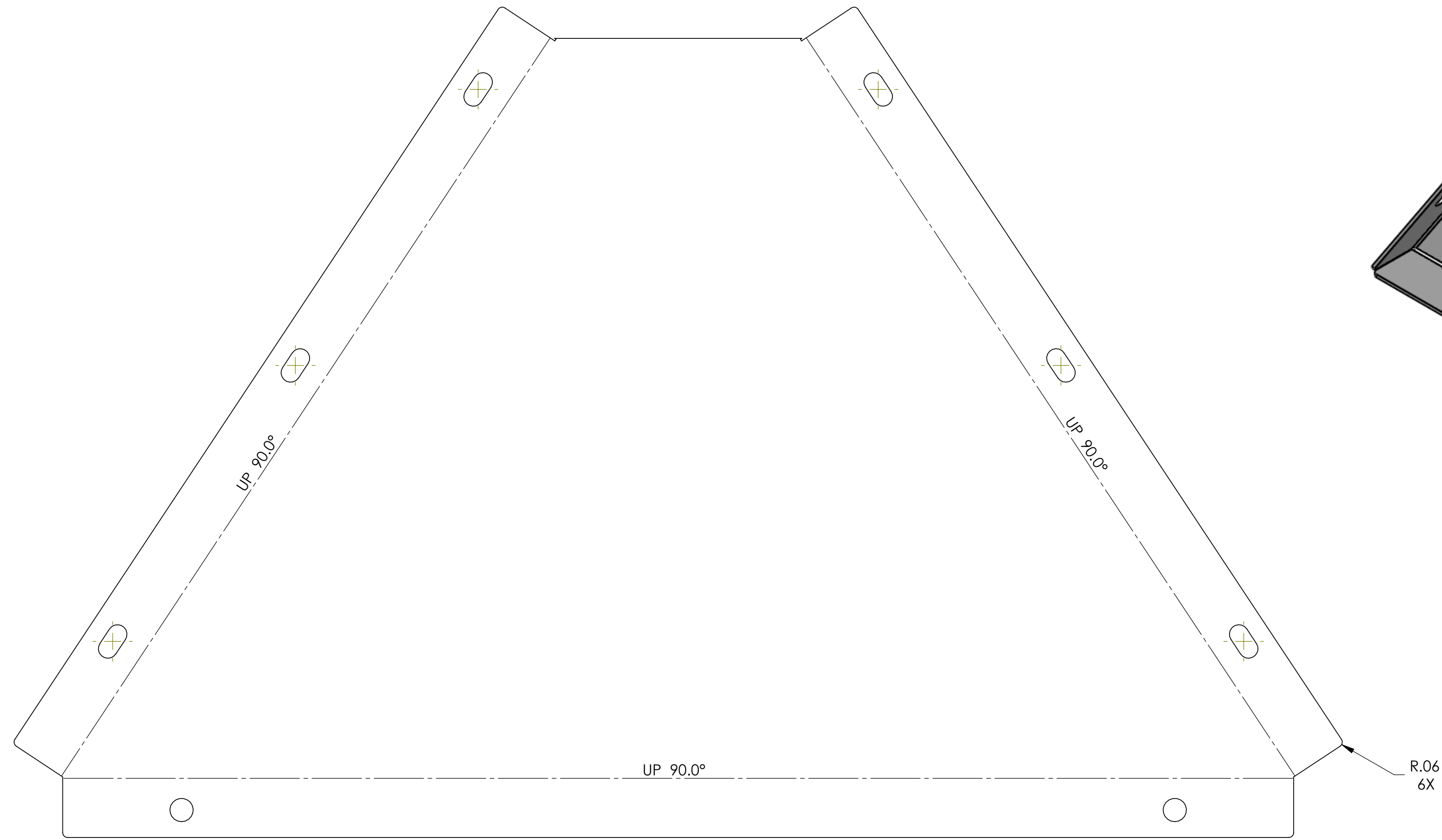
SUB-SYSTEM
 AOS

NEXT ASSY
 D1000977

PART NAME				SIZE		DWG. NO.		REV.
ARM BAFFLE MIDDLE REINFORCING PLATE				D		D1001365		v1
DESIGNER	N.Nguyen	01 Jun 2010	CHECKER	M. SMITH	02 AUG 2010	APPROVAL	D. COYNE	10 AUG 2010
SCALE: 1:1				PROJECTION:		SHEET 1 OF 2		

D1001365_A03_Arm Cavity Baffle Middle Reinforcing Plate PART PDM REV: X-017 DRAWING PDM REV: X-022

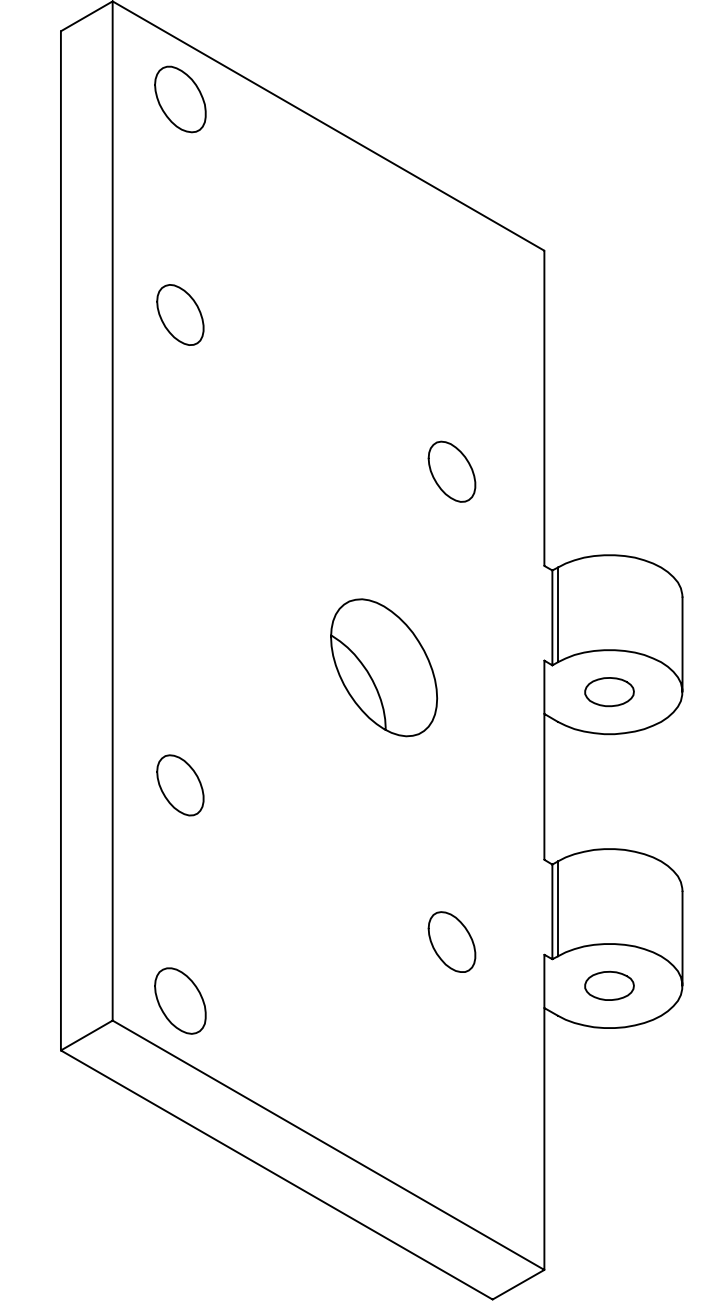
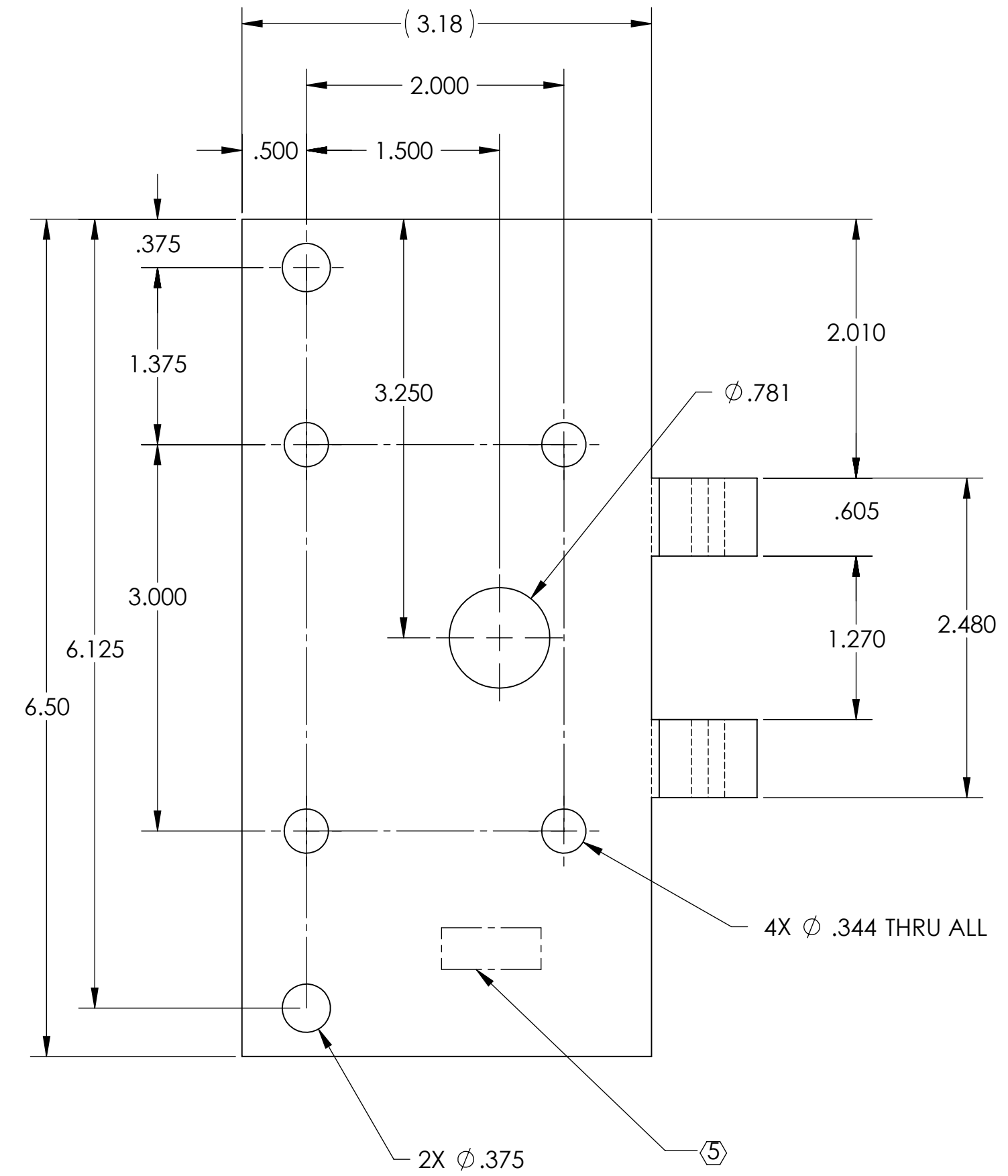
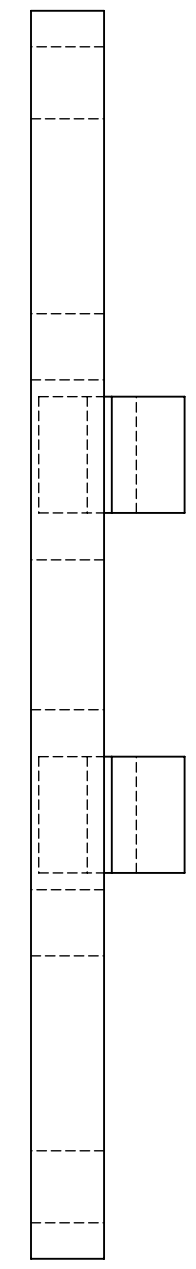
D:\001_365_Adu\GO_ACS_ARM_Cavity_Baffle_Middle_Reinforcing_Plate_PART.PDM REV: X-017.DRAWING PDM REV: X-022



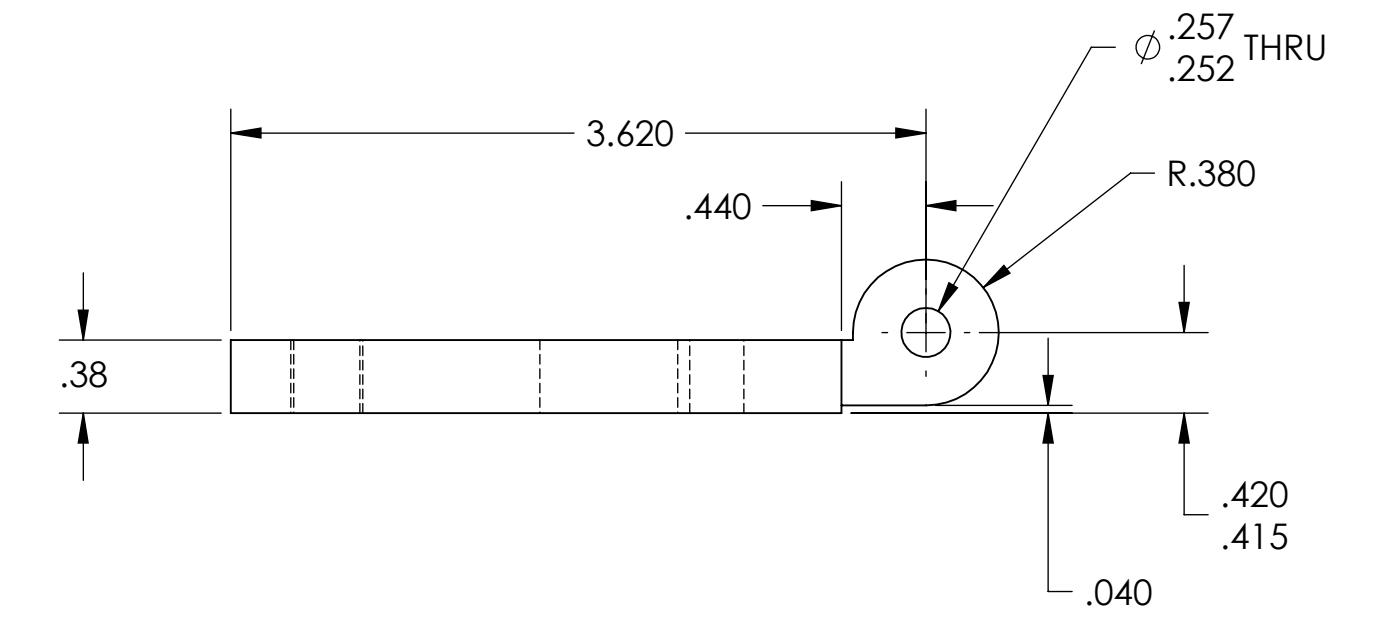
LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		REV.
SIZE	DWG. NO.	REV.
D	D1001365	v1
SCALE: 1:1	PROJECTION:	SHEET 2 OF 2

- NOTES: UNLESS OTHERWISE SPECIFIED**
1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.
 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 = 0.784 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 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	10 AUG 2010	E1000285	-
-	-	-	-
-	-	-	-



iso view

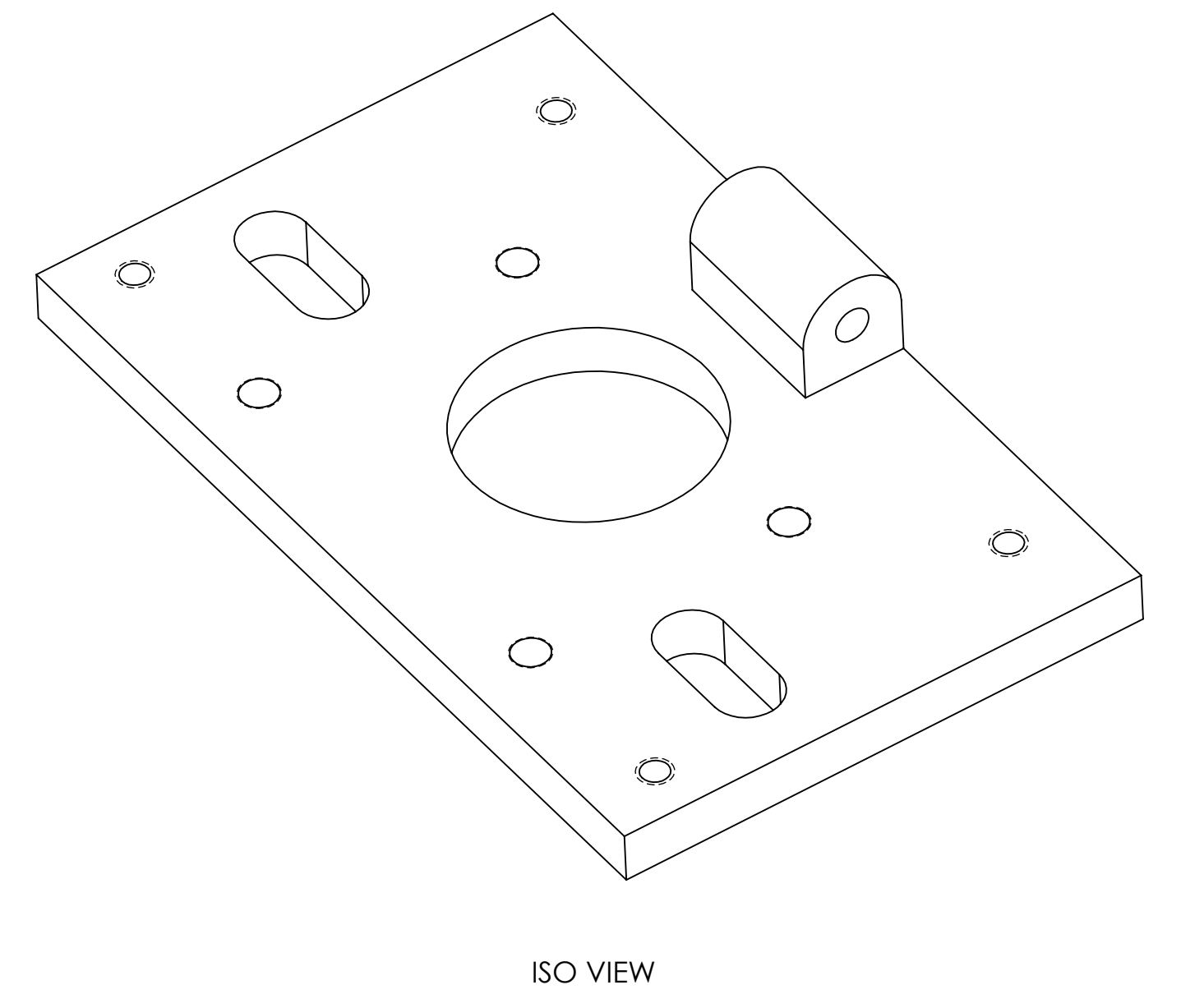
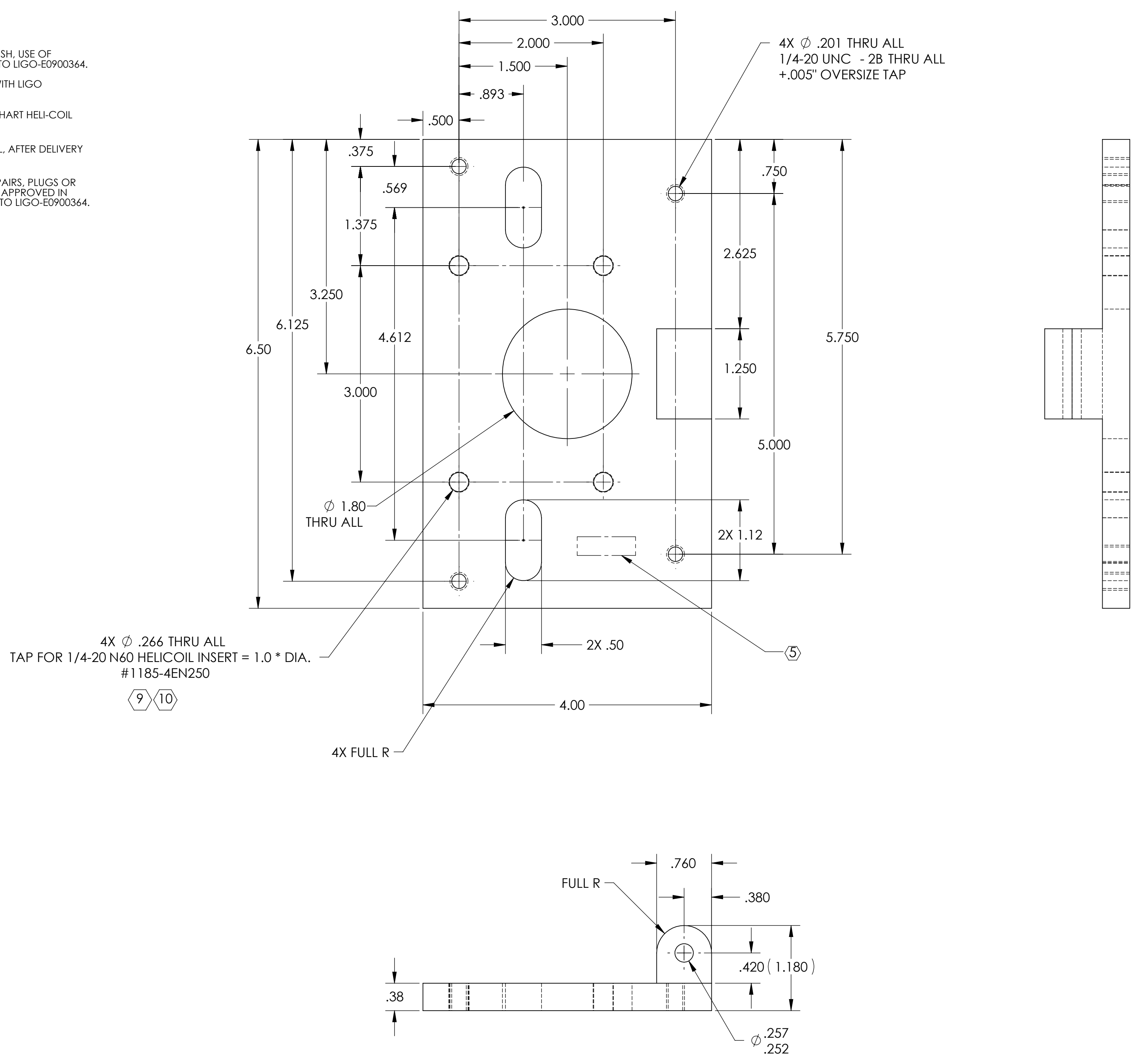


NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME						
DIMENSIONS ARE IN INCHES						ARM CAVITY BAFFLE UPPER MOUNTING HINGE						
TOLERANCES: .XX ± .01 .XXX ± .005 ANGULAR ± 0.5°						SYSTEM ADVANCED LIGO	SUB-SYSTEM AOS	DESIGNER N.Nguyen	DATE 12 AUG 2010	SIZE D	DWG. NO. D1001621	REV. v1
MATERIAL 6061-T6 Al				FINISH 63 μinch		NEXT ASSY D1002173		CHECKER M. SMITH	DATE 10 NOV 2010	SCALE: 1:1	PROJECTION:	SHEET 1 OF 1
						APPROVAL D. COYNE		DATE 20 NOV 2010				

D1001621_AutLIGO_AOS_ARM_Baffle Upper Mounting Hinge PART PDM REV: X-002 DRAWING PDM REV: X-012

- NOTES: UNLESS OTHERWISE SPECIFIED**
1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.
 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 = 0.883 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.
 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	10 AUG 2010	E1000285	



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				PART NAME	
DIMENSIONS ARE IN INCHES				ARM CAVITY BAFFLE LOWER MTG HINGE	
TOLERANCES: .XX ± .01 .XXX ± .005				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
ANGULAR ± 0.5°				ADVANCED LIGO AOS	
MATERIAL 6061-T6 Al		FINISH 63 μinch		NEXT ASSY D1002173	
DESIGNER N.Nguyen		DATE 02 Jul 2010		SIZE D	
DRAFTER TG. NGUYEN		DATE 18 OCT 2010		DWG. NO. D1001622	
CHECKER M. SMITH		DATE 10 NOV 2010		REV. v1	
APPROVAL D. COYNE		DATE 20 NOV 2010		SCALE: 1:1	
PROJECTION:				SHEET 1 OF 1	

D1001622_AdrLIGO_AOS_31C_ARM_Cavity_Baffle_Lower_Mounting_Hinge_PDR_PDM_REV-X-014_DRAWING_PDM_REV-X-021

D1001700_AdlIGO_AOS_SLC INTERFACE MOUNTING CLAMP, PART PDM REV: X-012, DRAWING PDM REV: X-015

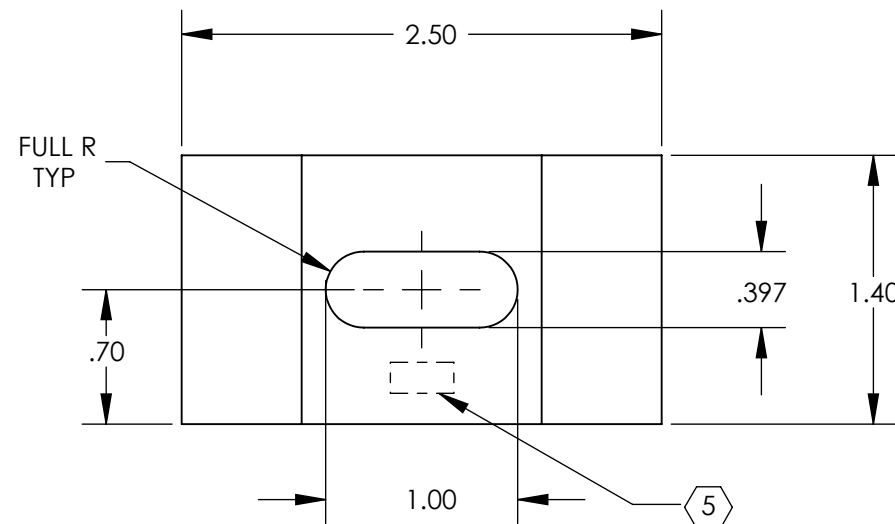
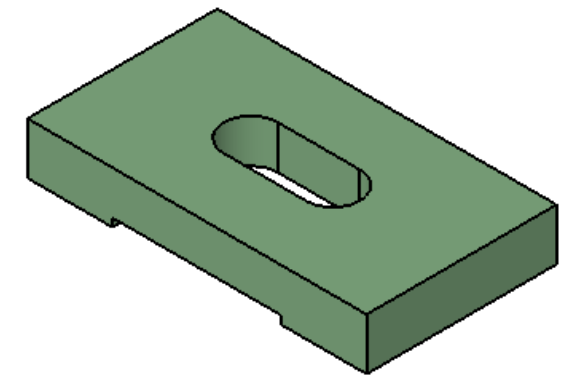
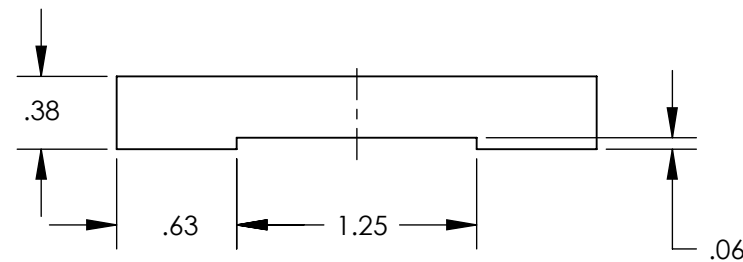
NOTES CONTINUED:

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 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: DXXXXX-VY, TYPE-XX, S/N XXX

- 6. APPROXIMATE WEIGHT=0.320 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 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 #
1	10 SEP 2010	E1000285	-
-	-	-	-
-	-	-	-



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES	
TOLERANCES: .XX ± .02 .XXX ± .010	
ANGULAR ± 1.0°	
1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES, 0.005" TO 0.015". 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.	
MATERIAL	304 SSSL
FINISH	63 μinch

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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

NEXT ASSY: **D0901376**

PART NAME: **SLC INTERFACE MOUNTING CLAMP**

DESIGNER	N.Nguyen	10 SEP 2010	SIZE	DWG. NO.	REV.
DRAFTER	N.NGUYEN	10 SEP 2010	B	D1001700	v1
CHECKER	M. SMITH	10 NOV 2010	SCALE: 1:1	PROJECTION:	SHEET 1 OF 1
APPROVAL	D. COYNE	20 NOV 2010			

8

7

6

5

4

3

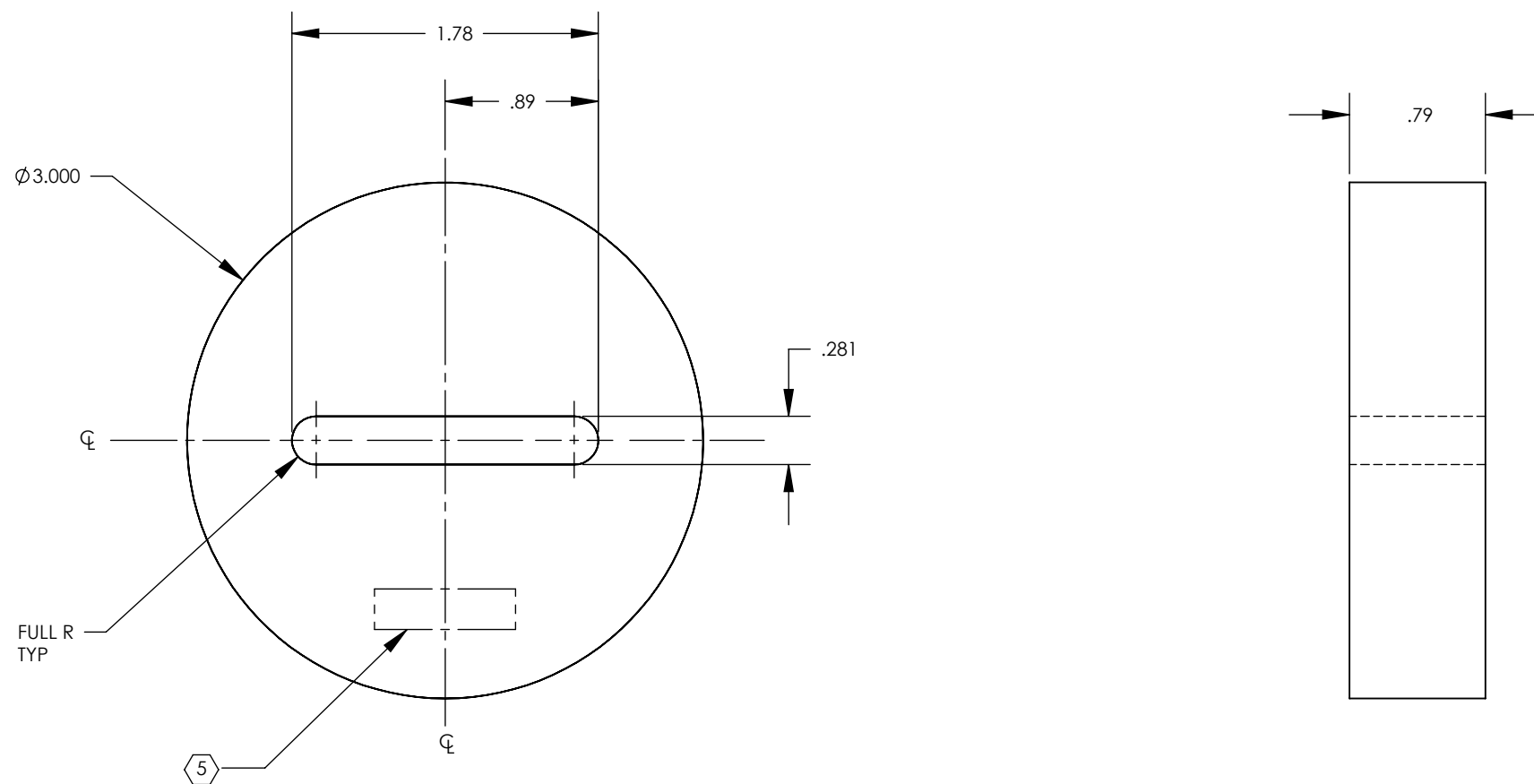
2

1

NOTES: UNLESS OTHERWISE SPECIFIED

- 1. INTERPRET DRAWING PER ASME Y14.5-1994.
- 2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".
- 3. DO NOT SCALE FROM DRAWING.
- 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.
- 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 = 1.503 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 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	10 SEP 2010	E1000285	



D1001826_AdlLIGO_AOS_SLC_ACB Balancing Weight, PART PDM REV: X-008, DRAWING PDM REV: X-011

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES
 TOLERANCES:
 .XX ± .03
 .XXX ± .010
 ANGULAR ± 0.5°

MATERIAL 304 SSSL FINISH 63 μinch

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SYSTEM ADVANCED LIGO SUB-SYSTEM AOS
 NEXT ASSY D0901376

PART NAME			SIZE		DWG. NO.		REV.
SLC ACB BALANCING WEIGHT			B	D1001826		v1	
DESIGNER	N. Nguyen	21 Jul 2010	CHECKER	M. Smith	10 NOV 2010	APPROVAL	D. Coyne
DRAFTER	N. Nguyen	21 Jul 2010	SCALE:	1:1	PROJECTION:	SHEET 1 OF 1	

8

7

6

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4

3

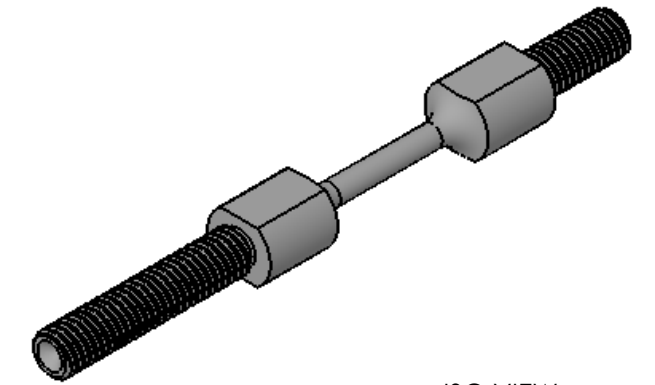
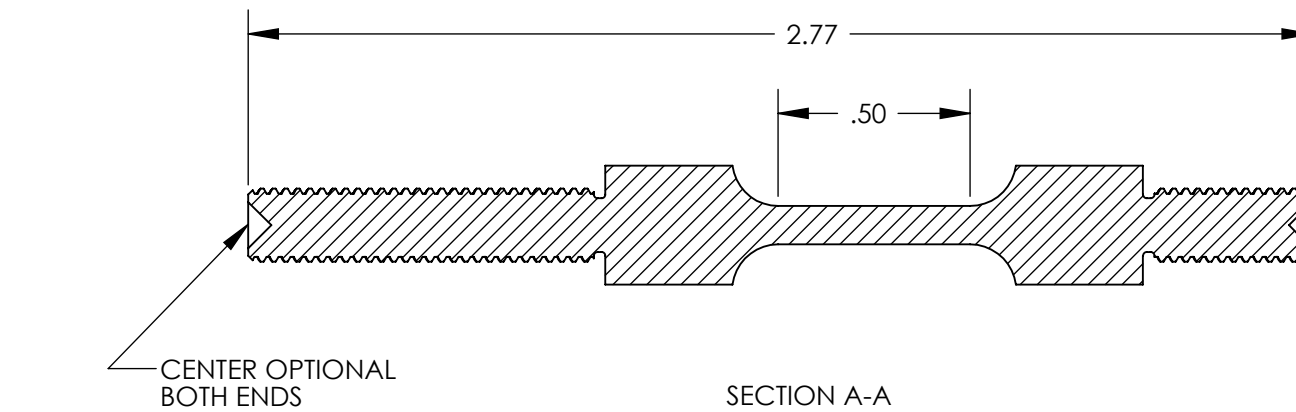
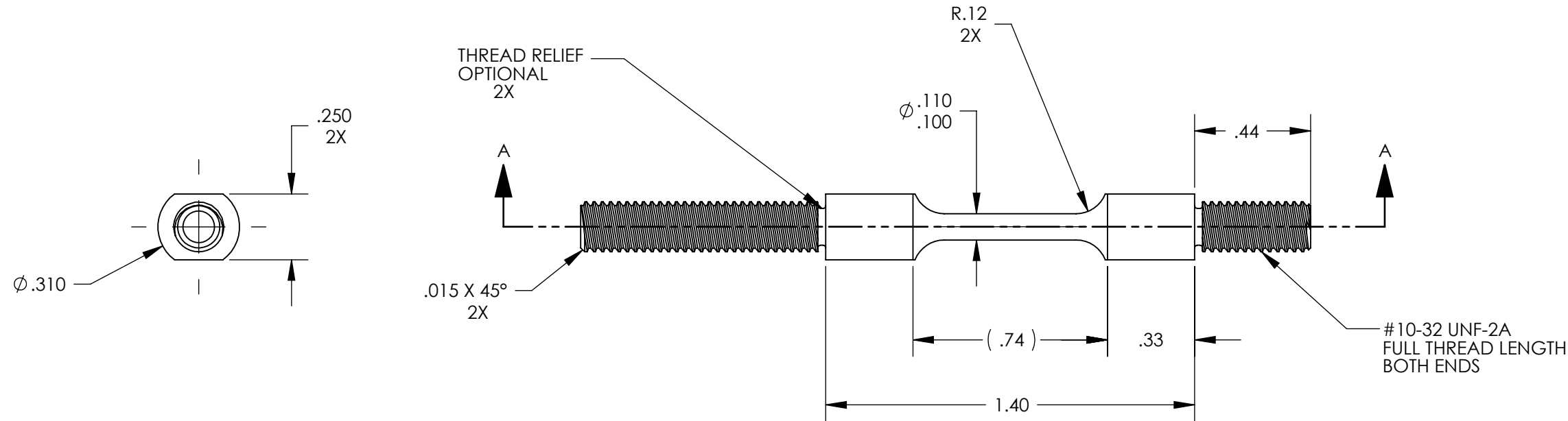
2

1

NOTES CONTINUED:

- 5. SCRIBE, ENGRAVE, OR MECHANICALLY STAMP (NO INKS OR DYES) DRAWING PART NUMBER, REVISION (AND VARIANT OR "TYPE" IF APPLICABLE) ON NOTED SURFACE OF PART FOLLOWED NEXT LINE WITH A THREE DIGIT SERIAL NUMBER. SERIAL NUMBERS START AT 001 FOR THE FIRST ARTICLE AND PROCEEDED CONSECUTIVELY. USE MINIMUM 0.12" HIGH CHARACTERS. UNLESS THE SIZE OF THE PART DICTATES SMALLER CHARACTERS. A VIBRATORY TOOL MAY BE USED.
EXAMPLE: DXXXXX-VY, TYPE-XX, S/N XXX
- 6. APPROXIMATE WEIGHT=0.025 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 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	18 OCT 2010	E1000285	-
-	-	-	-
-	-	-	-



ISO VIEW FOR REFERENCE ONLY

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES		1. INTERPRET DRAWING PER ASME Y14.5-1994.	
TOLERANCES:		2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".	
.XX ± .01		3. DO NOT SCALE FROM DRAWING.	
.XXX ± .005		4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.	
ANGULAR ± 0.5°		MATERIAL	FINISH
		316 S316	63 μinch

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SYSTEM: ADVANCED LIGO SUB-SYSTEM: AOS

NEXT ASSY: D1001005

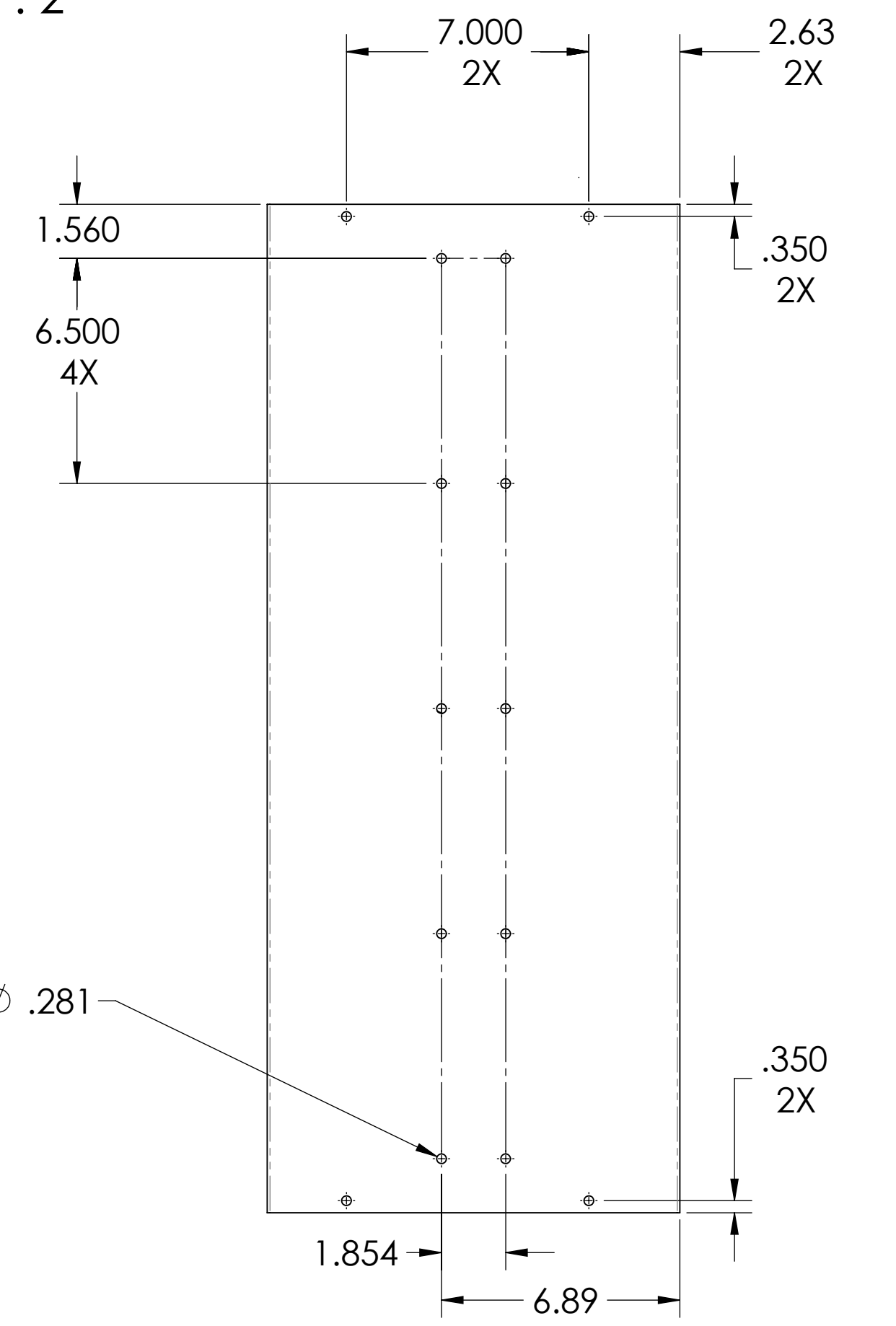
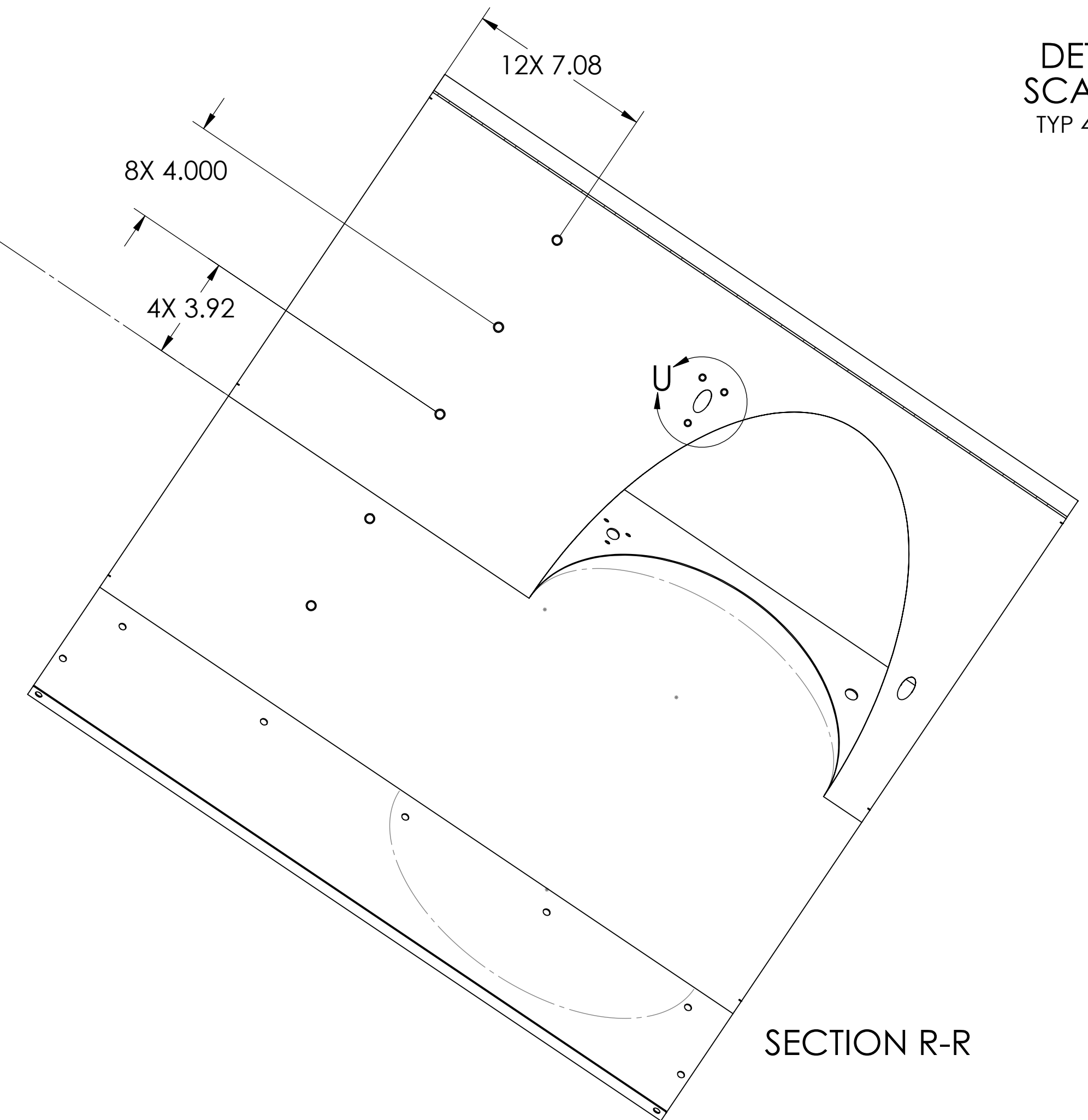
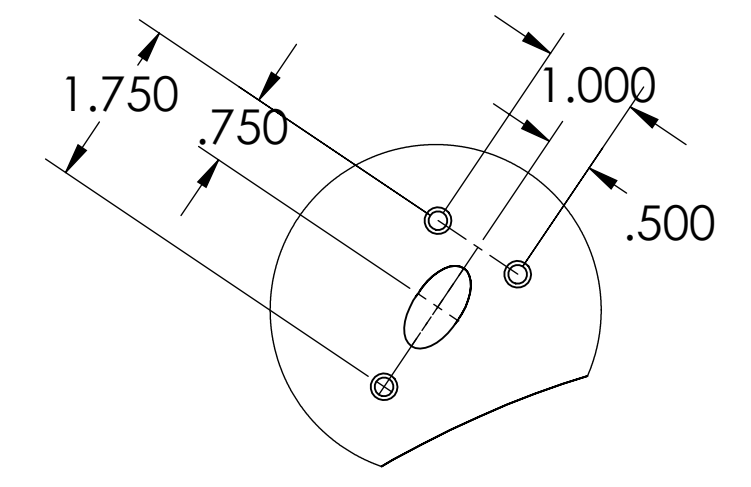
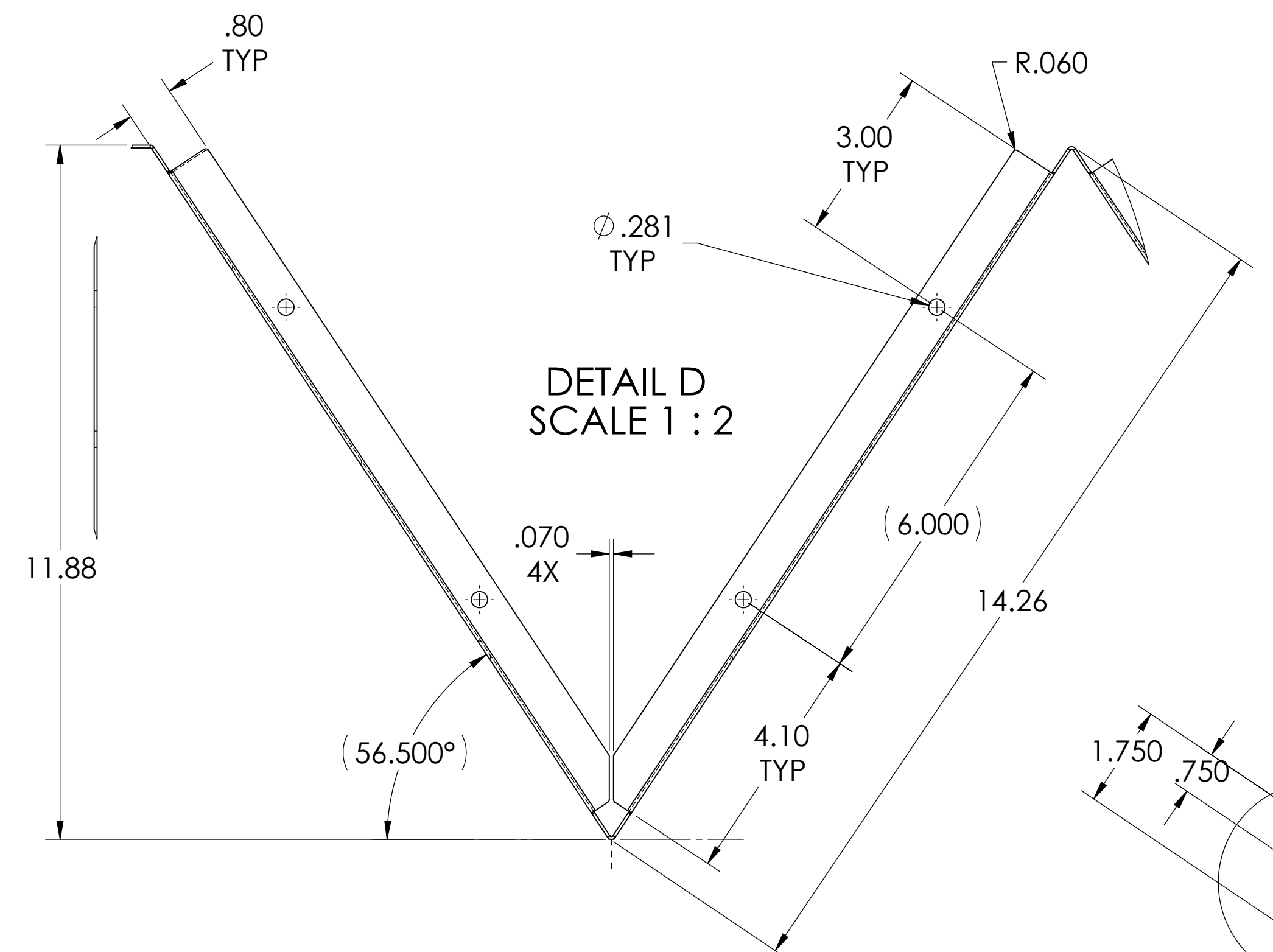
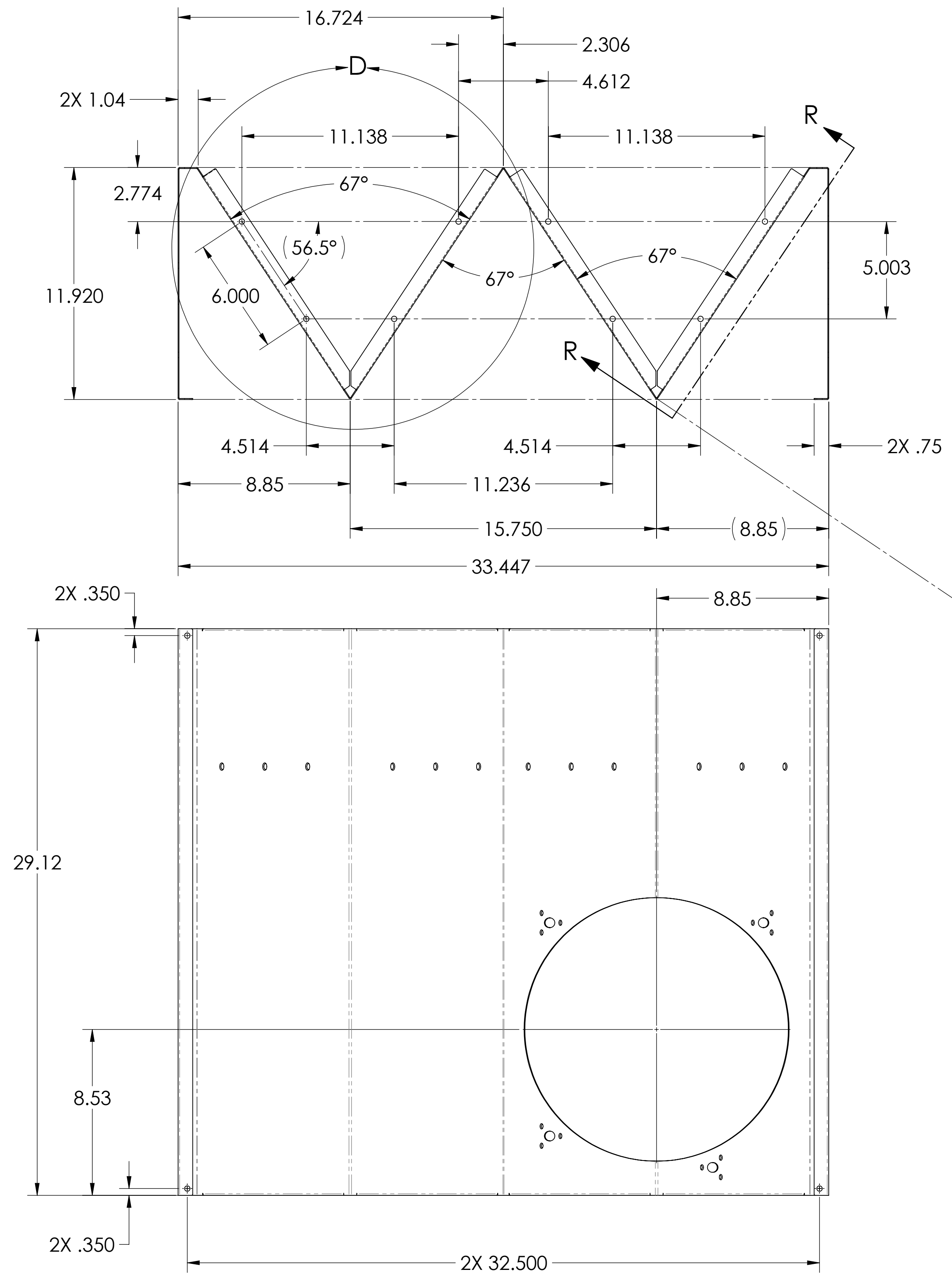
PART NAME				SLC ACB SUSPENSION ROD	
DESIGNER	N.Nguyen	01 SEP 2010	SIZE	DWG. NO.	REV.
DRAFTER	TQ. NGUYEN	18 OCT 2010	B	D1002340	v1
CHECKER	M. SMITH	01 NOV 2010	SCALE:	2:1	PROJECTION:
APPROVAL	D. COYNE	10 NOV 2010	SHEET 1 OF 1		

D1002340_AdlIGO_AOS_SLC Suspension Rod, PART PDM REV: X-005, DRAWING PDM REV: X-016

- 5. MAT'L: 18 GA ENAMELING STEEL -A424 TYPE I OR III.
 - 6. ALL EDGES TO BE SMOOTH AND FREE OFF BURRS.
 - 7. FINISH: PART WILL BE PORCELAIN COATED IN ACCORDANCE WITH LIGO SPECIFICATION E1000083
 - 8. ALL HOLE AREAS SHALL BE MASKED WITHIN .63 DIA PRIOR PORCELAIN COATED. BOTH SIDES
- SEE CAD FILE # D1002357 TO GENERATE ELLIPSE CURVES

REV.	DATE	DCN #	DRAWING TREE #
v1	03 JAN 2011	E1000868	

PART NO.	DESCRIPTION	SEE SHEET NO.
D1002357-01	ACB 1 HOLE RIGHT-QPD SKIN	1, 2 & 3
D1002357-02	ACB 1 HOLE LEFT-QPD SKIN	4 & 5
D1002357-03	ACB 1 HOLE RIGHT NO QPD SKIN	6 & 7
D1002357-04	ACB 1 HOLE LEFT NO QPD SKIN	8 & 9



D1002357-01 ONE HOLE RIGHT QPD SKIN

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)	
1. INTERPRET DRAWING PER ASME Y14.5-1994.	
2. REMOVE ALL SHARP EDGES, R.02 MIN.	
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	FINISH
ENAMEL STL A424 TYPE I	SEE NOTE 7
DIMENSIONS ARE IN INCHES	
TOLERANCES: .XX ± .02 .XXX ± .010	
ANGULAR ± 1.0°	

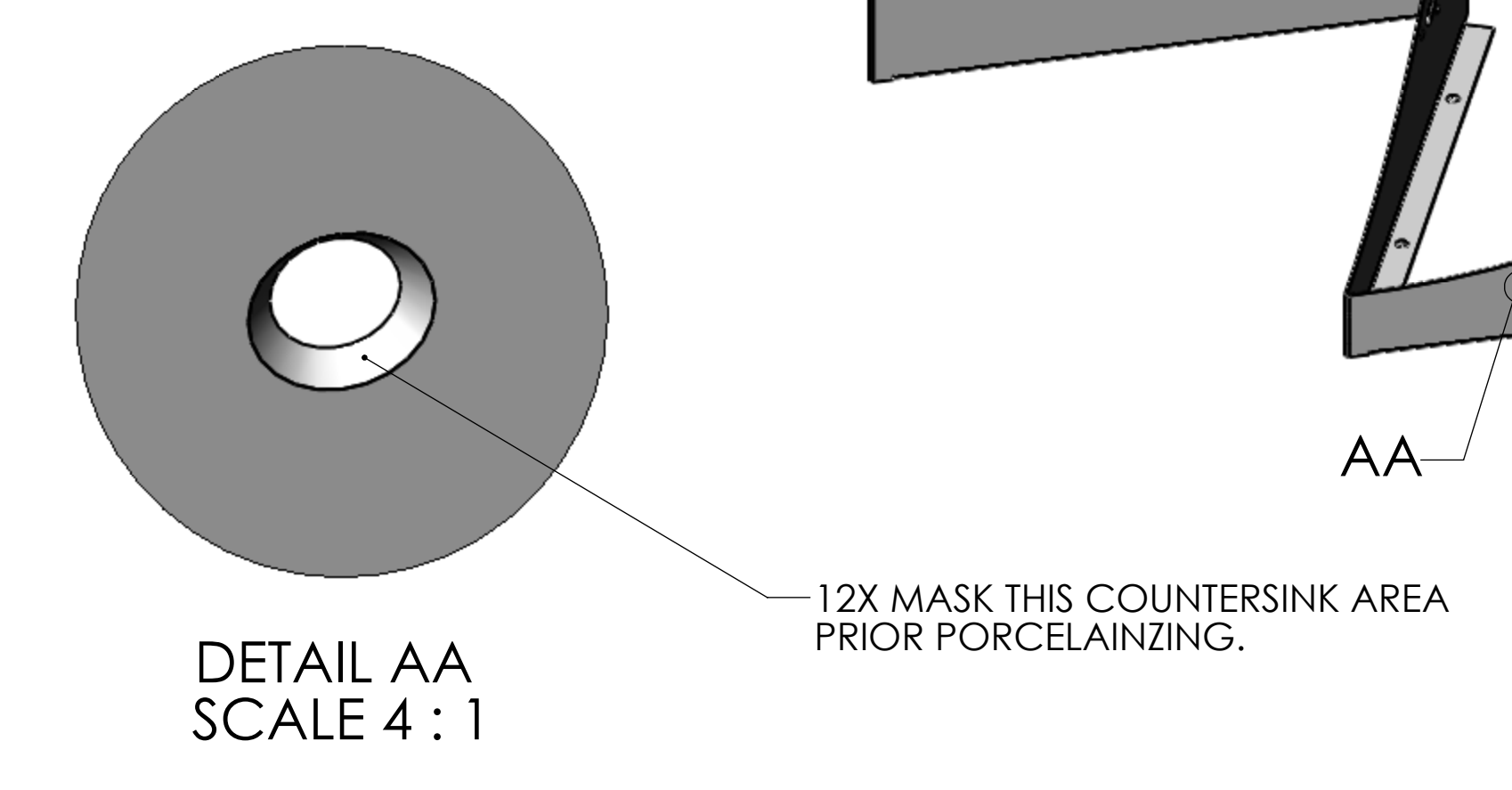
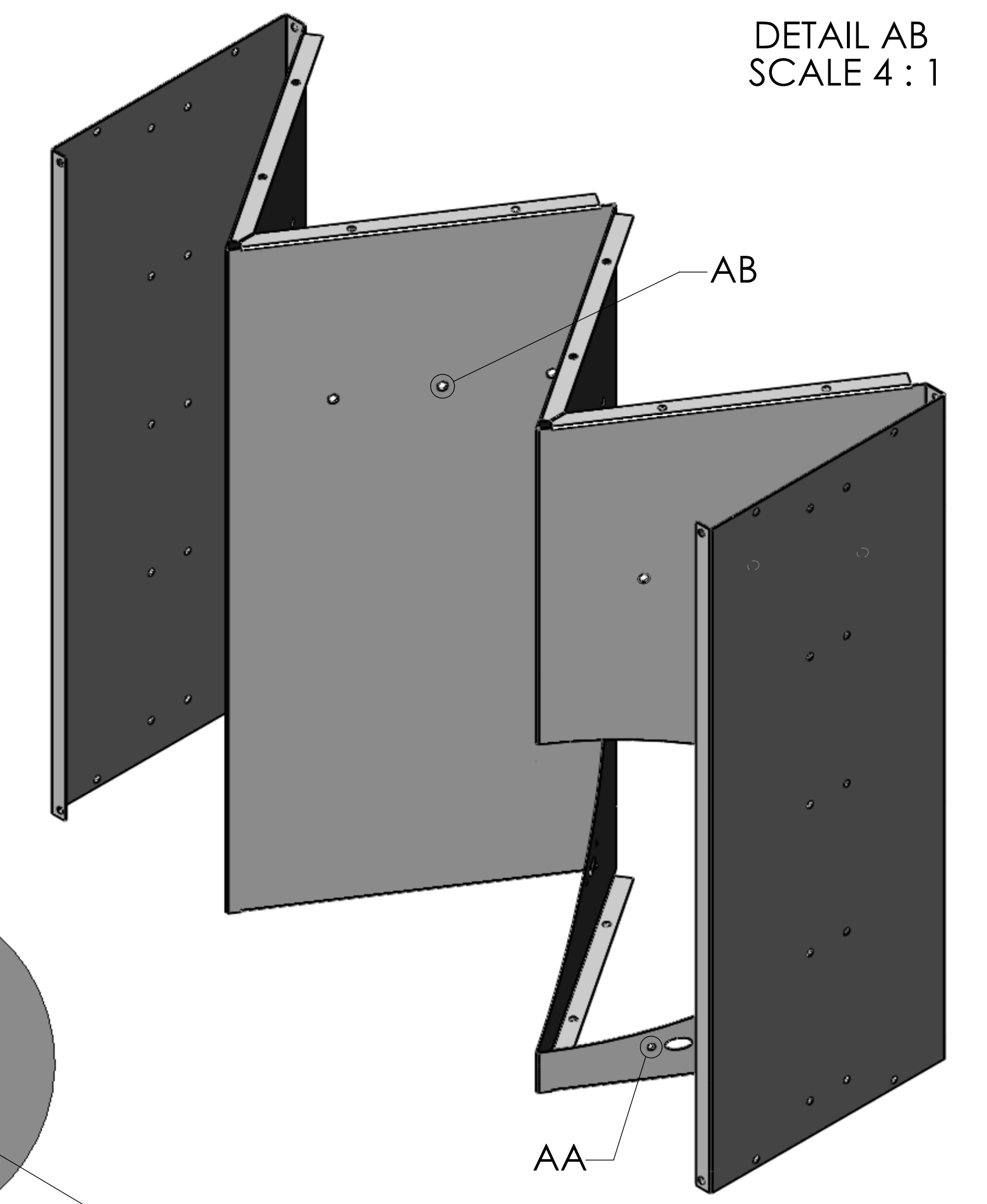
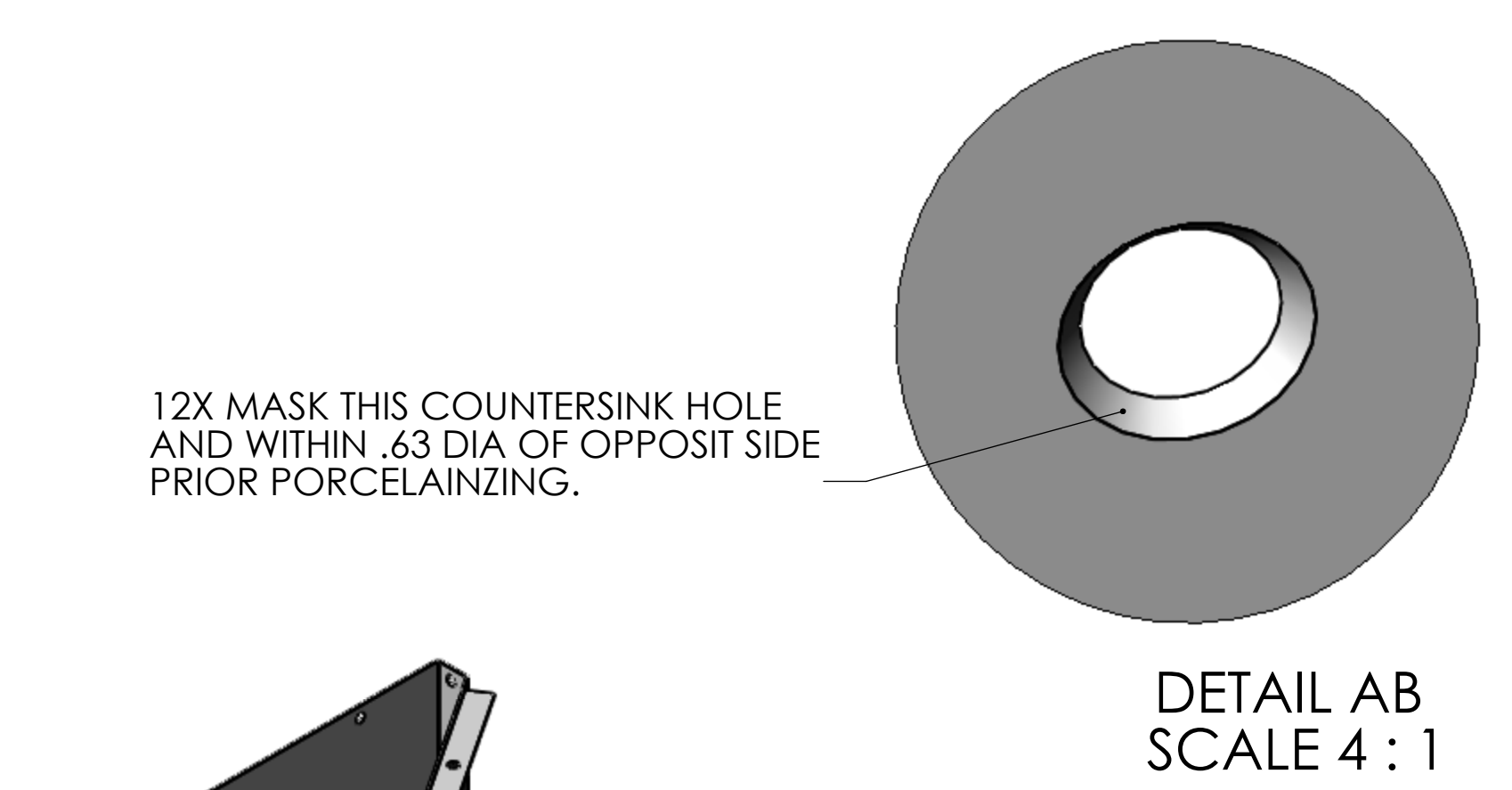
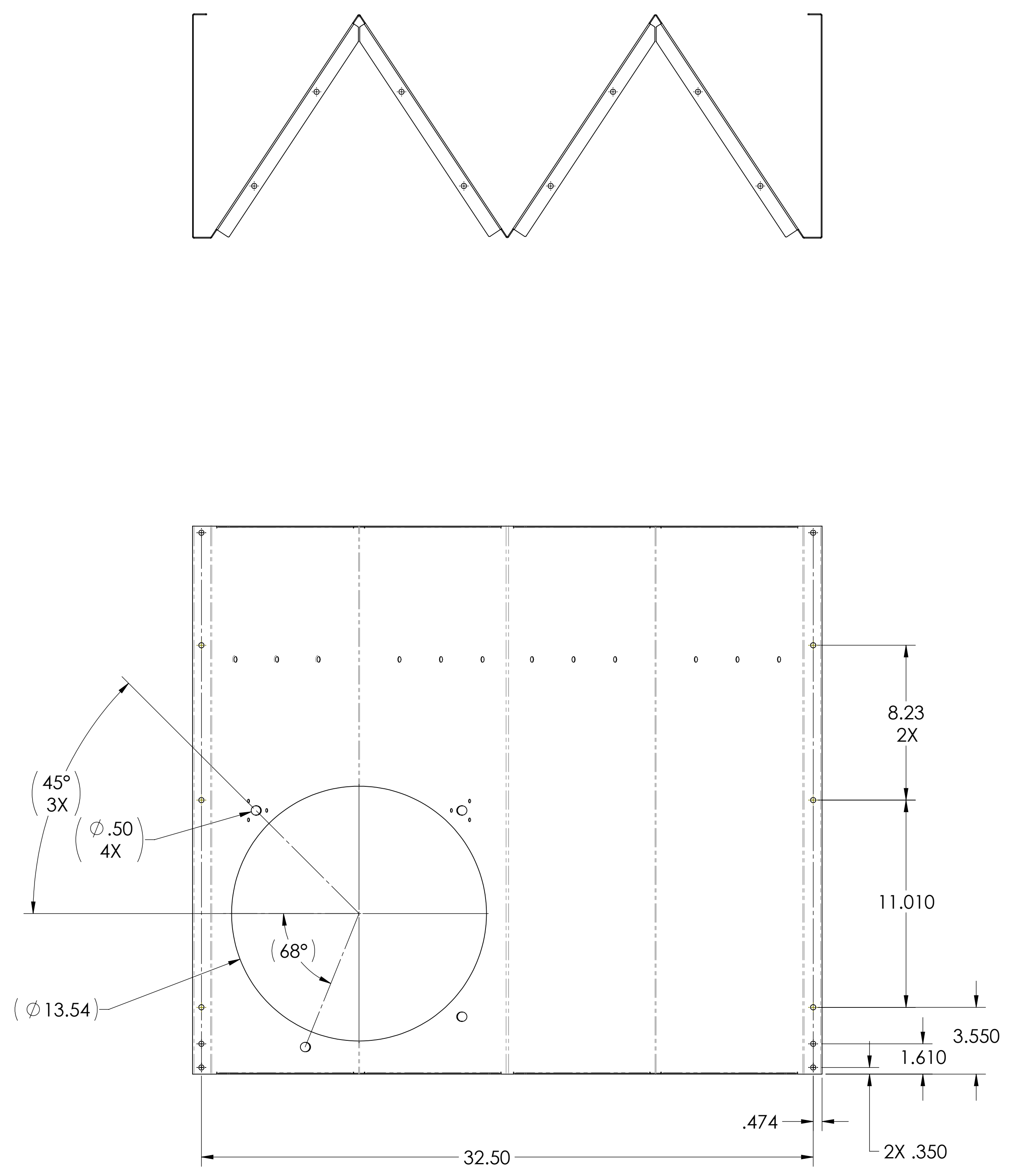
LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SYSTEM: ADVANCED LIGO SUB-SYSTEM: AOS

NEXT ASSY: D1002356

PART NAME				ACB ONE HOLE SKIN	
DESIGNER	N.Nguyen	20 Dec 2010	SIZE	DWG. NO.	REV.
DRAFTER	N. NGUYEN	20 DEC 2010	D	D1002357	v1
CHECKER	M. SMITH	10 JAN 2011	SCALE: 1:4	PROJECTION:	SHEET 1 OF 9
APPROVAL	D. COYNE	20 JAN 2011			

D1002357_AudiGO_ACS_SLC_ARM_Covily_Bottle_1 Hole Skin_PART.PDM_REV.X-006_DRAWING.PDM_REV.X-006



D1002357-01
ONE HOLE RIGHT QPD SKIN

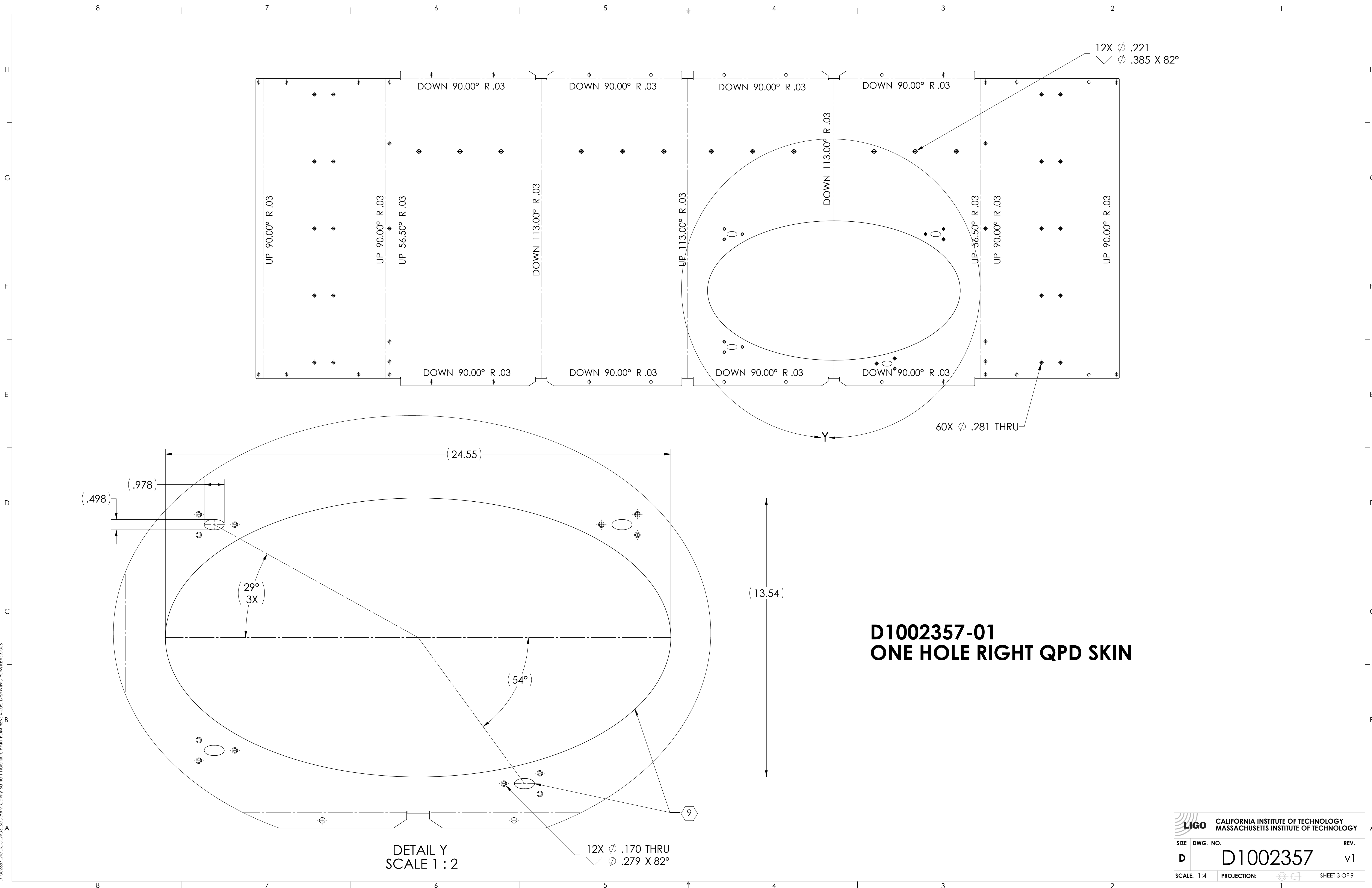
ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ	SPARE	TOTAL
1	D1002357-01	ACB 1 HOLE RIGHT-QPD SKIN	ENAMEL STL A424 TYPE I	1		1

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SIZE DWG. NO. **D1002357** REV. **v1**

SCALE: 1:4 PROJECTION: SHEET 2 OF 9

D:\002357_Audi\GO_ACS_SLC_ARM_Covily\Bottle_1 Hole Skin_PART PDM REV.X-006.DRAWING PDM REV.X-006



12X ϕ .221
 \surd ϕ .385 X 82°

60X ϕ .281 THRU

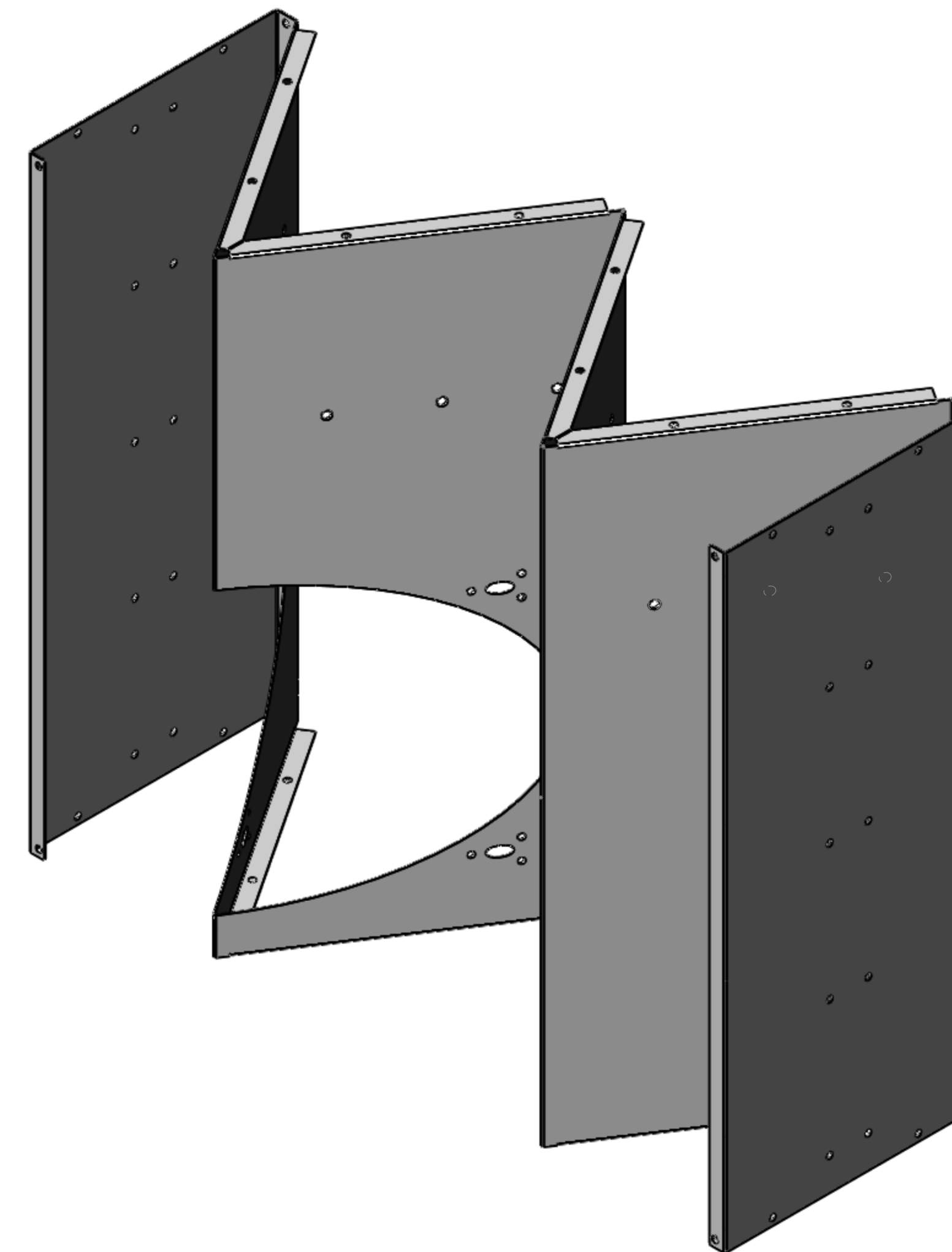
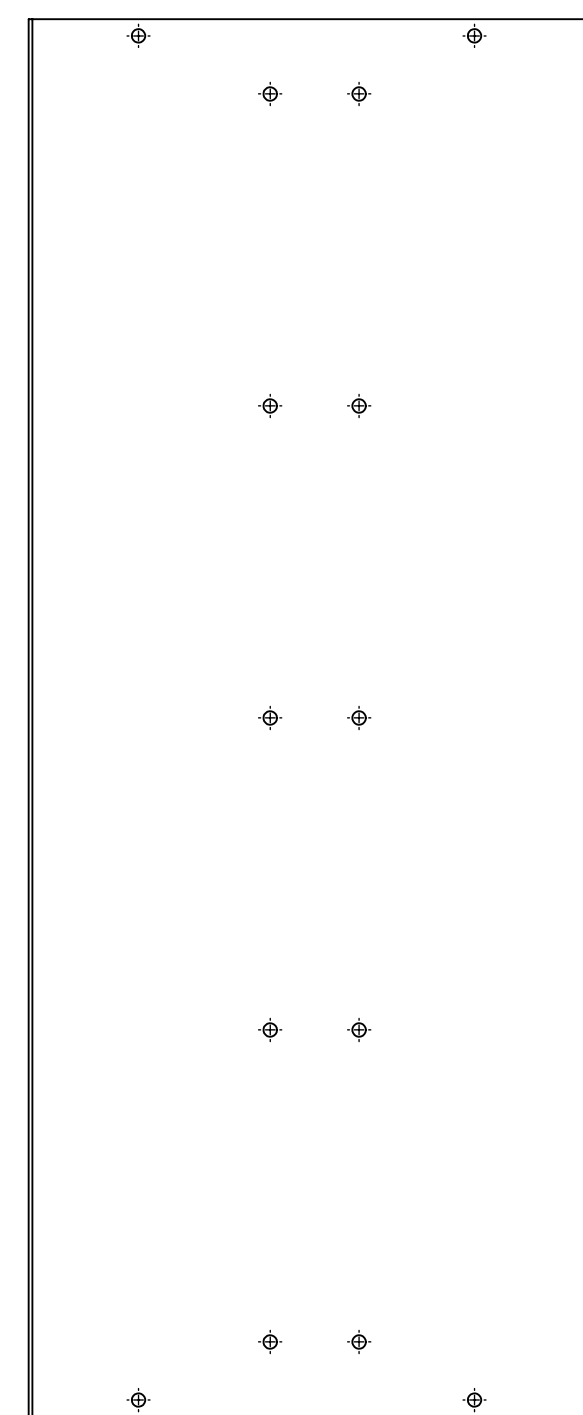
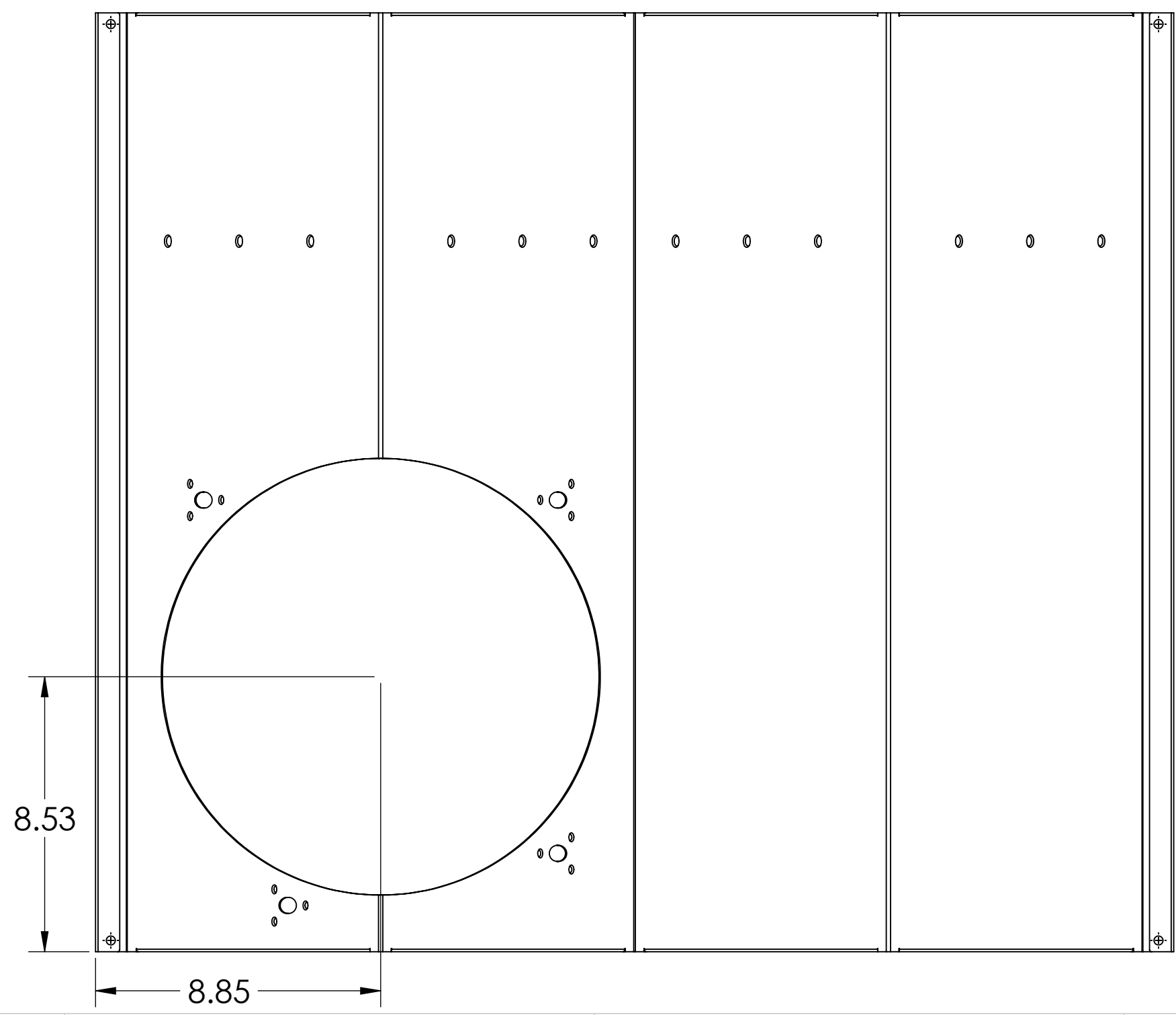
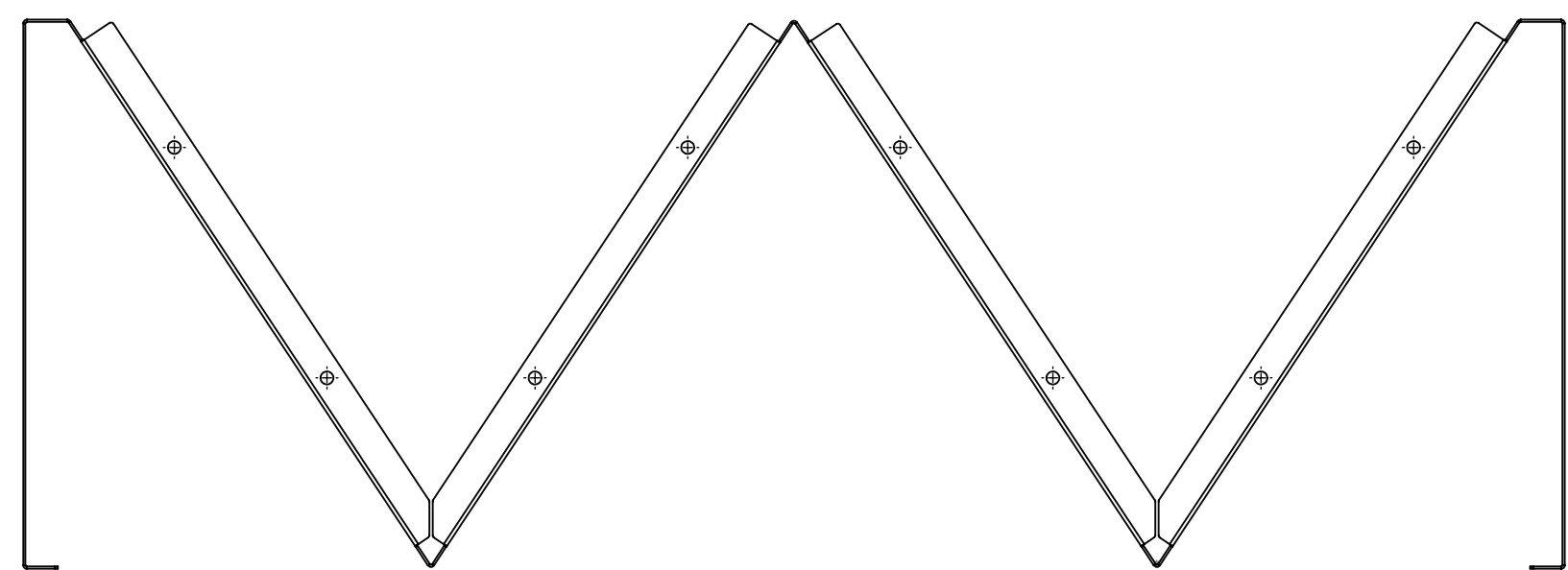
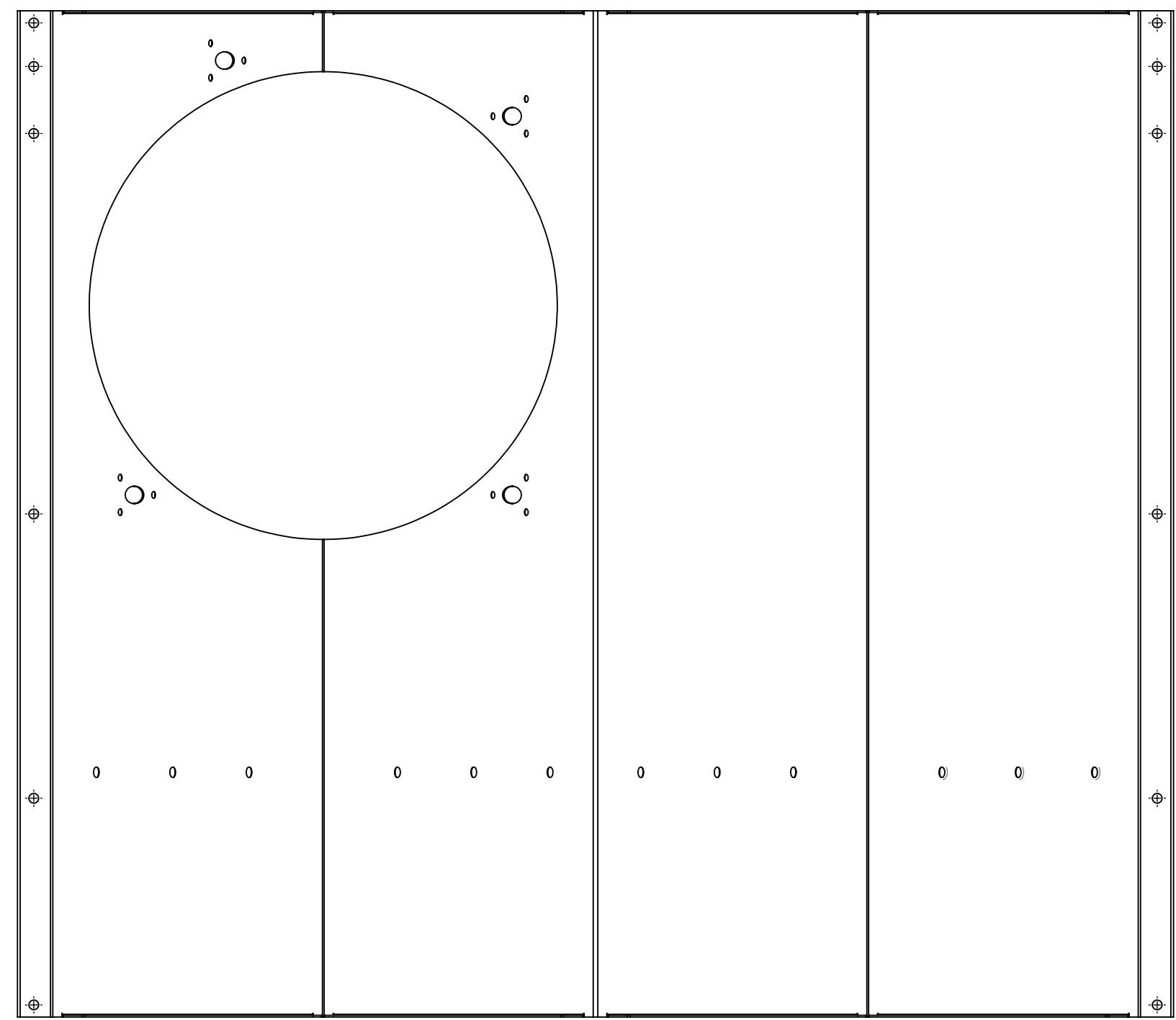
**D1002357-01
 ONE HOLE RIGHT QPD SKIN**

DETAIL Y
 SCALE 1 : 2

12X ϕ .170 THRU
 \surd ϕ .279 X 82°

CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		REV.
SIZE	DWG. NO.	REV.
D	D1002357	v1
SCALE: 1:4	PROJECTION:	SHEET 3 OF 9

D1002357_AudiGO_ACS_SLC_ARM_Cavity_Baffle_1 Hole_Skin_PART_PDM_REV_X.006_DRAWING_PDM_REV_X.006



D1002357-02
ONE HOLE LEFT QPD SKIN
SEE D1002357-01 FOR DIMS NOT SHOWN

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ	SPARE	TOTAL
1	D1002357-02	ACB 1 HOLE LEFT-QPD SKIN	ENAMEL STL A424 TYPE I	1		1

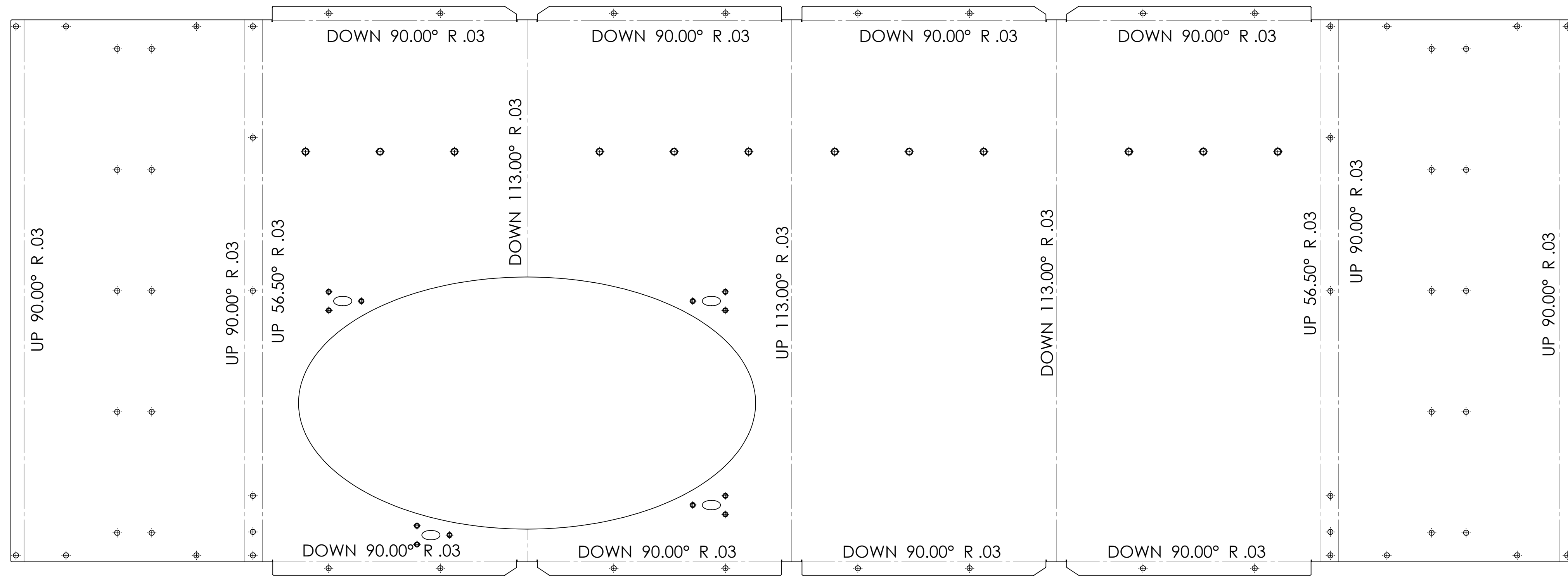
PARTS LIST

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SIZE DWG. NO. **D1002357** REV. **v1**

SCALE: 1:4 PROJECTION: SHEET 4 OF 9

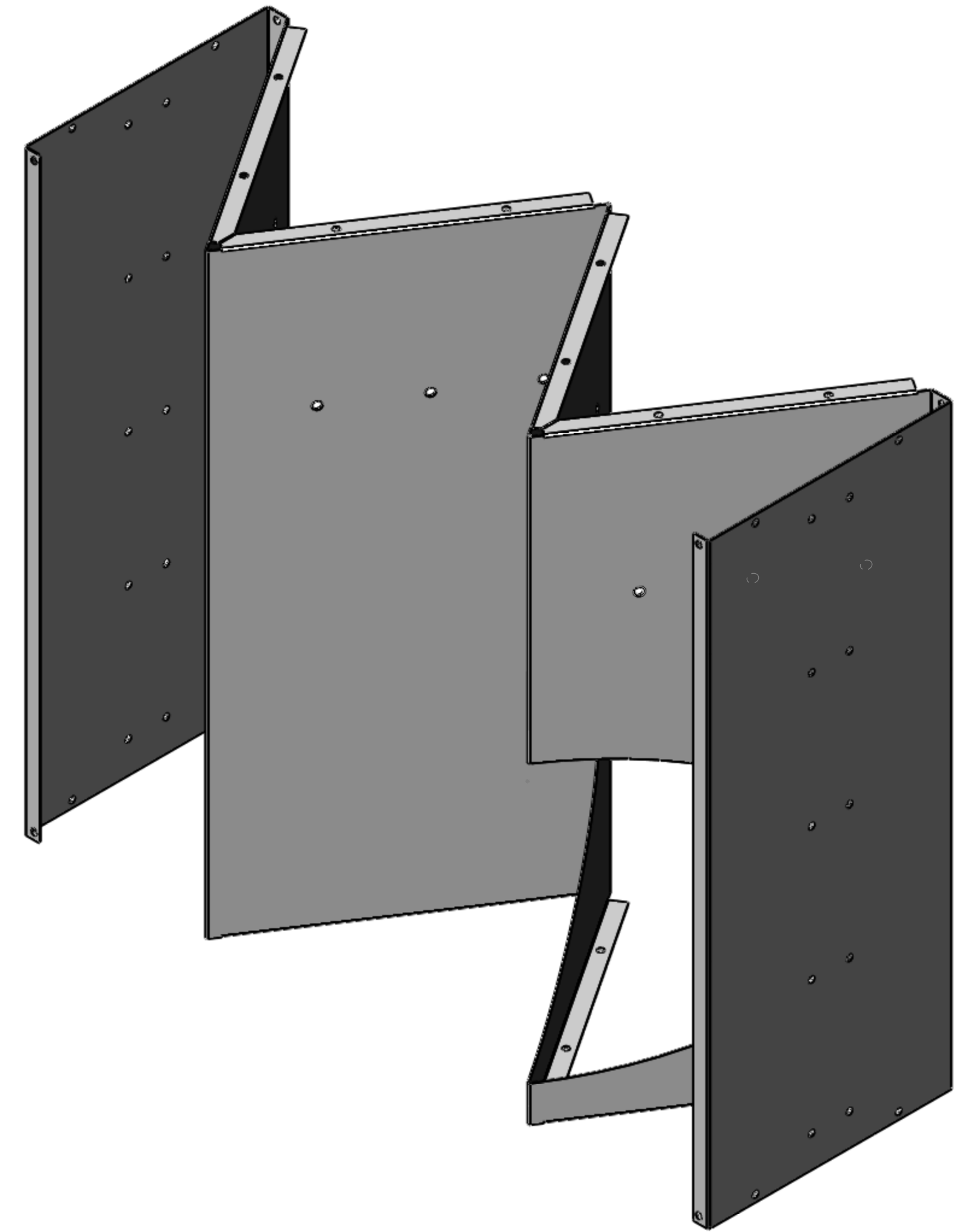
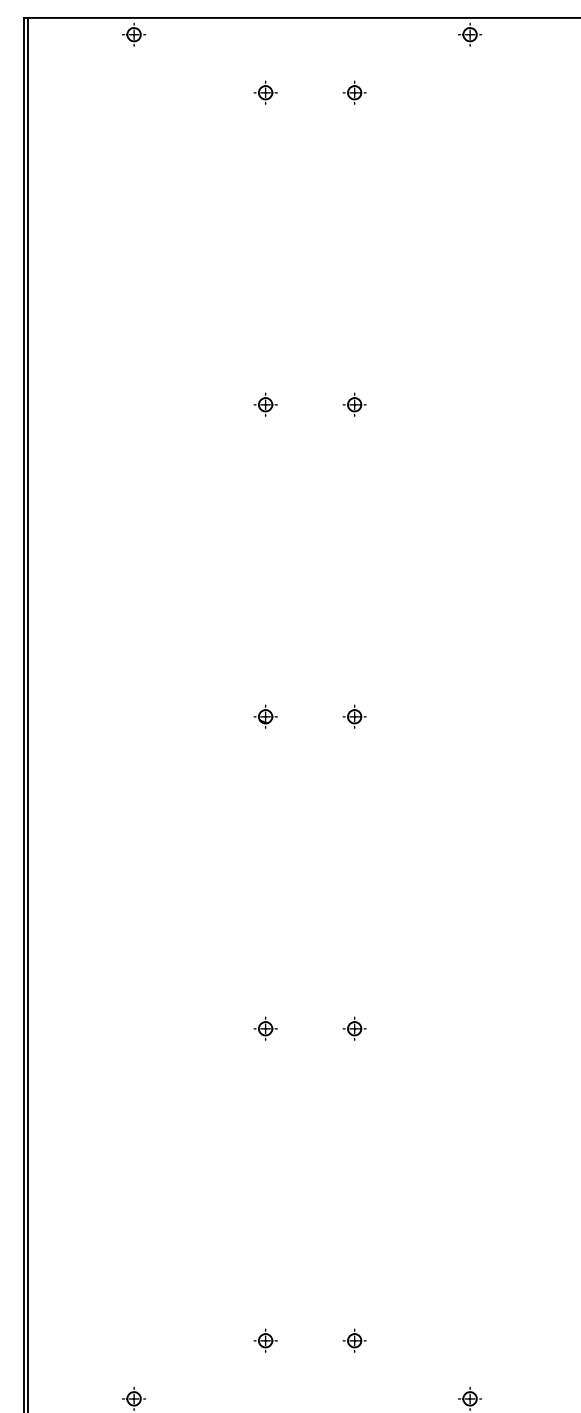
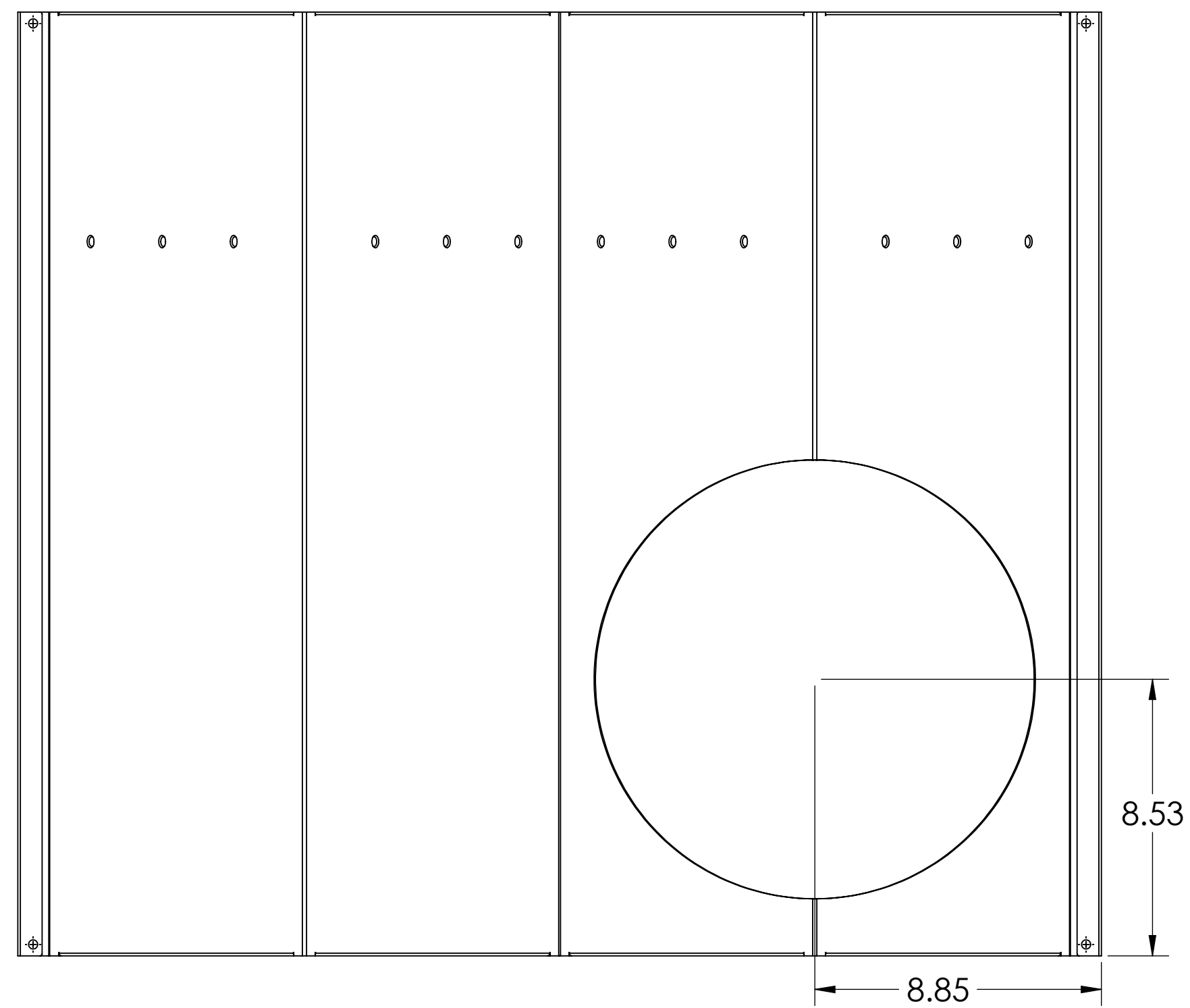
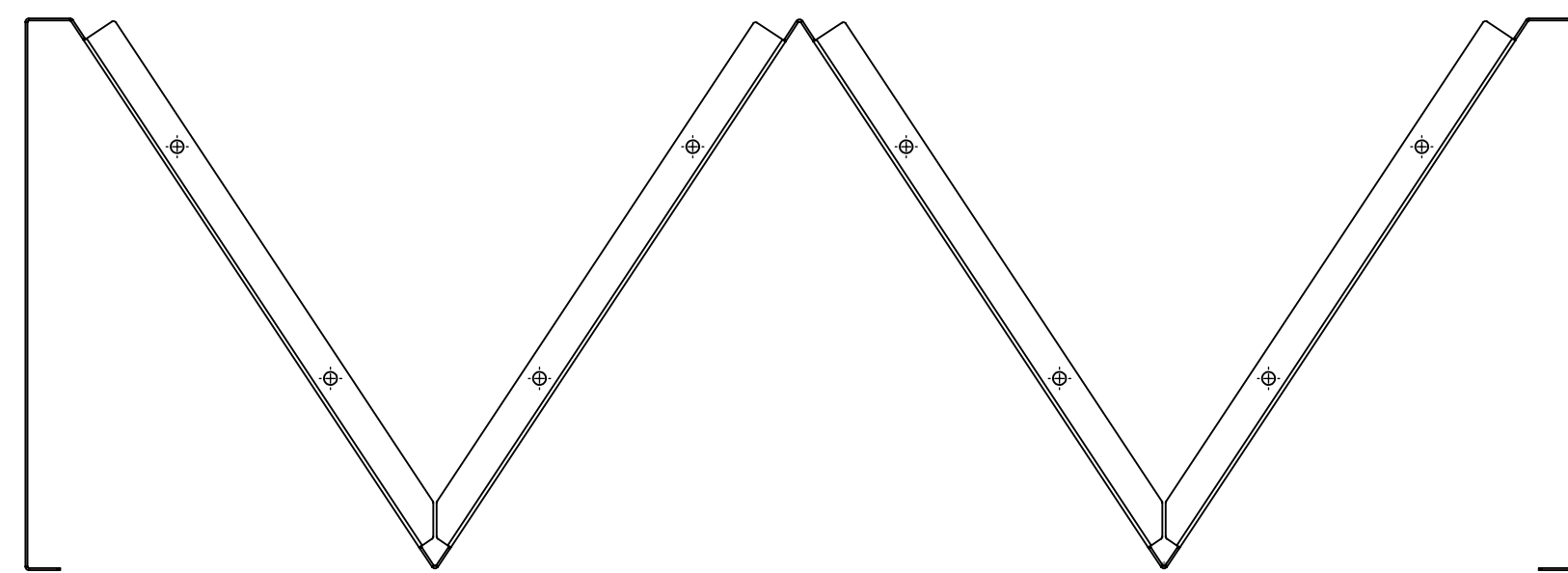
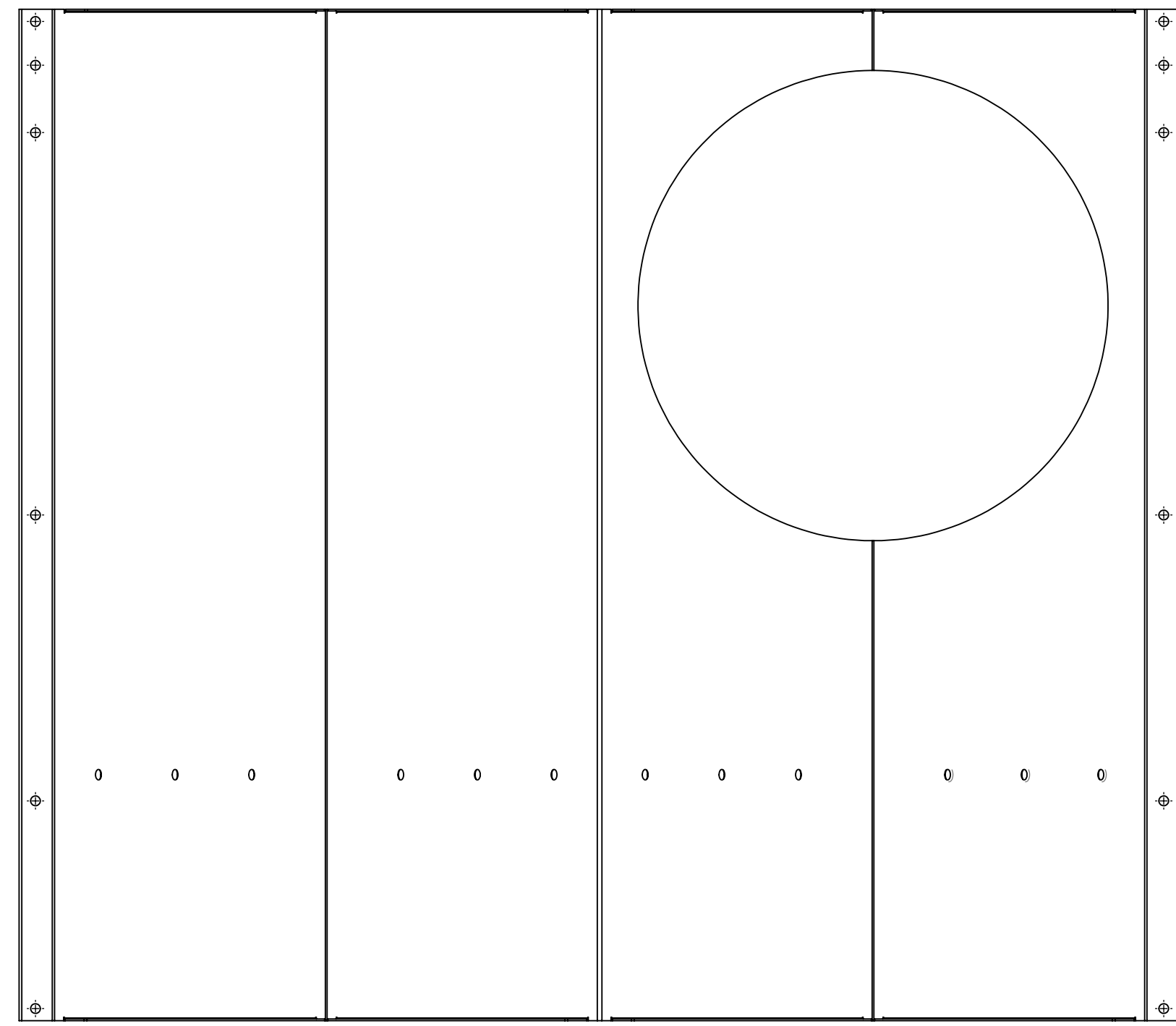
D1002357_AduIGO_ACS_SLC_ARM_Covily_Baffle_1 Hole Skin_PART PDM REV. X-006_DRAWING PDM REV. X-006



D1002357-02
ONE HOLE LEFT QPD SKIN
SEE D1002357-01 FOR DIMS NOT SHOWN

 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		SIZE DWG. NO. D D1002357	REV. v1
SCALE: 1:4	PROJECTION:	SHEET 5 OF 9	

D1002357_AudiLIGO_ACS_SLC_ARM_Cavity_Baffle_1 Hole_Skin_PART.PDM_REV.X.006_DRAWING.PDM_REV.X.006



D1002357-03
ONE HOLE RIGHT NO QPD SKIN
SEE D1002357-01 FOR DIMS NOT SHOWN

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ	SPARE	TOTAL
1	D1002357-03	ACB 1 HOLE RIGHT NO QPD SKIN	ENAMEL STL A424 TYPE I	1		1

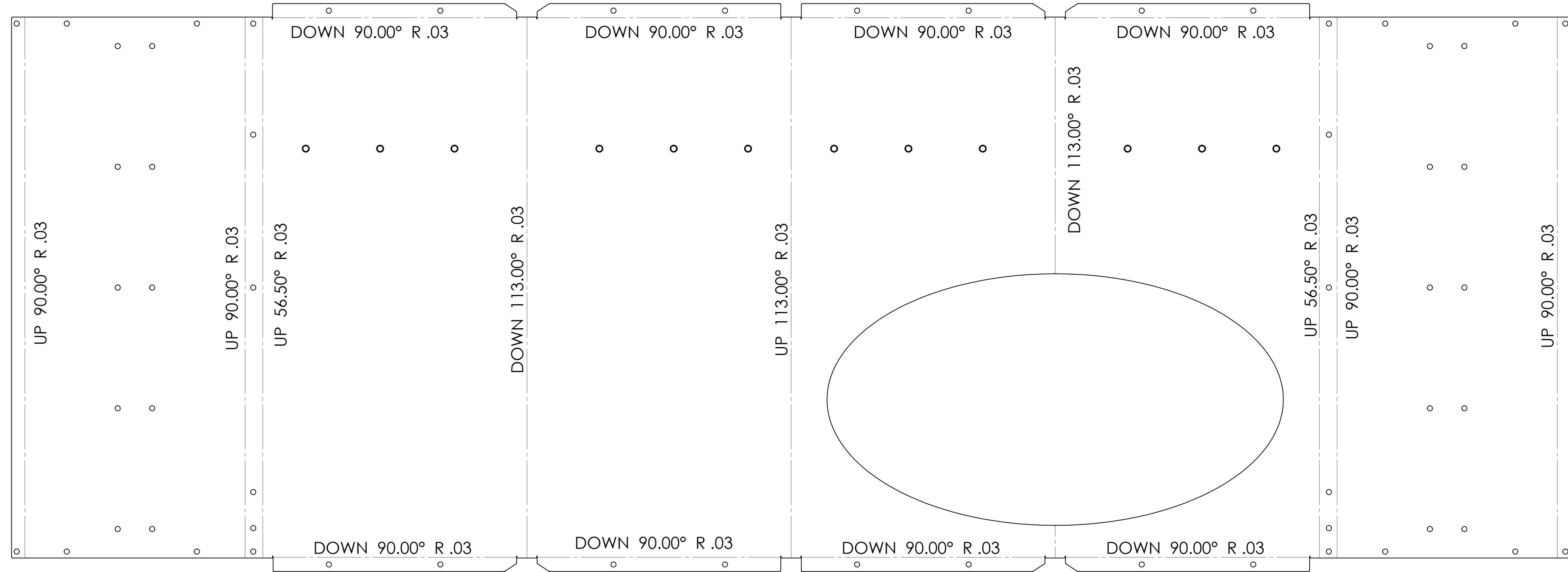
PARTS LIST

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY



SIZE DWG. NO. REV.
D **D1002357** v1

SCALE: 1:4 PROJECTION: SHEET 6 OF 9

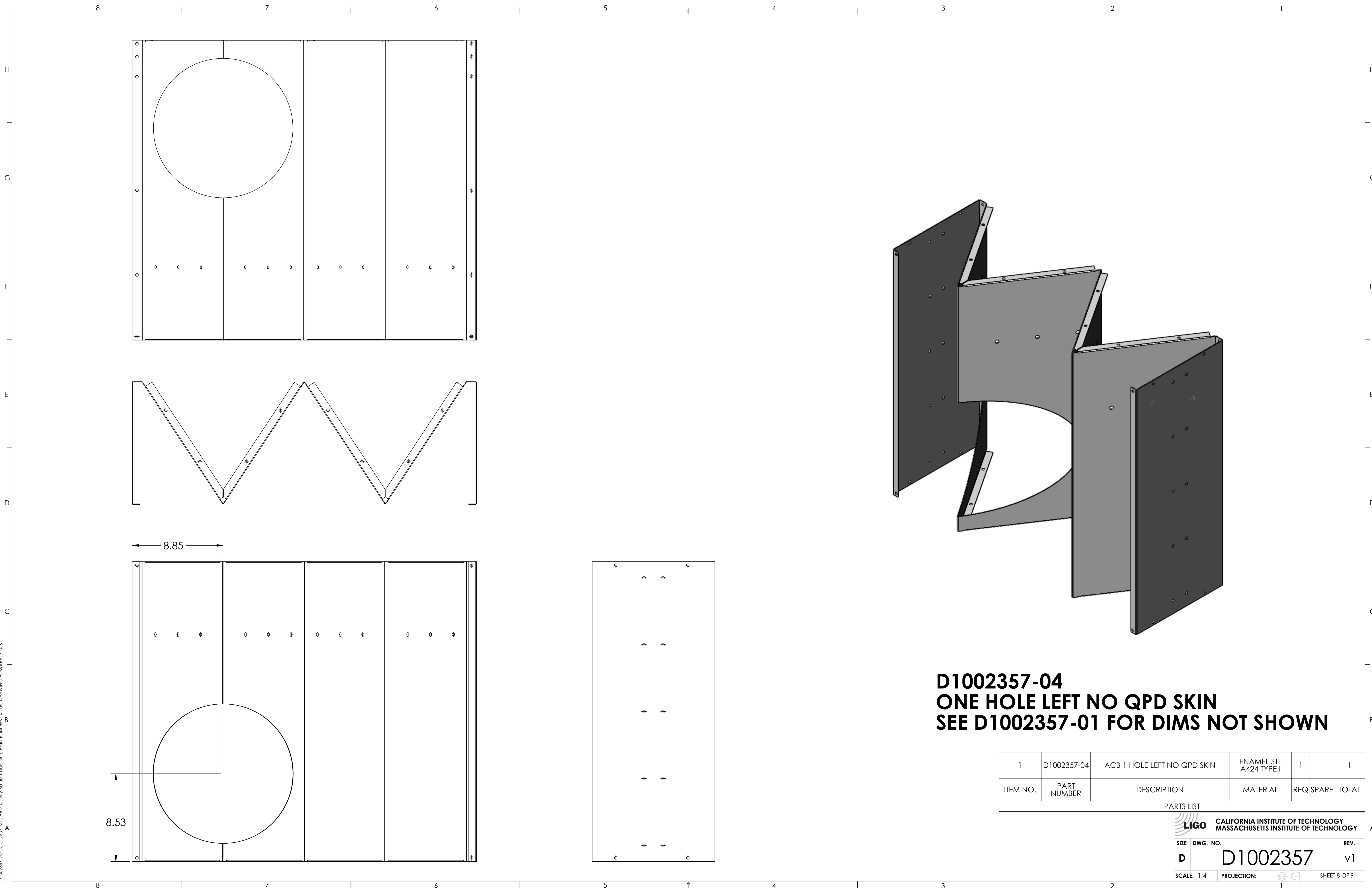
D1002357_AduLIGO_ACS_SLC_ARM_Covlly_Baffle_1 Hole Skin_PART PDM REV. X-006_DRAWING PDM REV. X-006



D1002357-03
ONE HOLE RIGHT NO QPD SKIN
SEE D1002357-01 FOR DIMS NOT SHOWN

 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		REV. v1
SIZE D	DWG. NO. D1002357	SHEET 7 OF 9
SCALE: 1:4	PROJECTION:	

D1002357_AduLIGO_AOS_SLC_ARM_Covily_Bottle_1 Hole Skin_PART PDM REV. X.006_DRAWING PDM REV. X.006



D1002357-04
ONE HOLE LEFT NO QPD SKIN
SEE D1002357-01 FOR DIMS NOT SHOWN

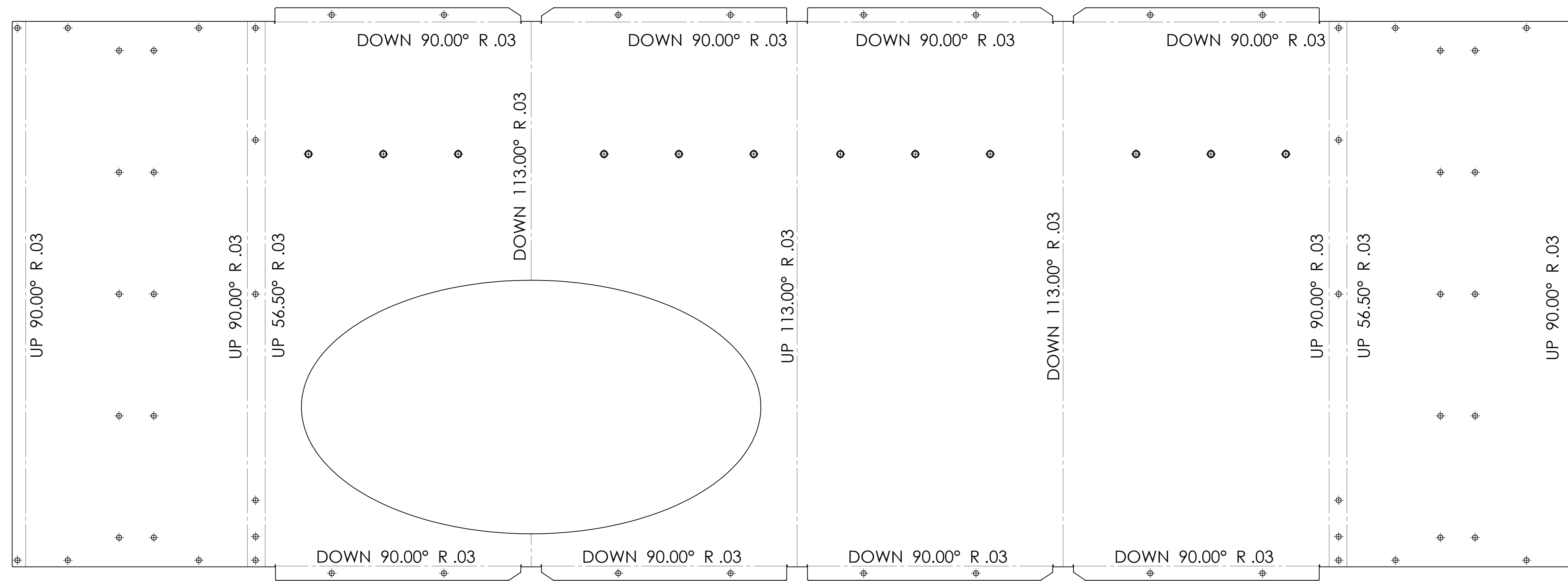
ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	REQ	SPARE	TOTAL
1	D1002357-04	ACB 1 HOLE LEFT NO QPD SKIN	ENAMEL STL A424 TYPE I	1		1

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SIZE DWG. NO. **D1002357** REV. **v1**

SCALE: 1:4 PROJECTION: SHEET 8 OF 9

D1002357_AduLIGO_AOS_SLC_ARM_Covily_Bottle_1 Hole Skin_PART PDM REV: X-006_DRAWING PDM REV: X-006



D1002357-04
ONE HOLE LEFT NO QPD SKIN
SEE D1002357-01 FOR DIMS NOT SHOWN

 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		REV.
SIZE	DWG. NO.	REV.
D	D1002357	v1
SCALE: 1:4	PROJECTION:	SHEET 9 OF 9

D1002357_AduLIGO_AOS_SLC_ARM_Covly_Bottle_1 Hole Skin_PART PDM REV. X.006_DRAWING PDM REV. X.006

NOTES: UNLESS OTHERWISE SPECIFIED
 1. INTERPRET DRAWING PER ASME Y14.5-1994.

2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".

3. DO NOT SCALE FROM DRAWING.

4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.

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.

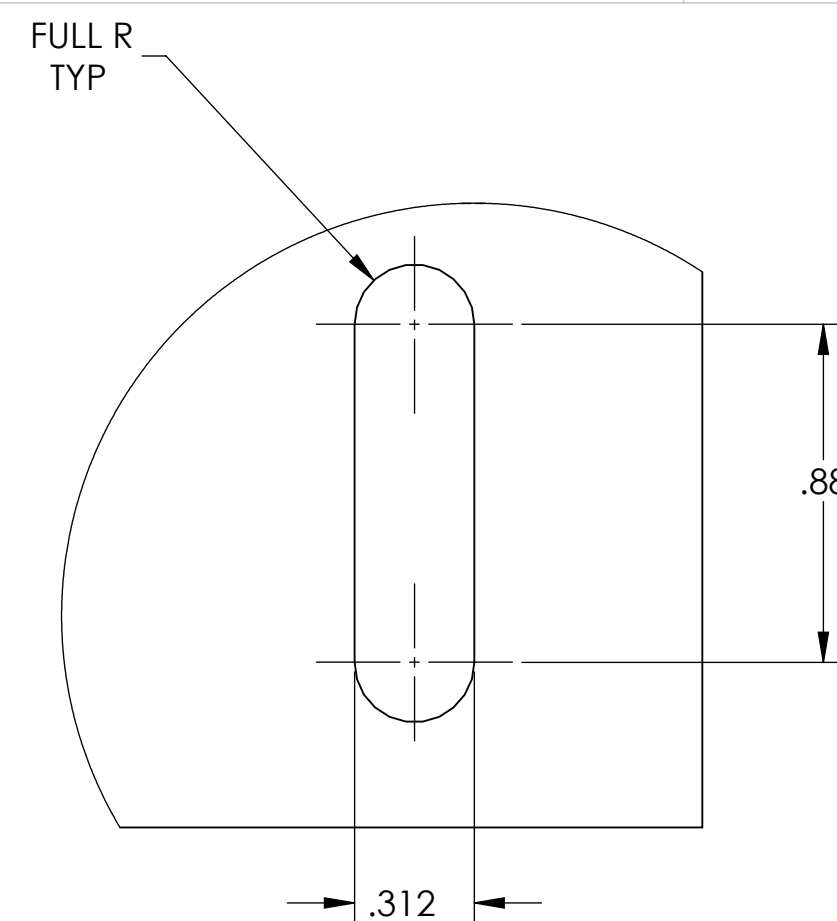
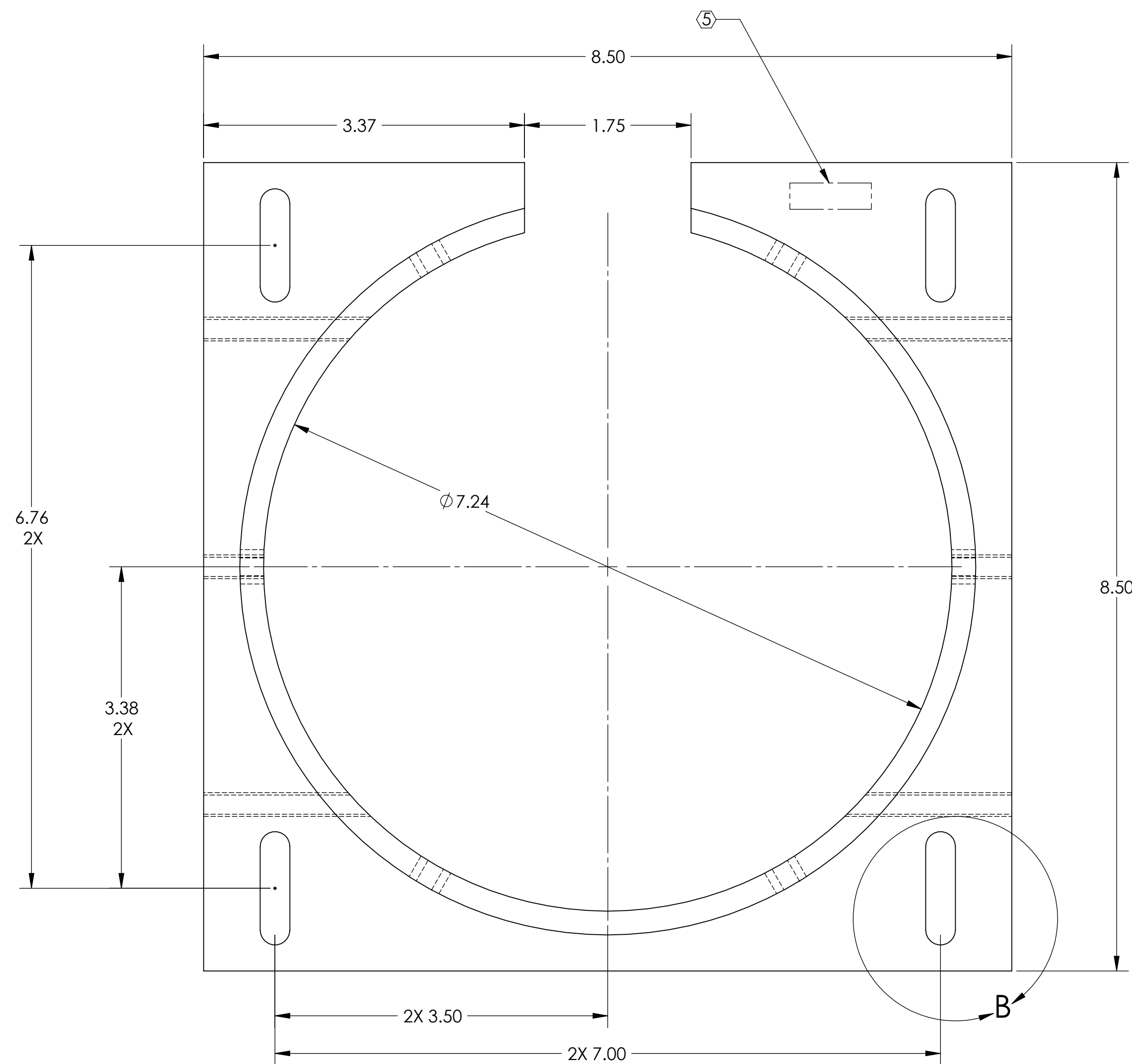
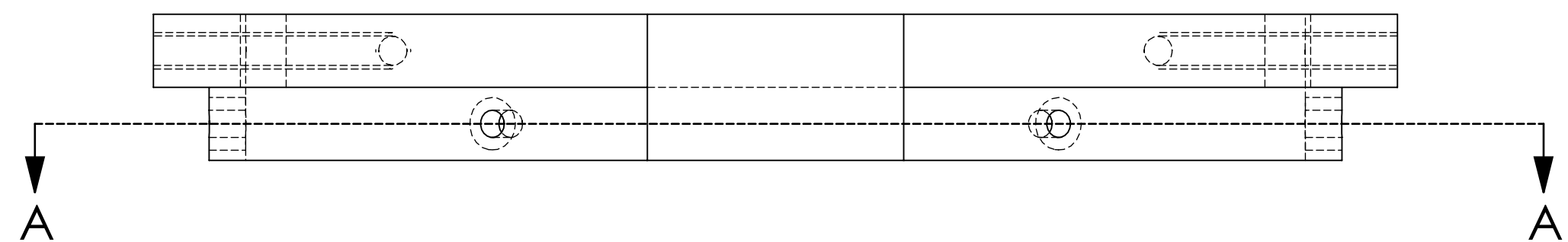
EXAMPLE: DXXXXXX-VY, TYPE-XX, S/N XXX

6. APPROXIMATE WEIGHT = 1.647 LB.

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

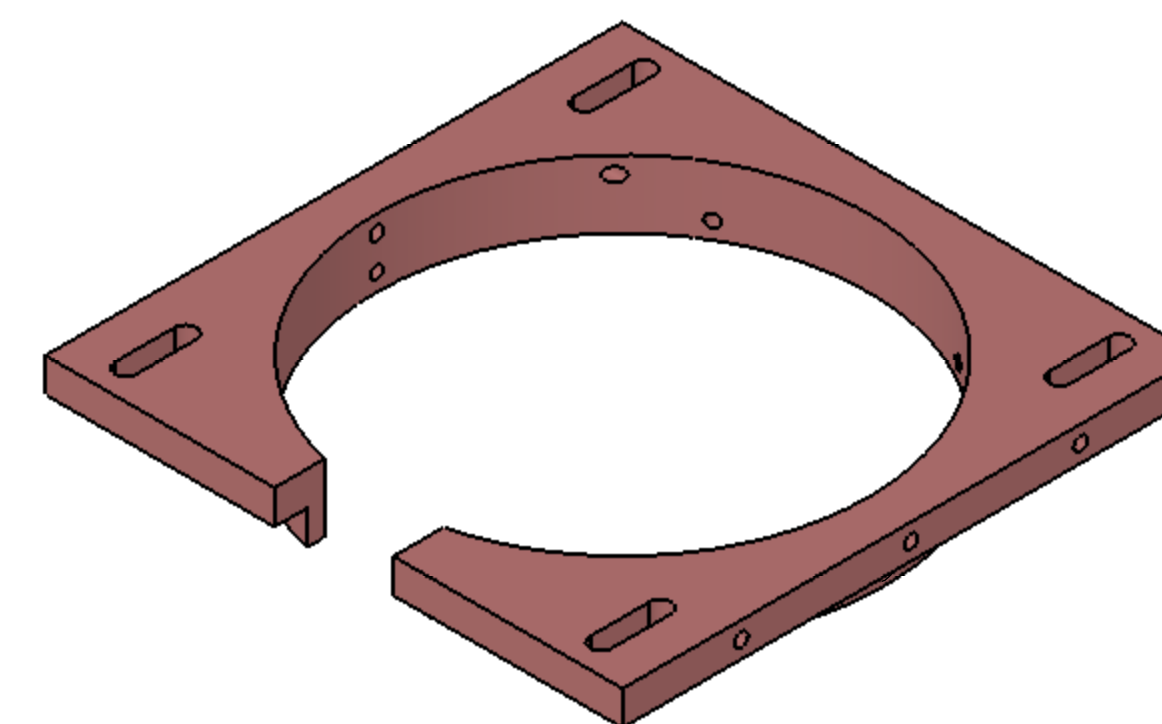
8. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.

9. ALL 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.

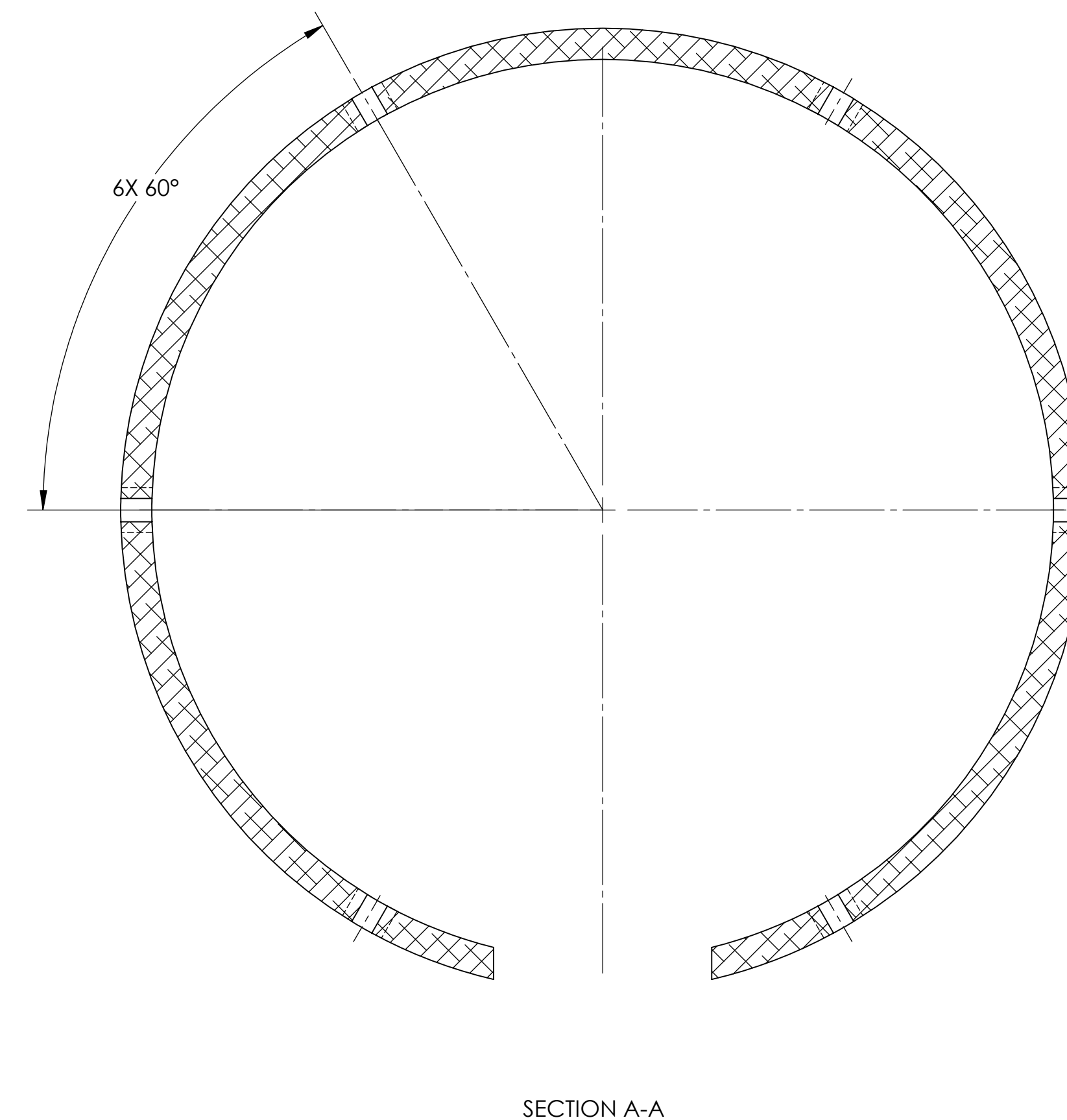
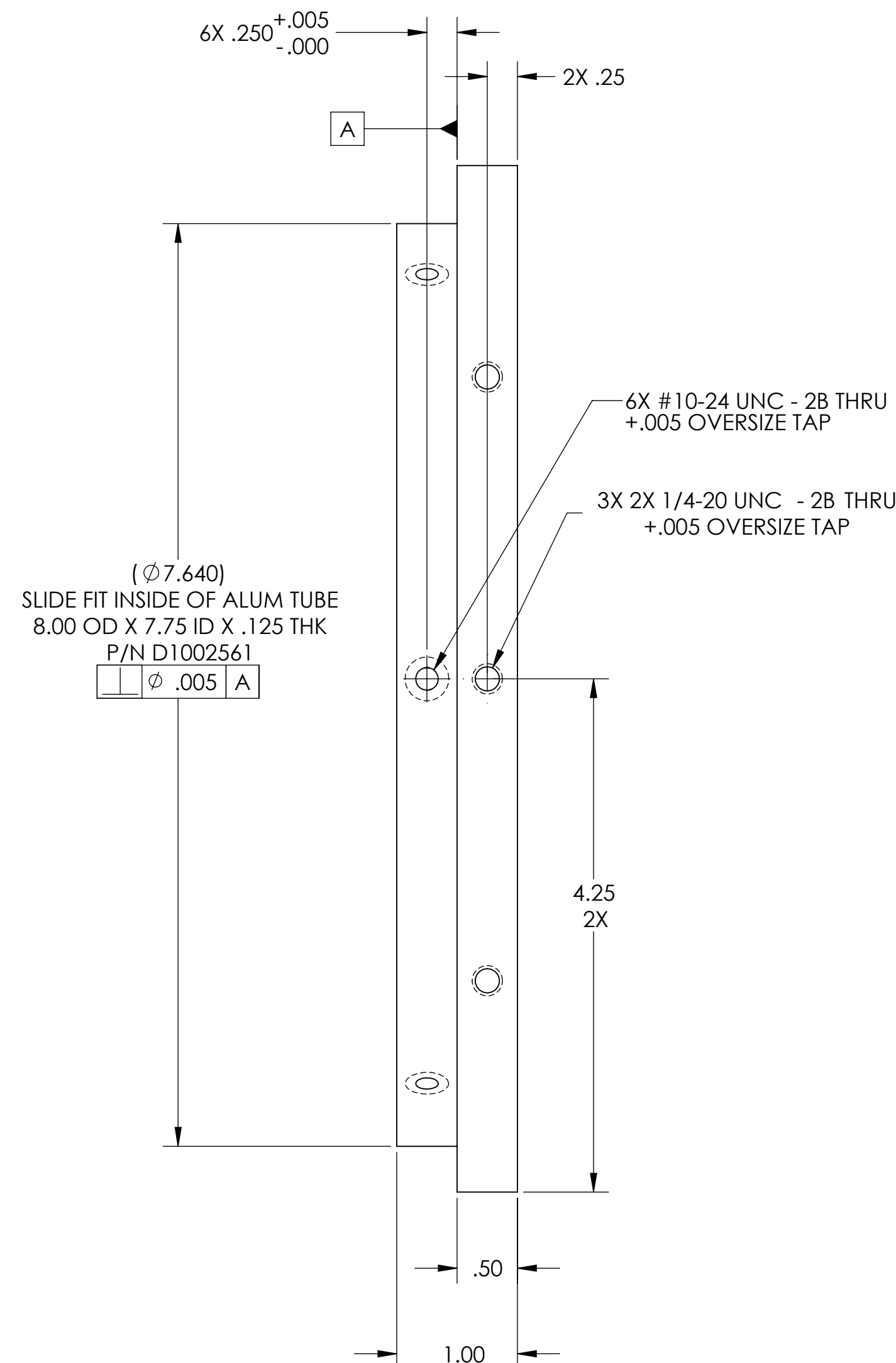


DETAIL B
SCALE 2 : 1
4X

REV.	DATE	DCN #	DRAWING TREE #
v1	03 JUN 2010	E1000285	



FOR REFERENCE VIEW ONLY
NO SCALE



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES

TOLERANCES:
.XX ± .01
.XXX ± .005

ANGULAR ± .5°

LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

SYSTEM: ADVANCED LIGO SUB-SYSTEM: AOS

NEXT ASSY: D1002563

PART NAME: SLC DAMPING TUBE TOP PLATE

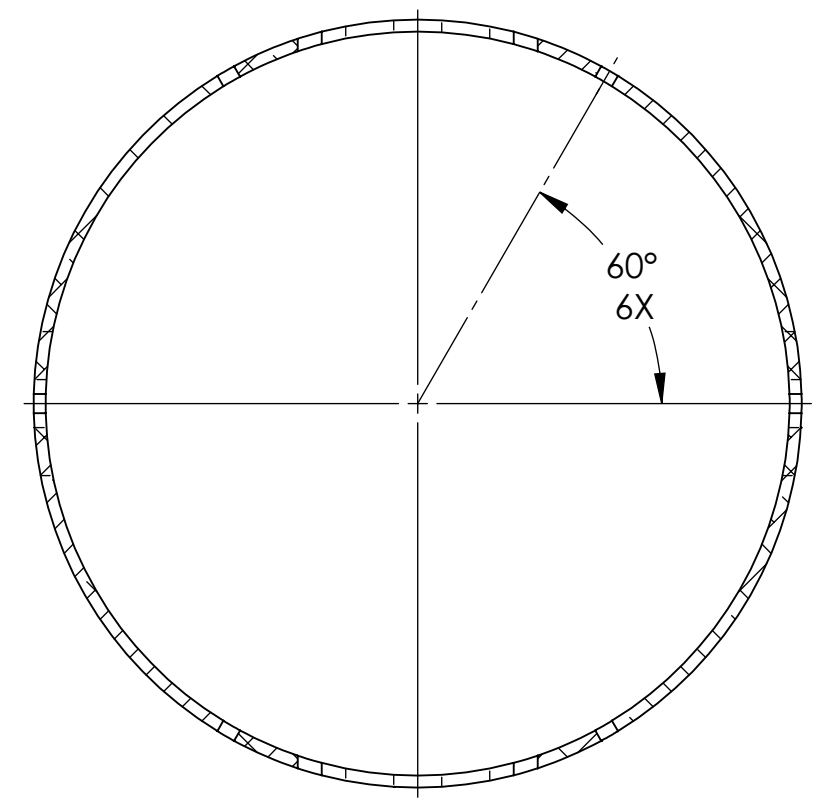
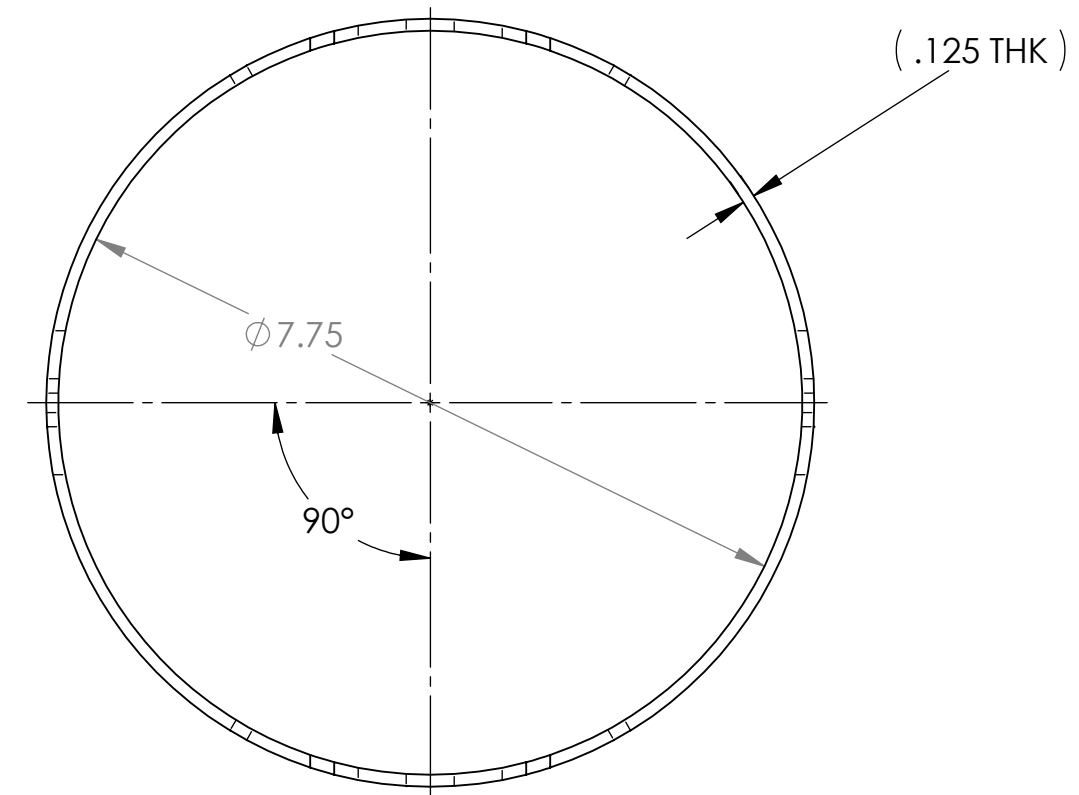
DESIGNER	DATE	SIZE	DWG. NO.	REV.
N.Nguyen	01 Jun 2010	D	D1002560	v1
TG. NGUYEN	21 MAY 2010			
M. SMITH	01 NOV 2010			
D. COYNE	10 NOV 2010			

SCALE: 1:1 PROJECTION: SHEET 1 OF 1

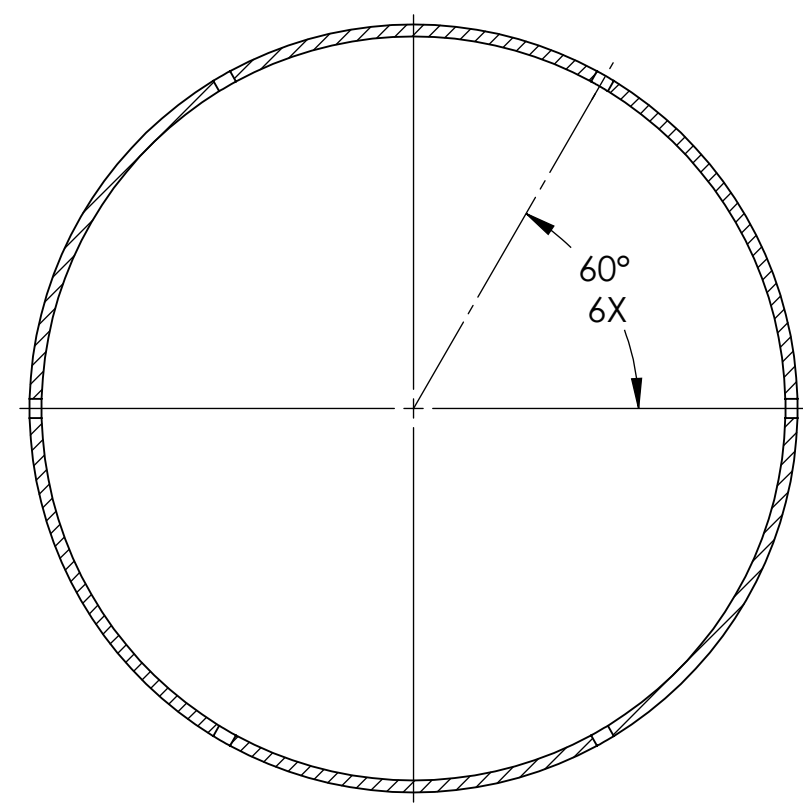
D1002560_AudiGO_AOS_SLC Damping Tube Top Plate_PART PDM REV: X.010_DRAWING PDM REV: X.008

- NOTES: UNLESS OTHERWISE SPECIFIED**
- INTERPRET DRAWING PER ASME Y14.5-1994.
 - REMOVE ALL SHARP EDGES 0.005" TO 0.015".
 - DO NOT SCALE FROM DRAWING.
 - ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.
 - 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
 - APPROXIMATE WEIGHT = 4.713 LB.
 - ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.
 - 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.
 - ELECTROPOLISHING PER E0900364, SECTION 5.1, TO REMOVE ALL SURFACE OXIDES AND POTENTIALLY EMBEDDED CONTAMINANTS.
 - SUGGESTING RESOURCE:
COAST ALUMINUM AND ARCM
P/N 818TB61
PHONE: 800-810-6061
FAX: 56-946-4188

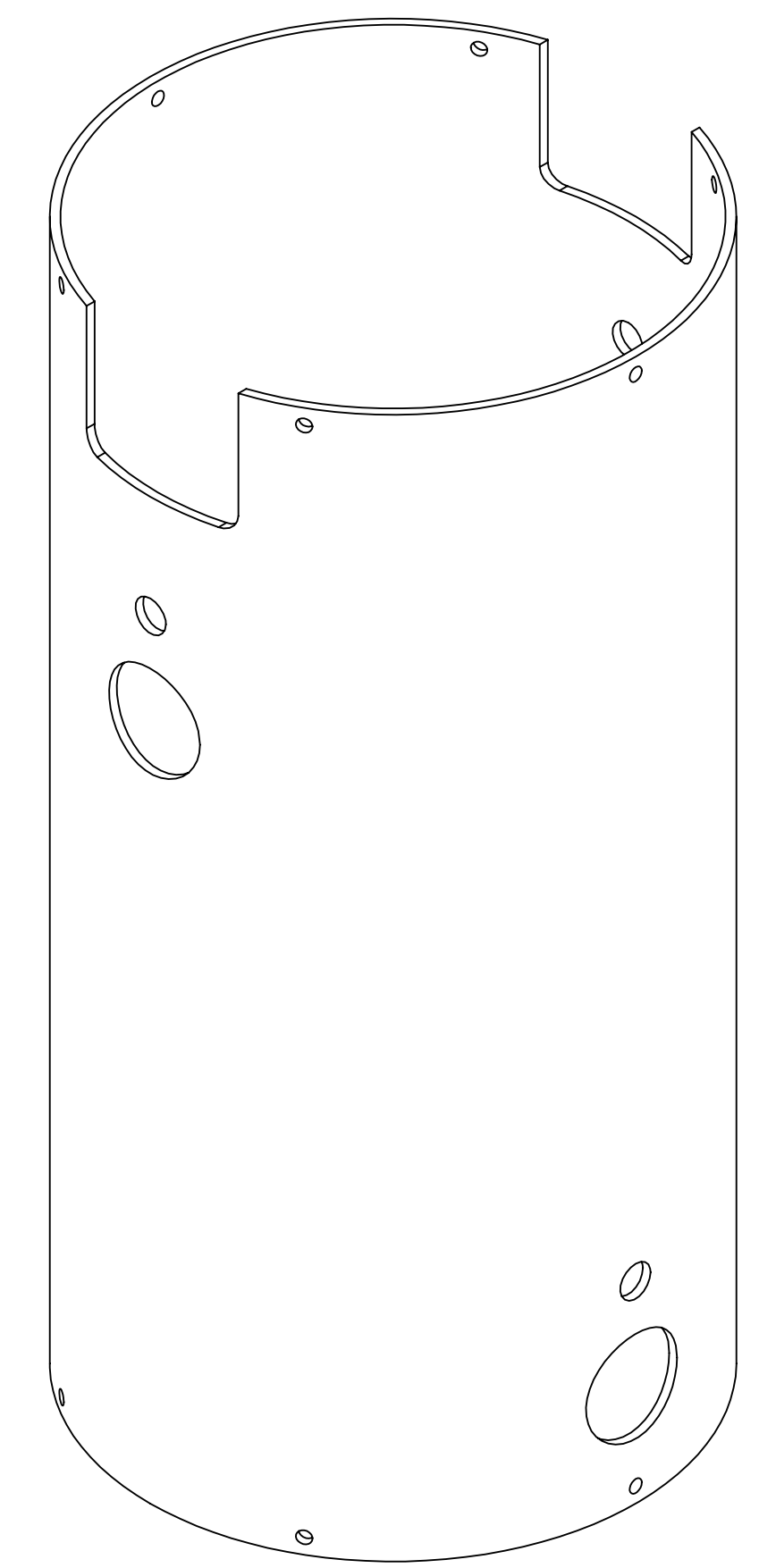
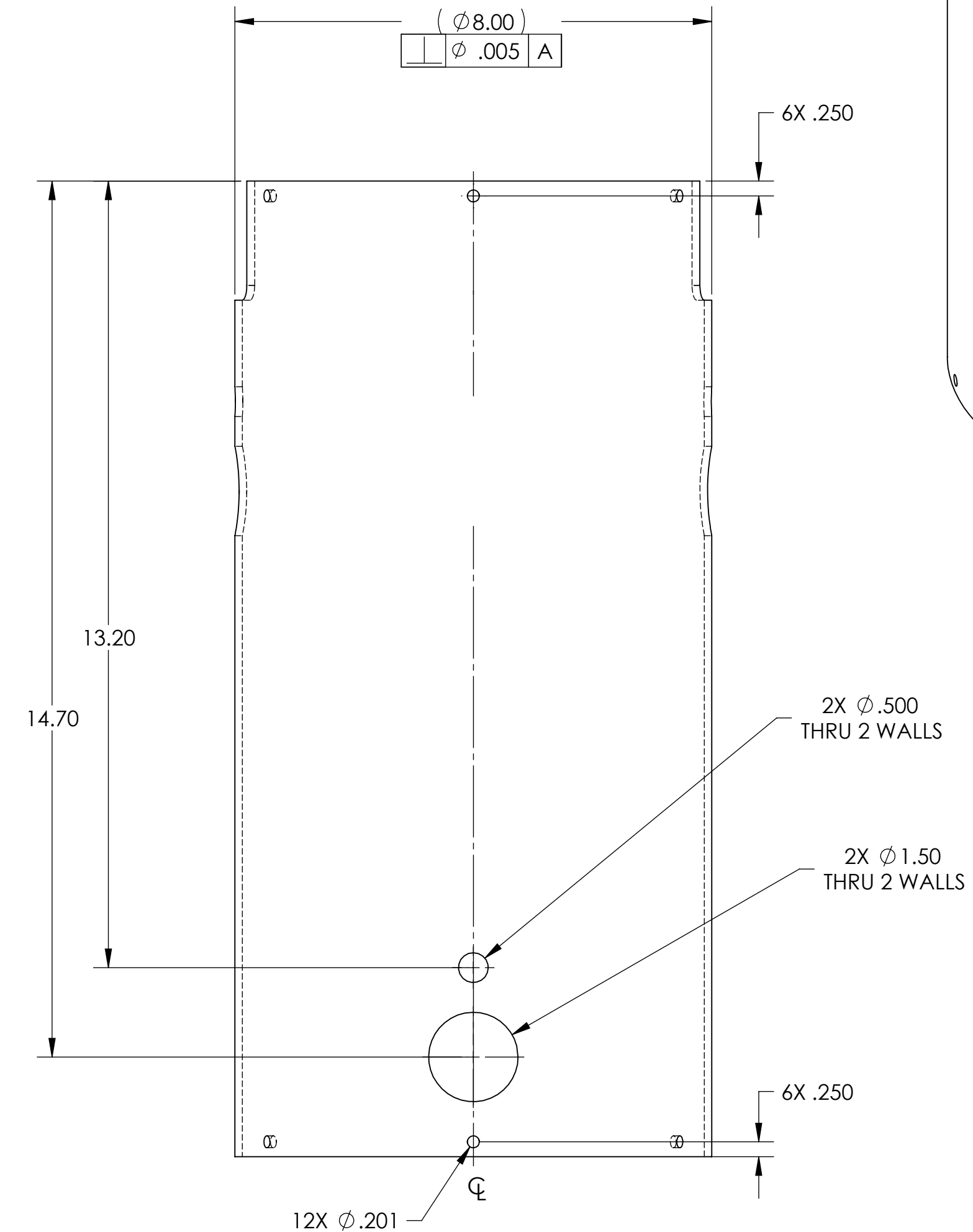
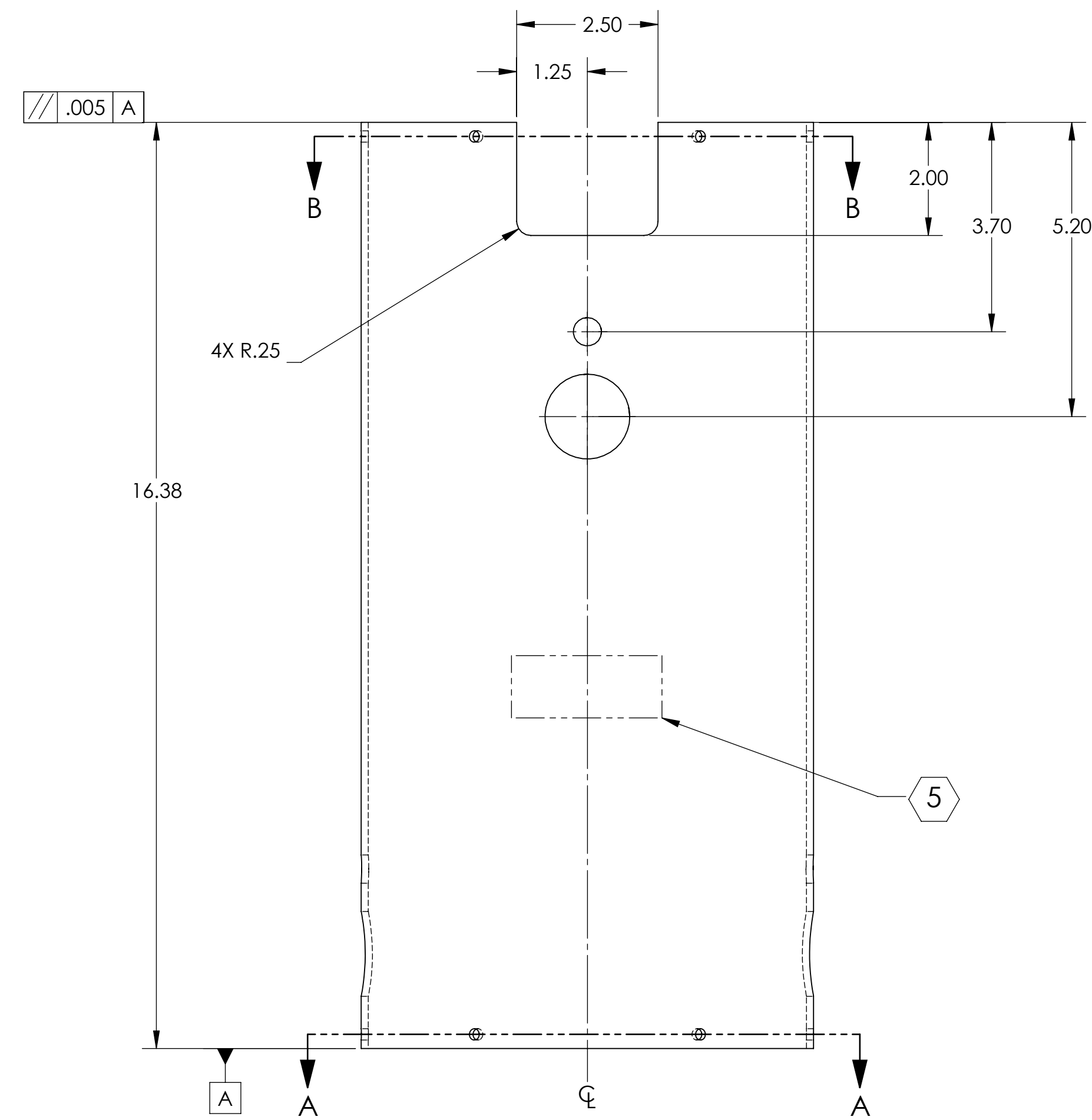
REV.	DATE	DCN #	DRAWING TREE #
v1	03 JUN 2010	E1000285	-
-	-	-	-
-	-	-	-



SECTION B-B



SECTION A-A



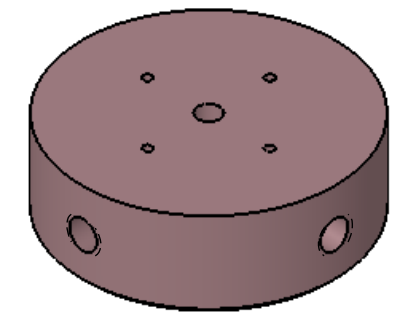
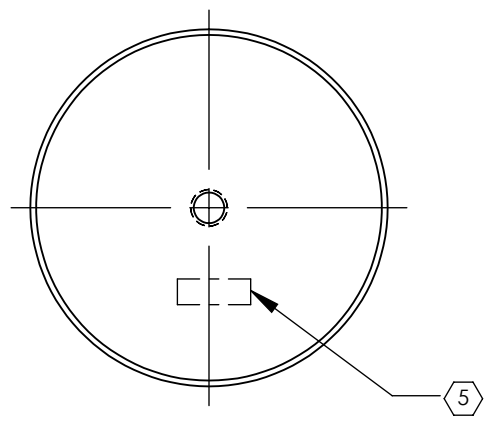
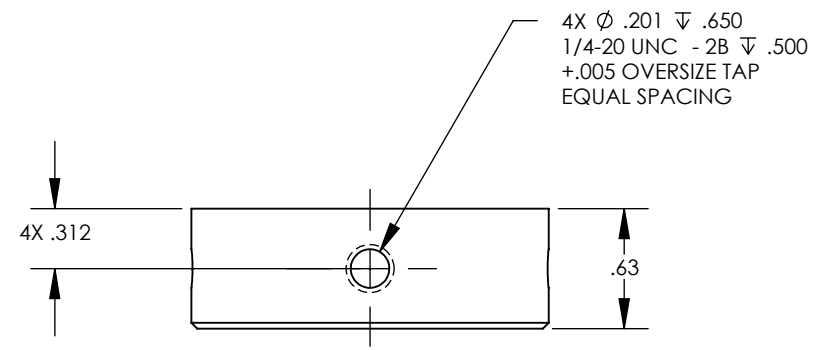
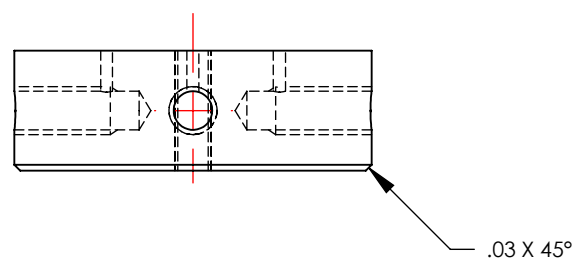
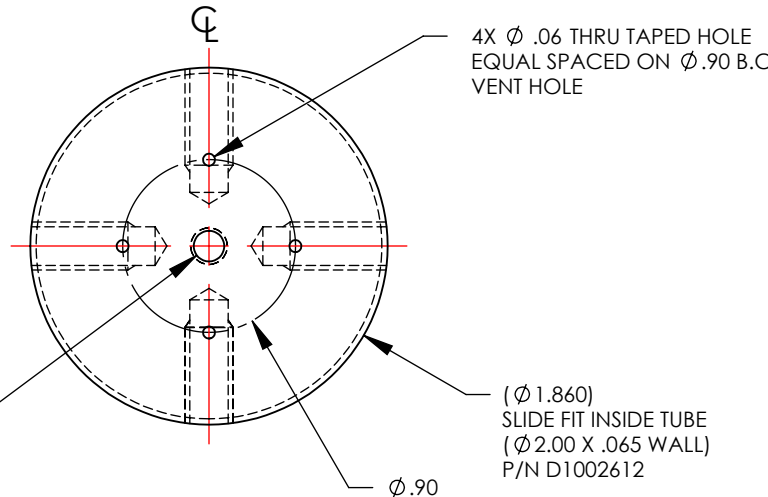
FOR REFERENCE ONLY
NO SCALE

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY				PART NAME					
DIMENSIONS ARE IN INCHES								SLC DAMPING 8 DIA TUBE					
TOLERANCES: .XX ± .01 .XXX ± .005 ANGULAR ± 1.0°								SYSTEM ADVANCED LIGO		SUB-SYSTEM AOS		DESIGNER N.Nguyen	01 Jul 2010
MATERIAL 6061-T6 Al				FINISH 63 μinch		NEXT ASSY D1002563		CHECKER M. SMITH	01 NOV 2010	SCALE: 1:2		PROJECTION:	SHEET 1 OF 1
				APPROVAL D. COYNE		10 NOV 2010							

NOTES: UNLESS OTHERWISE SPECIFIED

1. INTERPRET DRAWING PER ASME Y14.5-1994.
2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".
3. DO NOT SCALE FROM DRAWING.
4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.
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 = 0.156 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 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	02 JUNE 2010	E1000285	



ISO VIEW

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES

TOLERANCES:
 .XX ± .01
 .XXX ± .005
 ANGULAR ± 1.0°

MATERIAL	6061-T6 Al	FINISH	63 μinch
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LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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

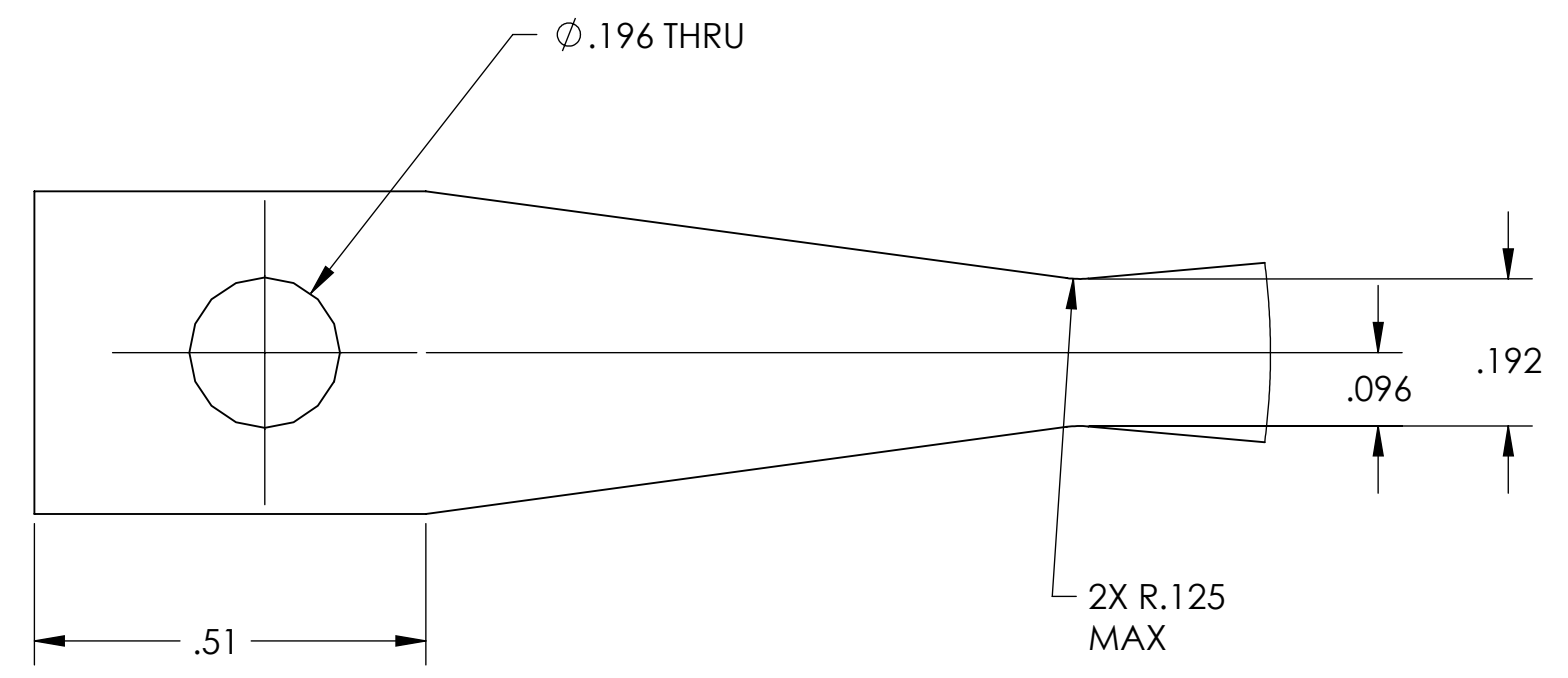
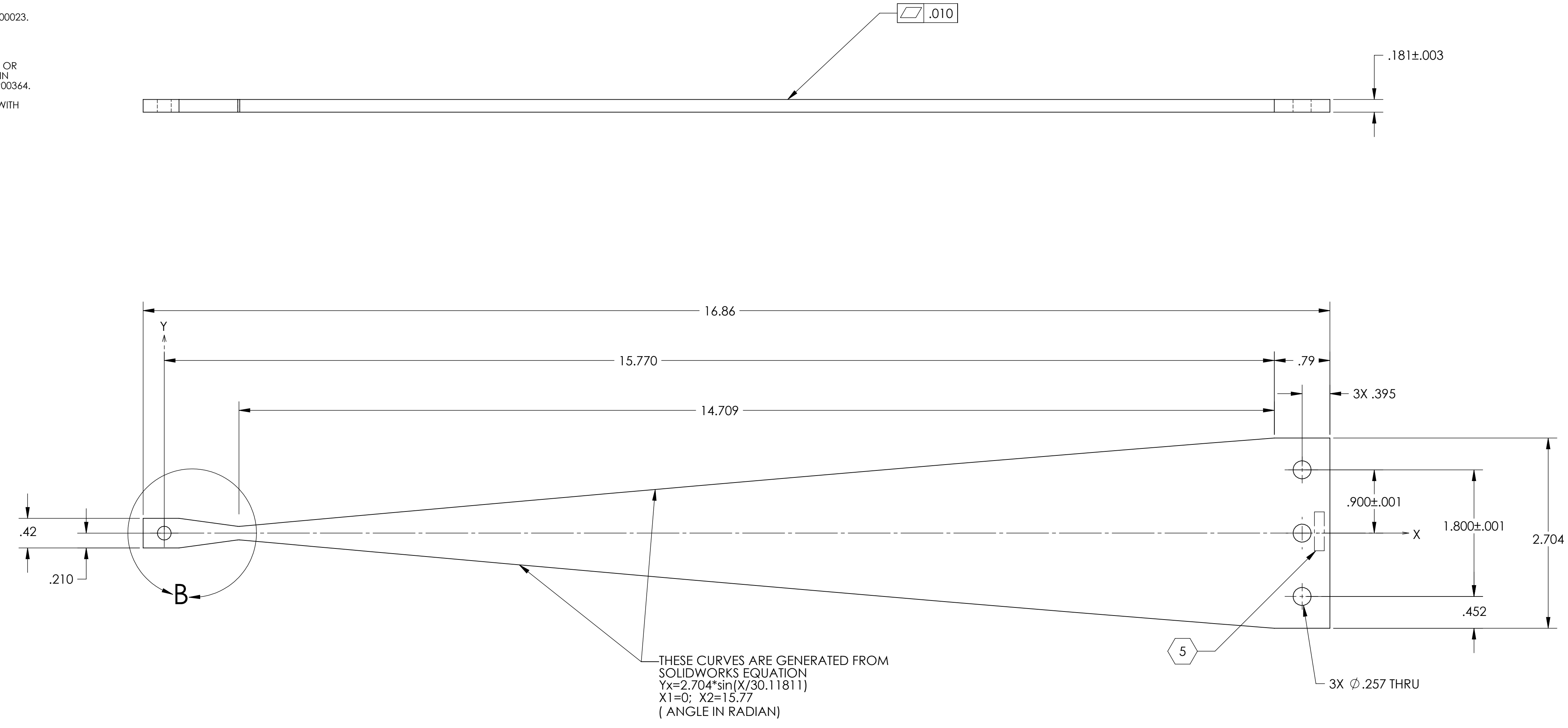
NEXT ASSY: **D1002582**

PART NAME SLC SUSPENSION ROD SUPPORT			
DESIGNER	N.Nguyen	01 Jun 2010	SIZE DWG. NO.
DRAFTER	TQ. NGUYEN	24 MAY 2010	B
CHECKER	M. SMITH	01 NOV 2010	D1002581
APPROVAL	D. COYNE	10 NOV 2010	REV. v1
SCALE: 1:1		PROJECTION:	
SHEET 1 OF 1			

D1002581_AdlLIGO_AOS_SLC Suspension Rod Support, PART PDM REV: X-004, DRAWING PDM REV: X-005

- NOTES: UNLESS OTHERWISE SPECIFIED**
1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.
 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 = 1.27 LB.
 7. MACHINE ALL SURFACES TO REMOVE OXIDES AND MILL FINISH, USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED. REFER TO LIGO-E0900023.
 8. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900023.
 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. PART TO BE MANUFACTURED, TREATED AND PLATED IN ACCORDANCE WITH LIGO SPECIFICATION E0900023.

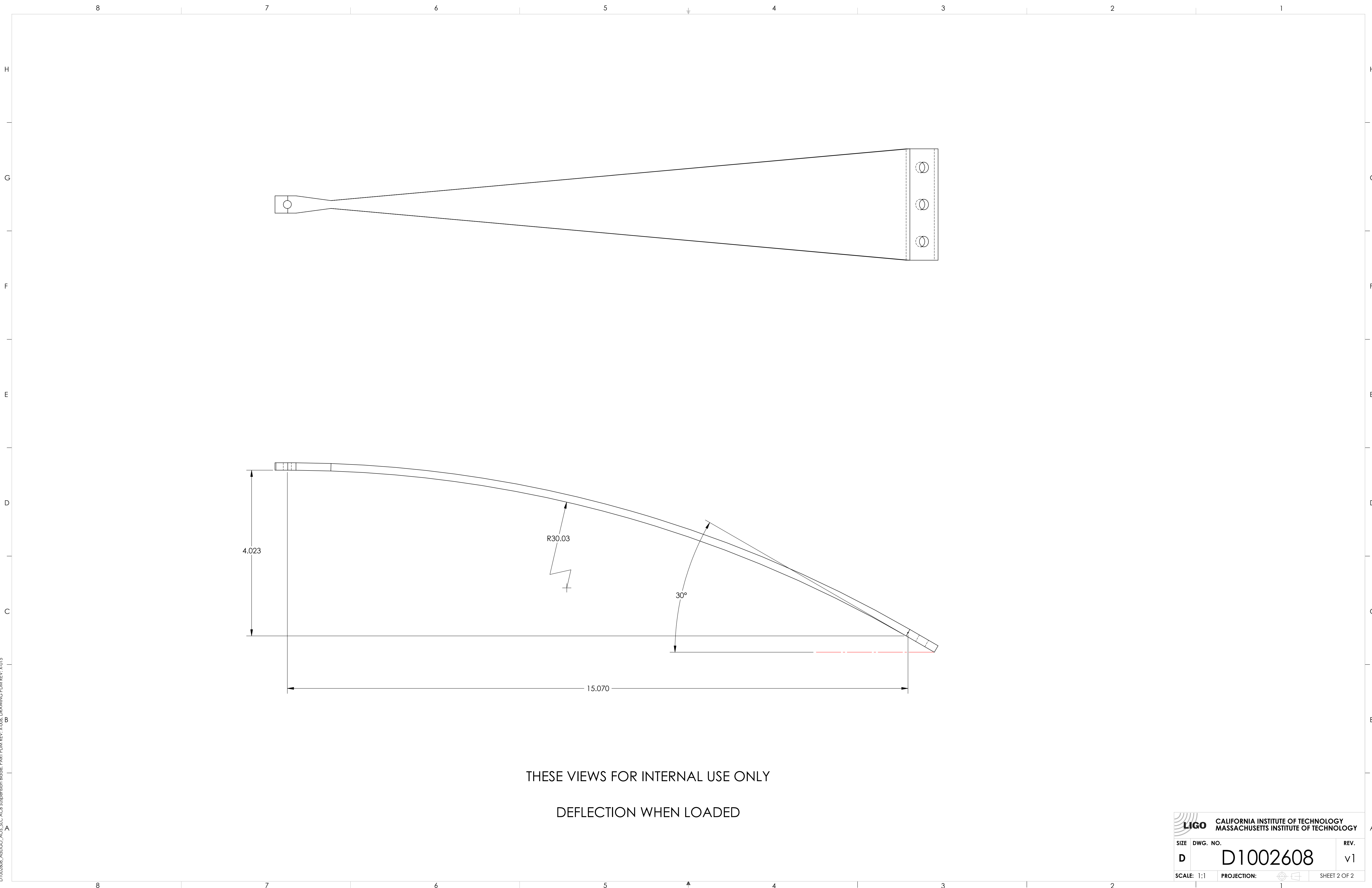
REV.	DATE	DCN #	DRAWING TREE #
v1	22 JUL 2010	E1000285	



**DETAIL B
SCALE 4 : 1**


NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME						
DIMENSIONS ARE IN INCHES						SLC ACB SUSPENSION BLADE						
TOLERANCES: .XX ± .01 .XXX ± .005 ANGULAR ± 1.0°						SYSTEM ADVANCED LIGO	SUB-SYSTEM AOS	DESIGNER N.Nguyen	DATE 01 Jun 2010	SIZE D	DWG. NO. D1002608	REV. v1
MATERIAL MARAGING STEEL C250				FINISH 63 μinch		NEXT ASSY D1001005		CHECKER M. SMITH	DATE 01 NOV 2010	SCALE: 1:1	PROJECTION:	SHEET 1 OF 2
						APPROVAL D. COYNE		DATE 20 NOV 2010				

D1002608_AutLIGO_AOS_SLC ACB Suspension Blade: PART PDM REV: X-004, DRAWING PDM REV: X-015



THESE VIEWS FOR INTERNAL USE ONLY

DEFLECTION WHEN LOADED

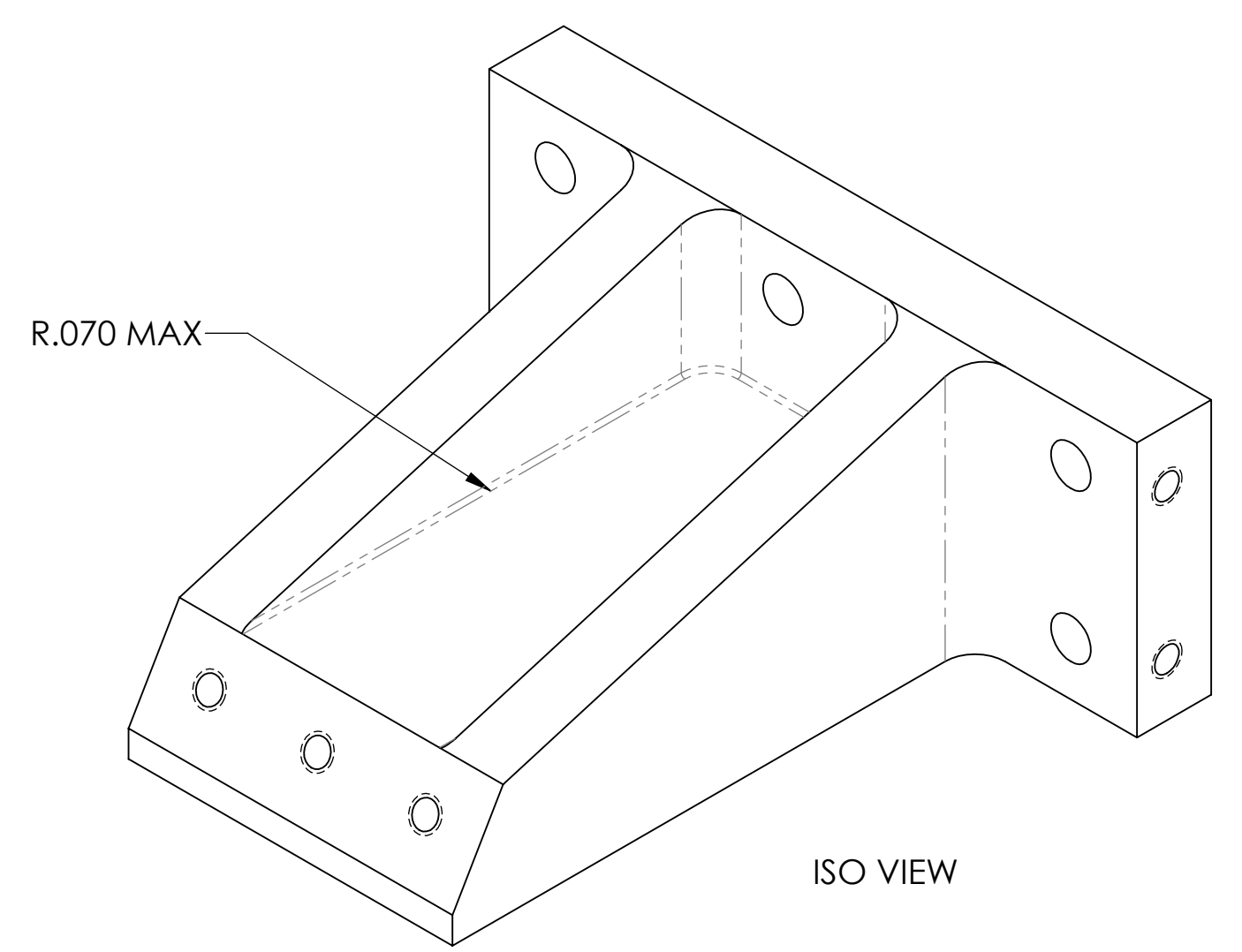
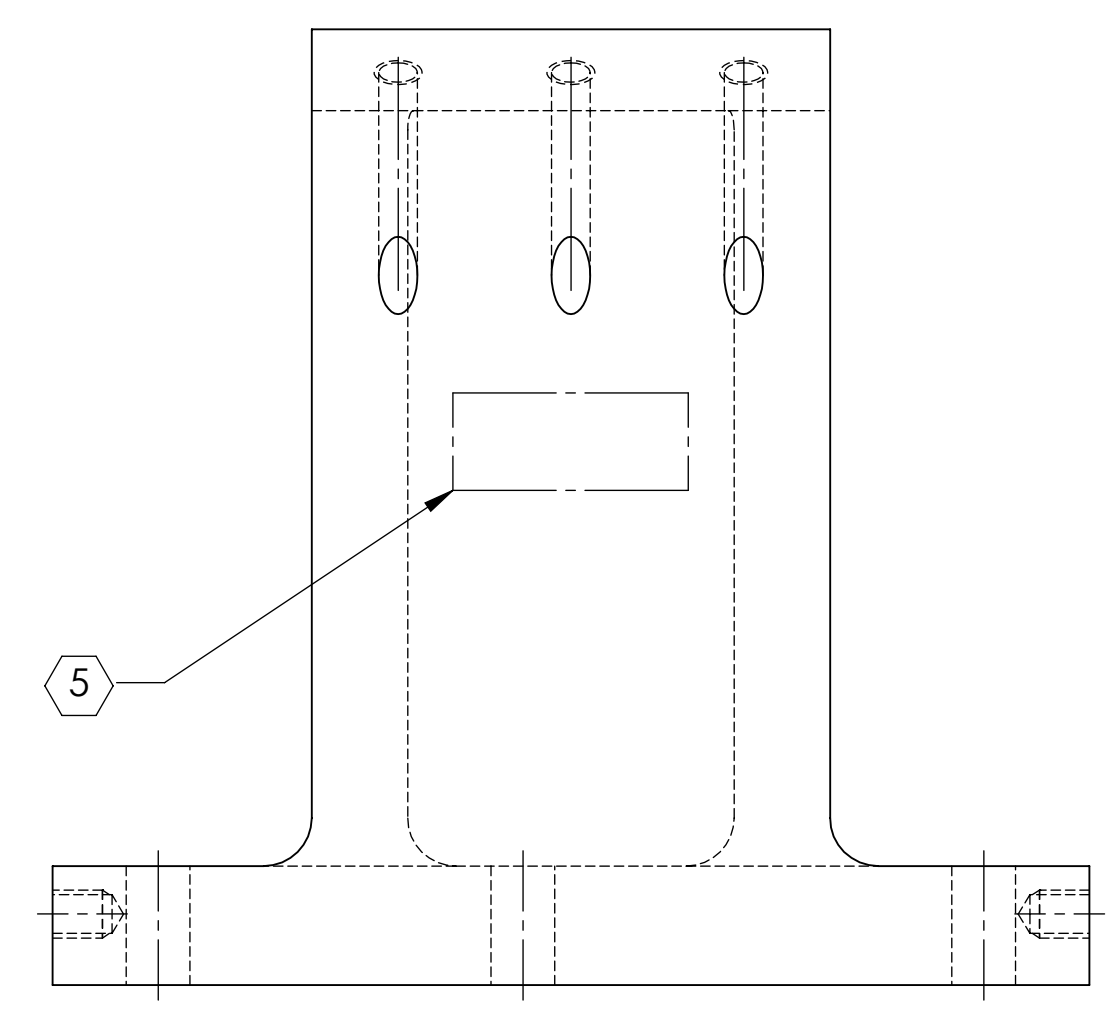
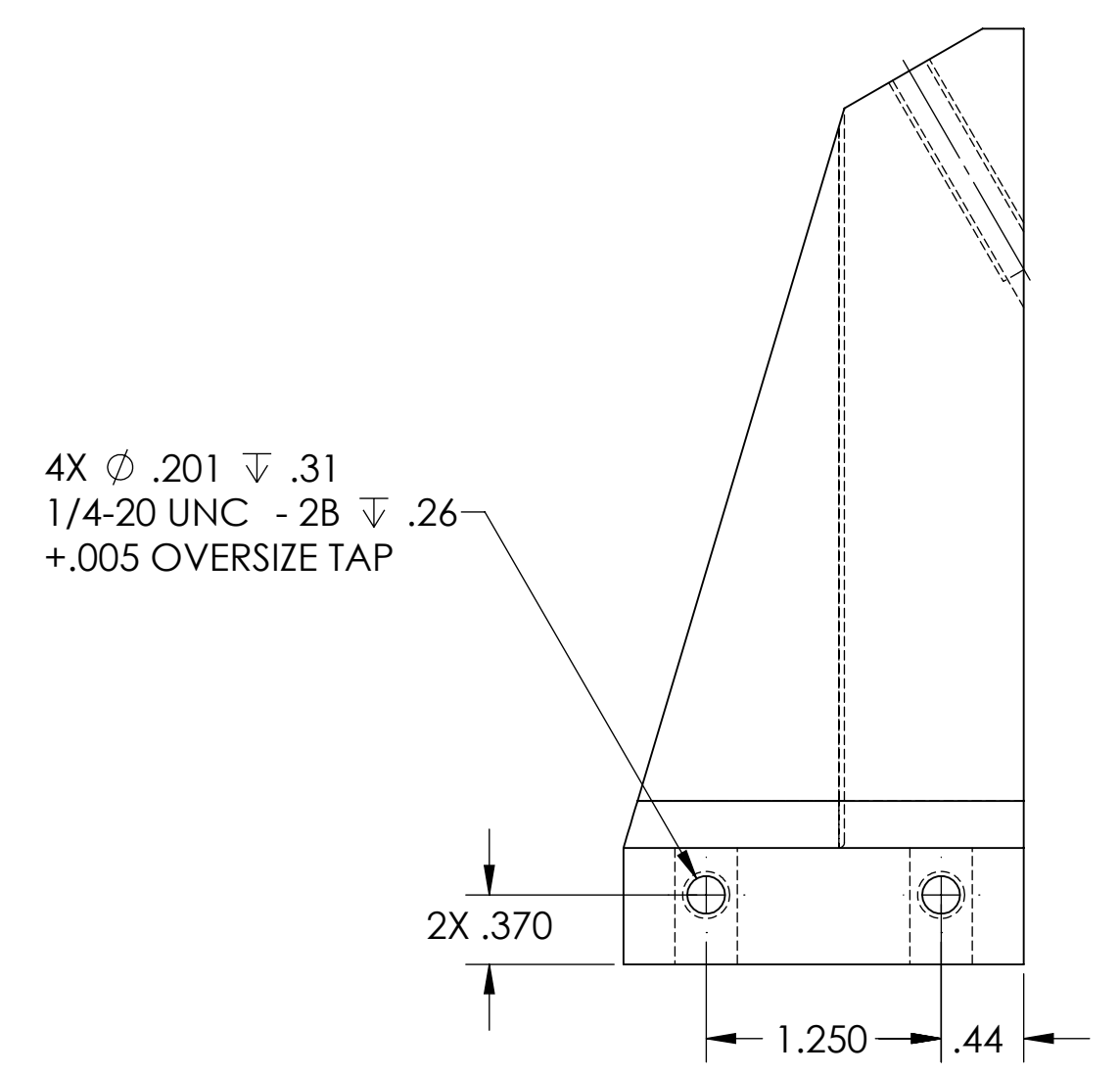
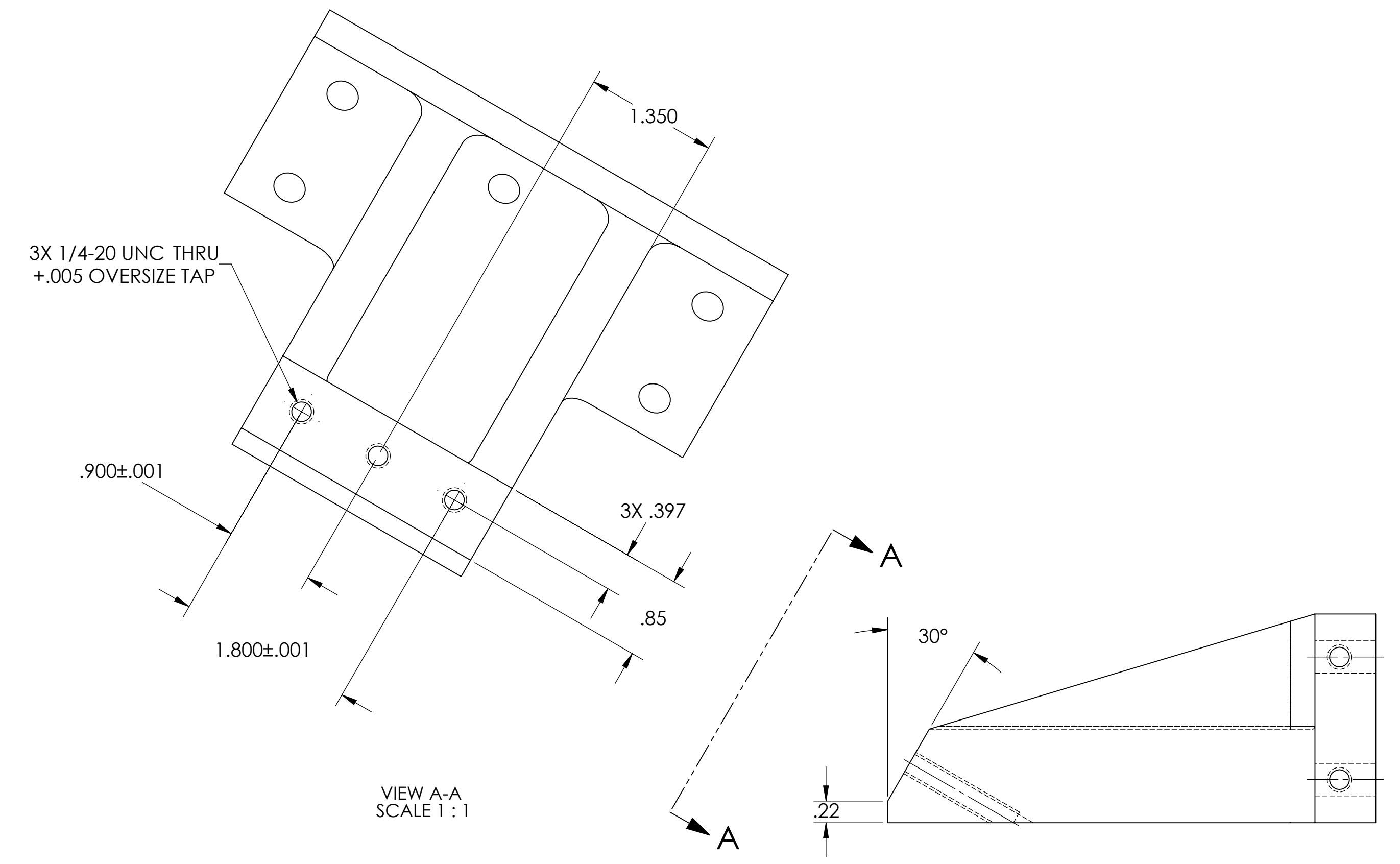
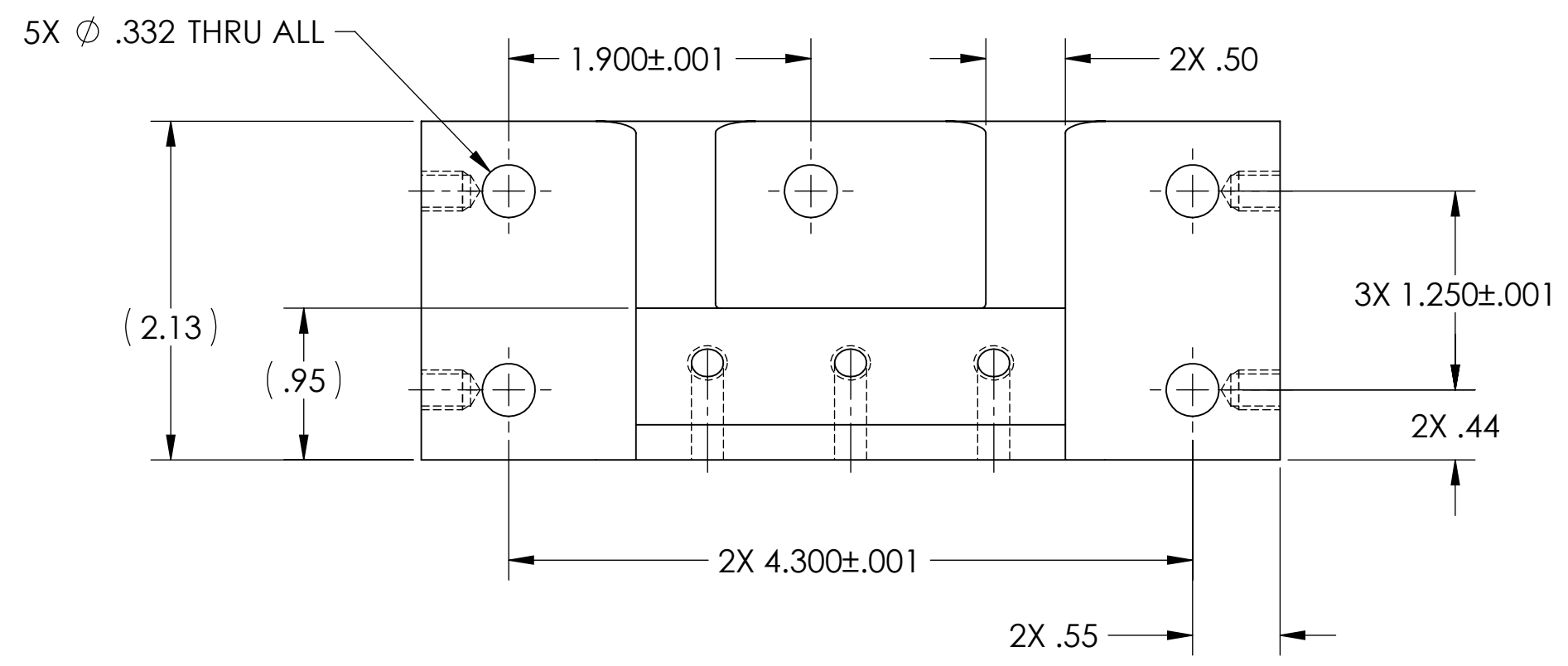
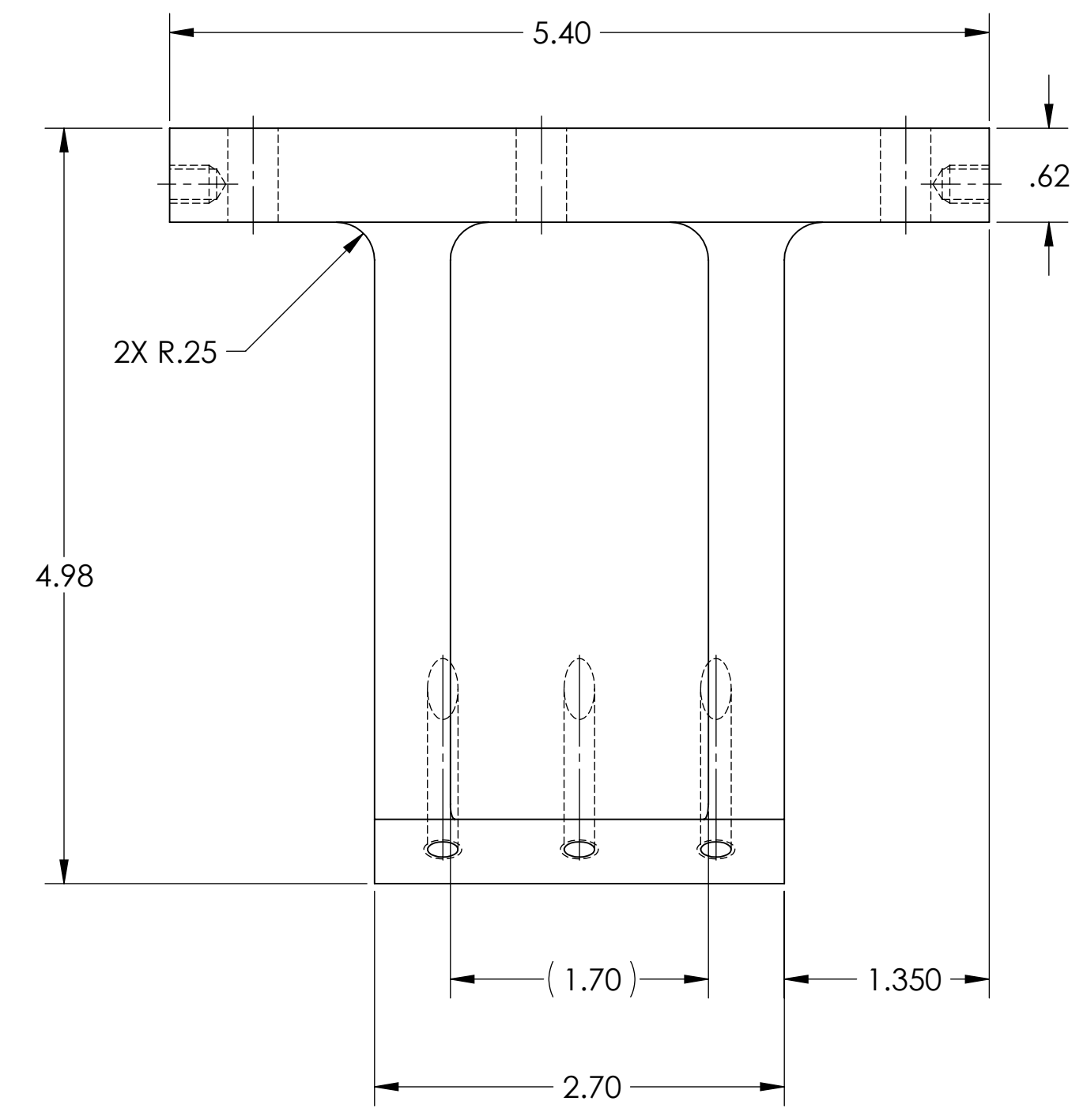
 CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		REV.
SIZE	DWG. NO.	REV.
D	D1002608	v1
SCALE: 1:1	PROJECTION:	SHEET 2 OF 2

D:\002608_Adu\GO_ACS_Suspension Blade_PART PDM REV.X-004_DRAWING PDM REV.X-015

D:\002609_Audi\GO_AOS_SLC Blade Mounting Bracket_PART PDM REV: X.008 DRAWING PDM REV: X.015

- NOTES: UNLESS OTHERWISE SPECIFIED**
1. INTERPRET DRAWING PER ASME Y14.5-1994.
 2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".
 3. DO NOT SCALE FROM DRAWING.
 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.
 5. SCRIBE, ENGRAVE, OR MECHANICALLY STAMP (NO INKS OR DYES) DRAWING PART NUMBER, REVISION (AND VARIANT OR "TYPE" IF APPLICABLE) ON NOTED SURFACE OF PART FOLLOWED 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. A VIBRATORY TOOL MAY BE USED.
EXAMPLE: DXXXXXX-VY, TYPE-XX, S/N XXX
 6. APPROXIMATE WEIGHT = 5.783 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 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	10 SEP 2010	D1000285	



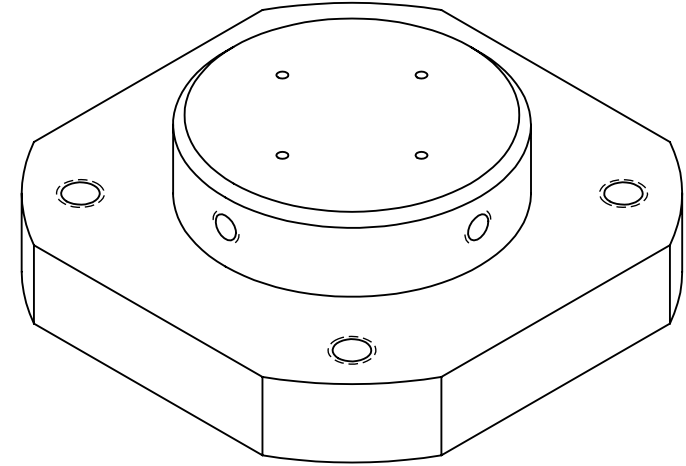
NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME									
DIMENSIONS ARE IN INCHES						SLC BLADE MOUNTING BRACKET									
TOLERANCES: .XX ± .01 .XXX ± .005						SYSTEM	ADVANCED LIGO	SUB-SYSTEM	AOS	DESIGNER	N.Nguyen	01 Jun 2010	SIZE	DWG. NO.	REV.
ANGULAR ± 1.0°				MATERIAL	304 SSSL	FINISH	63 μinch	NEXT ASSY	D1001005	CHECKER	M. SMITH	01 NOV 2010	D	D1002609	v1
						APPROVAL	D. COYNE	20 NOV 2010	SCALE: 1:2	PROJECTION:	SHEET 1 OF 1				

8 7 6 5 4 3 2 1

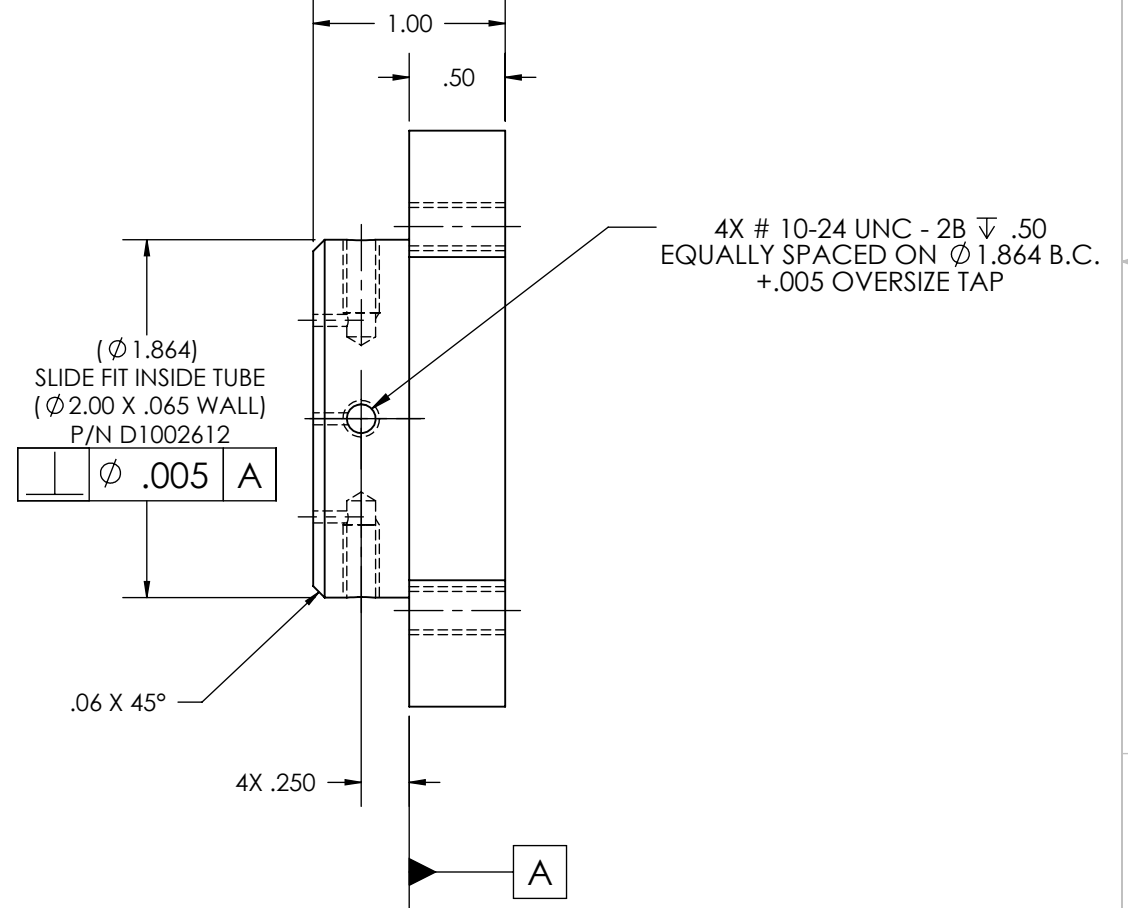
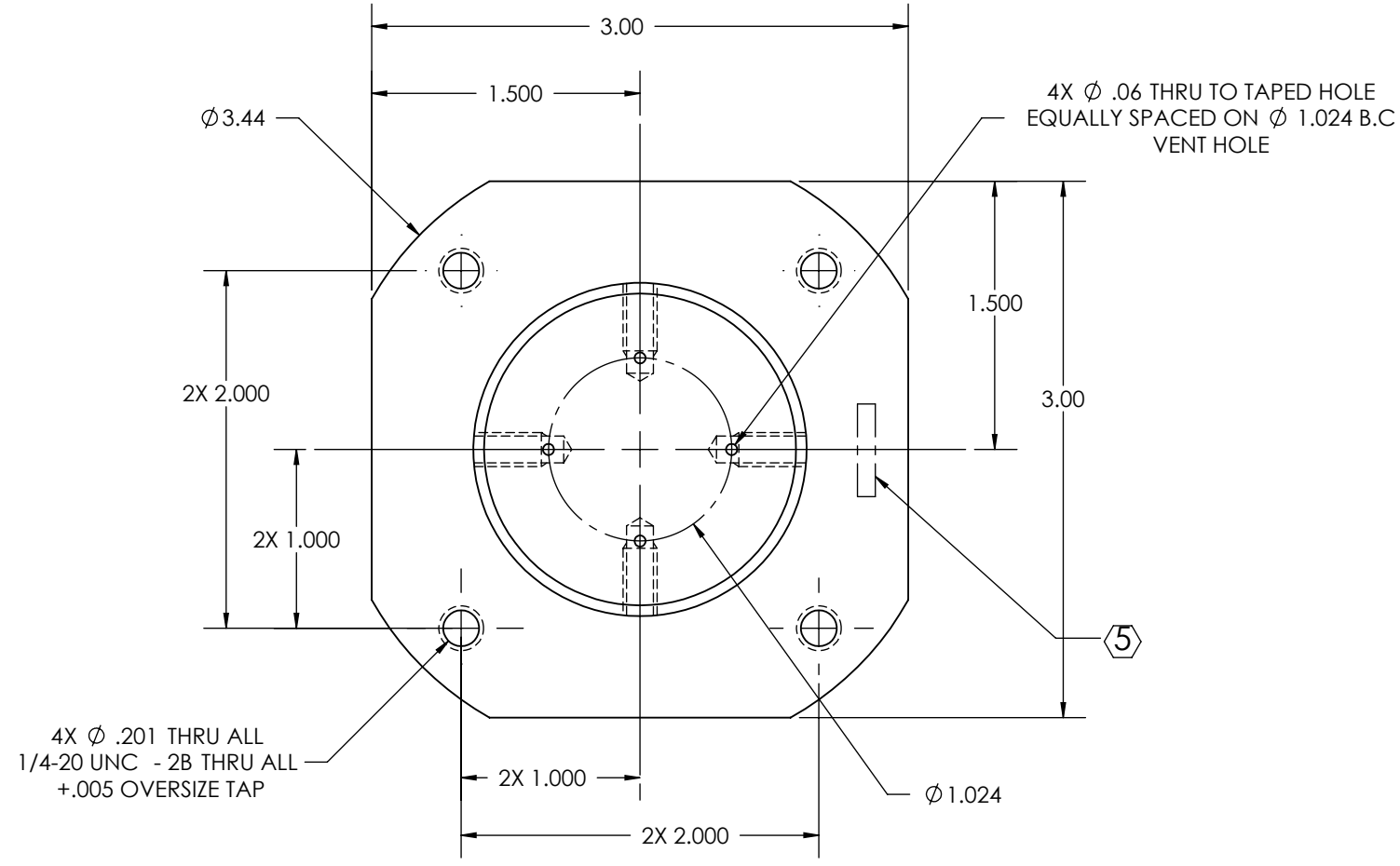
NOTES: UNLESS OTHERWISE SPECIFIED

1. INTERPRET DRAWING PER ASME Y14.5-1994.
2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".
3. DO NOT SCALE FROM DRAWING.
4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.
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 = 0.526 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 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	19 JUN 2010	E1000285	-
-	-	-	-
-	-	-	-



ISO VIEW



D1002610_AdlLIGO_AOS_SLC Tube Up Connector Plate, PART PDM REV: X-003, DRAWING PDM REV: X-007

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME	
DIMENSIONS ARE IN INCHES				ADVANCED LIGO		SLC TUBE UP CONNECTOR PLATE	
TOLERANCES: .XX ± .01 .XXX ± .005				SUB-SYSTEM AOS		DESIGNER	N.Nguyen 01 Jul 2010
ANGULAR ± 1.0°				NEXT ASSY D1002582		DRAFTER	TQ. NGUYEN 19 JUL 2010
MATERIAL	6061-T6 Al	FINISH	63 µinch	CHECKER	M. SMITH 19 JUL 2010	SIZE	DWG. NO. B D1002610
				APPROVAL	D. COYNE 10 SEP 2010	REV.	v1
				SCALE: 1:1		PROJECTION: SHEET 1 OF 1	

8 7 6 5 4 3 2 1

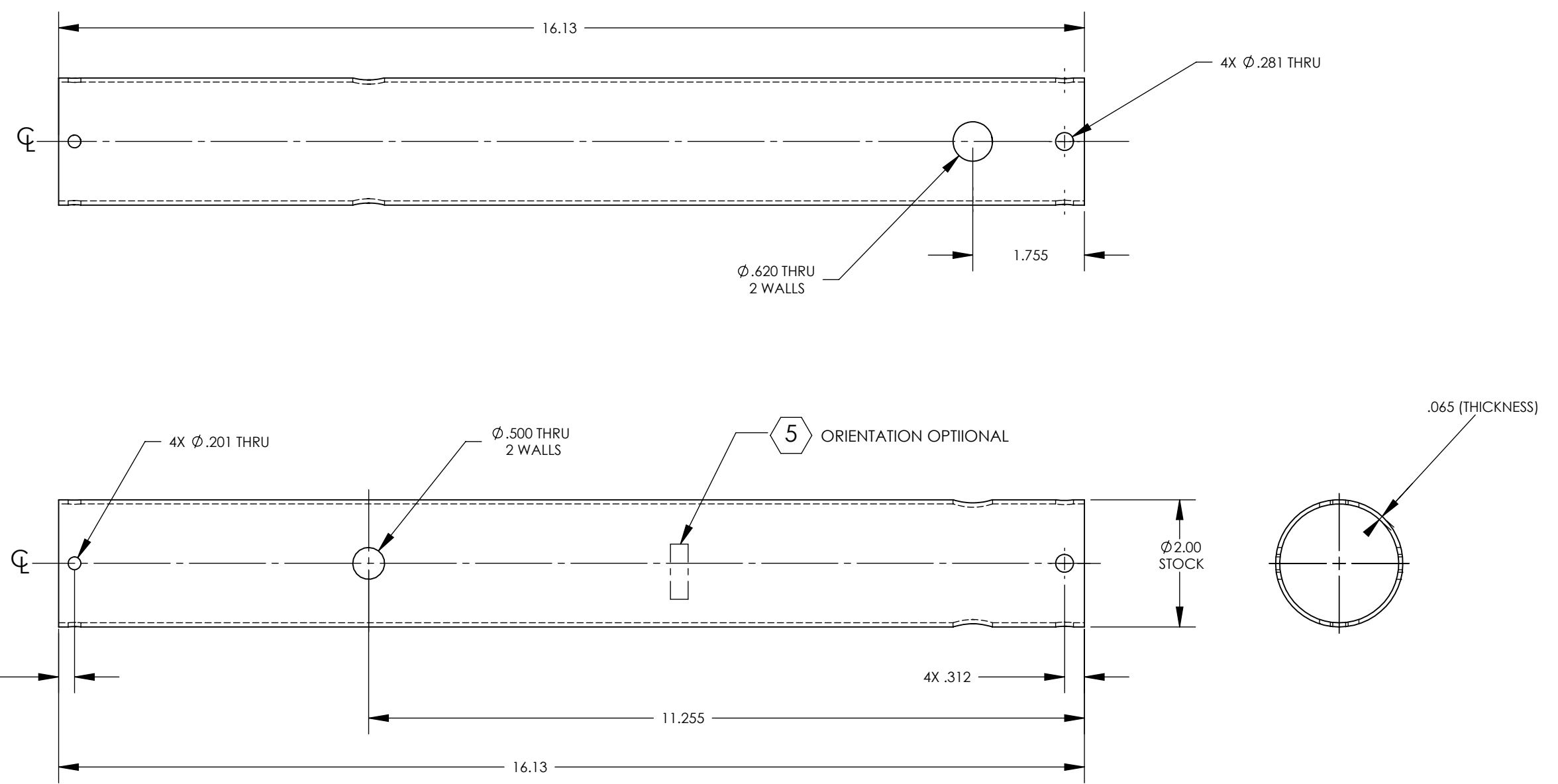
NOTES CONTINUED:

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 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=0.613 LB.
- 7. ALL PARTS SHALL BE MANUFACTURED IN ACCORDANCE WITH LIGO SPECIFICATION E0900364.
- 8. 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.
- 9. ELECTROPOLISHING PER E0900364, SECTION 5.1, TO REMOVE ALL SURFACE OXIDES AND POTENTIALLY EMBEDDED CONTAMINANTS.

REV.	DATE	DCN #	DRAWING TREE #
v1	19 JUL 2010	E1000285	

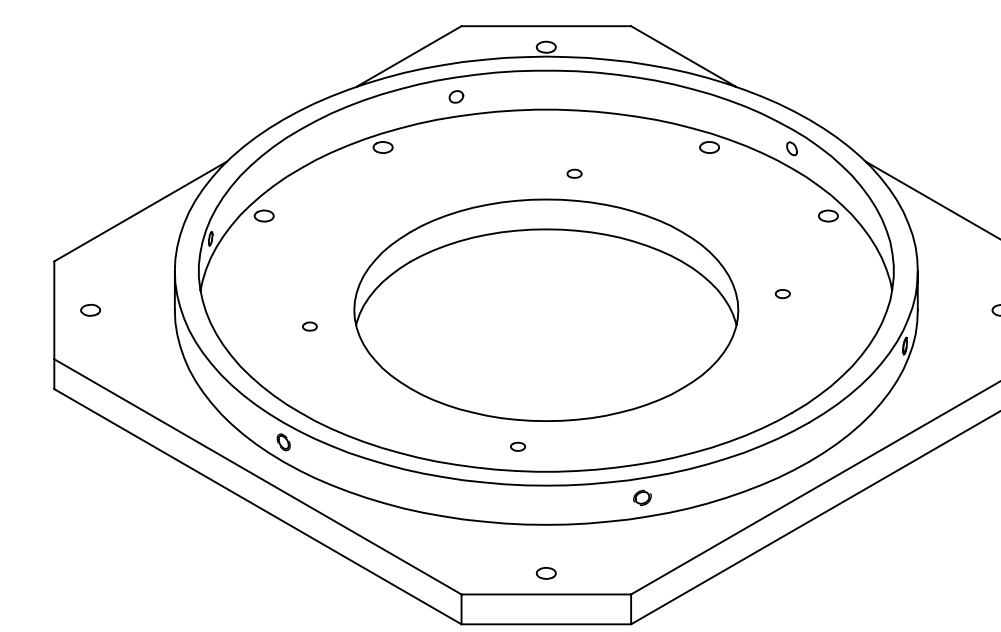
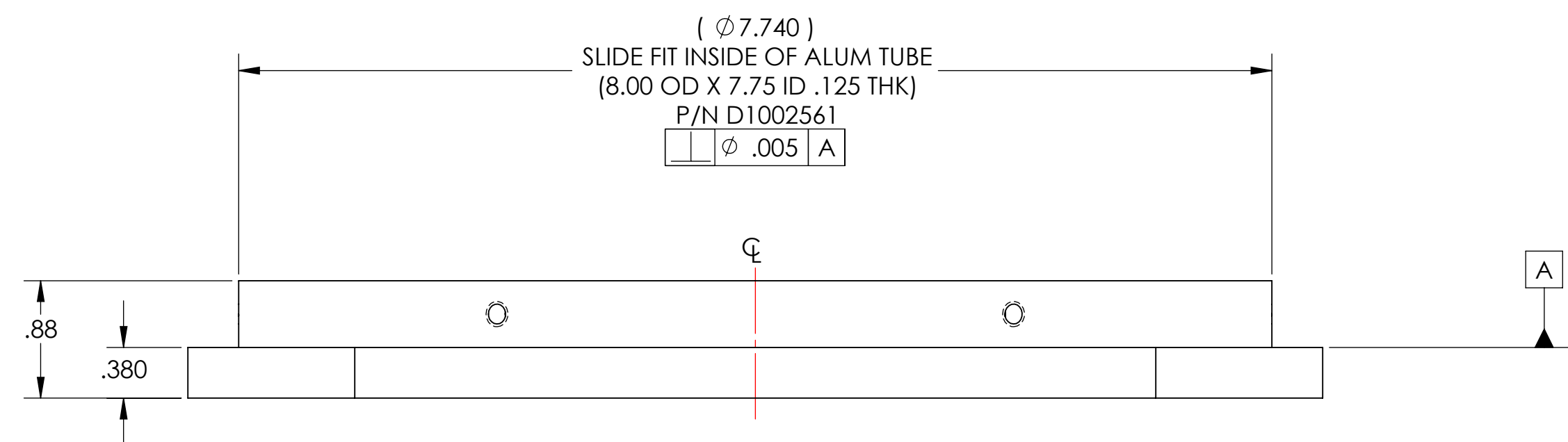


D1002612_AdlIGO_AOS_SLC_UpperTube, PART PDM REV: X-004, DRAWING PDM REV: X-012

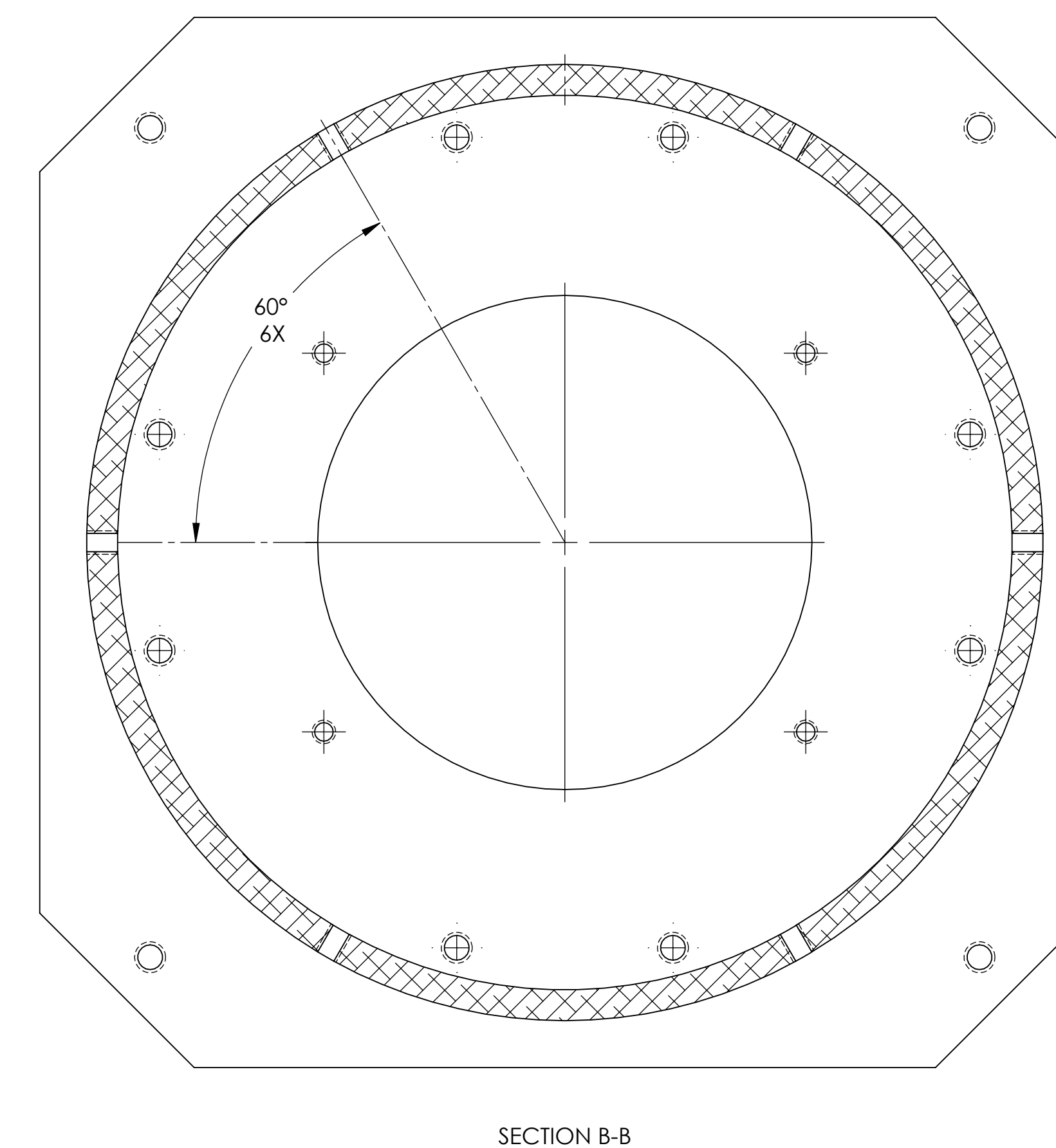
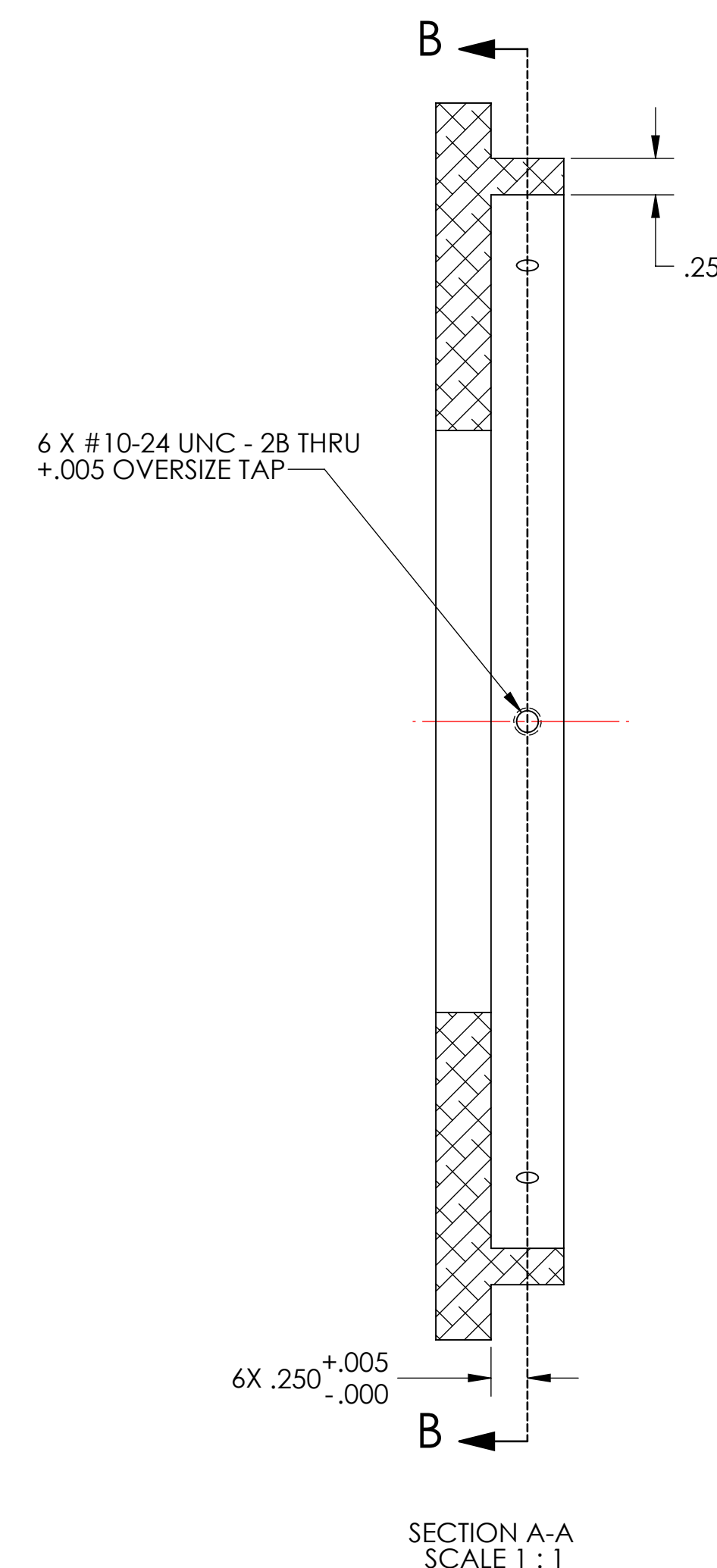
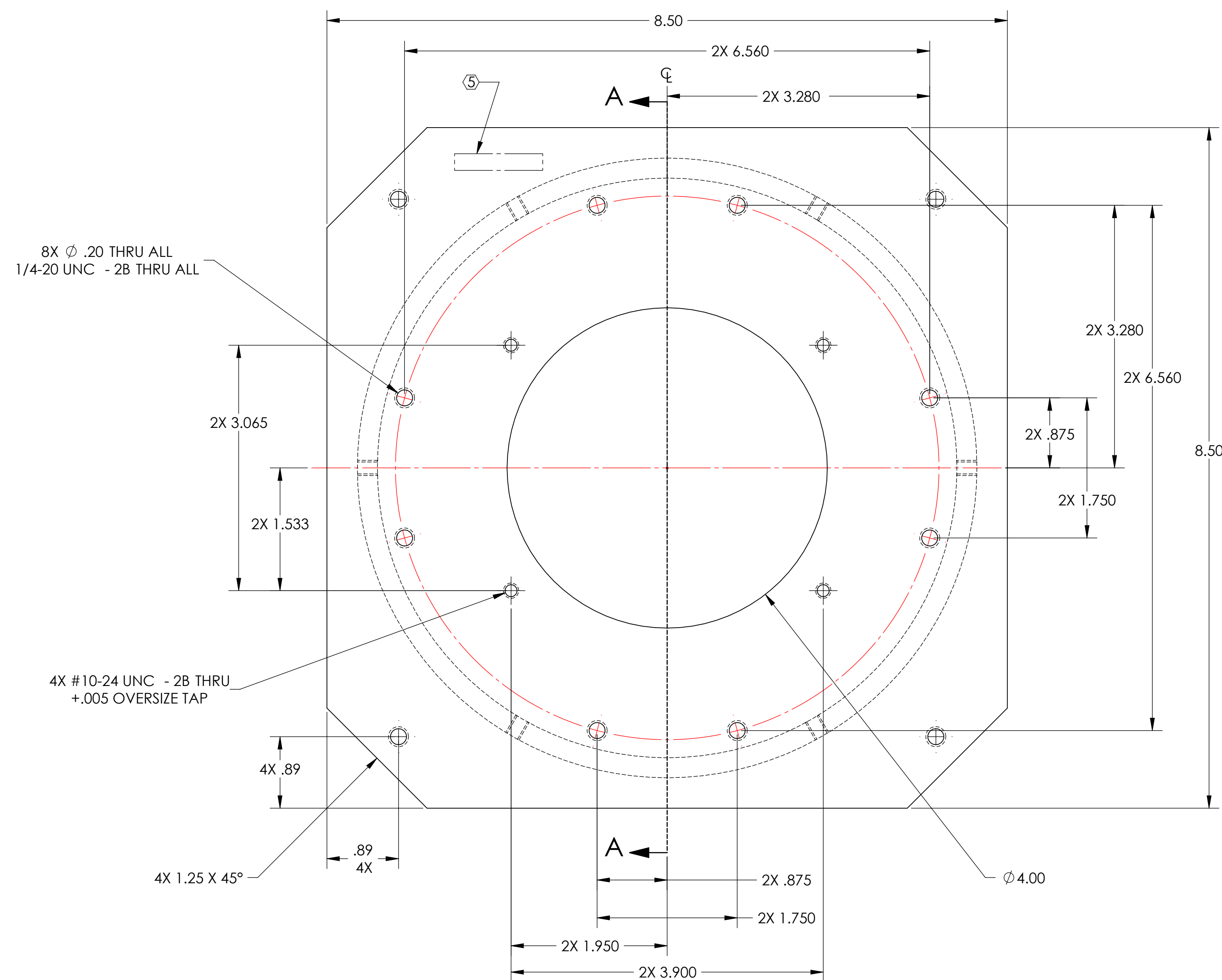
NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME	
DIMENSIONS ARE IN INCHES TOLERANCES: .XX ± .03 .XXX ± .005 ANGULAR ± 1.0°				1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES 0.005" TO 0.015". 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.		SLC UPPER TUBE	
MATERIAL 6061-T6 Al		FINISH 63 μinch		NEXT ASSY D1002582		DESIGNER N.Nguyen 01 Jul 2010 DRAFTER TQ. NGUYEN 19 JUL 2010 CHECKER M. SMITH 01 NOV 2010 APPROVAL D. COYNE 10 NOV 2010	
SYSTEM ADVANCED LIGO SUB-SYSTEM AOS				SIZE DWG. NO. B D1002612		REV. v1	
				SCALE: 1:2		PROJECTION: SHEET 1 OF 1	

- 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 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: DXXXXX-VY, TYPE-XX, S/N XXX
 6. APPROXIMATE WEIGHT=2.363 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 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	03 JUN 2010	E1000285	



NO SCALE
FOR REFERENCE ONLY



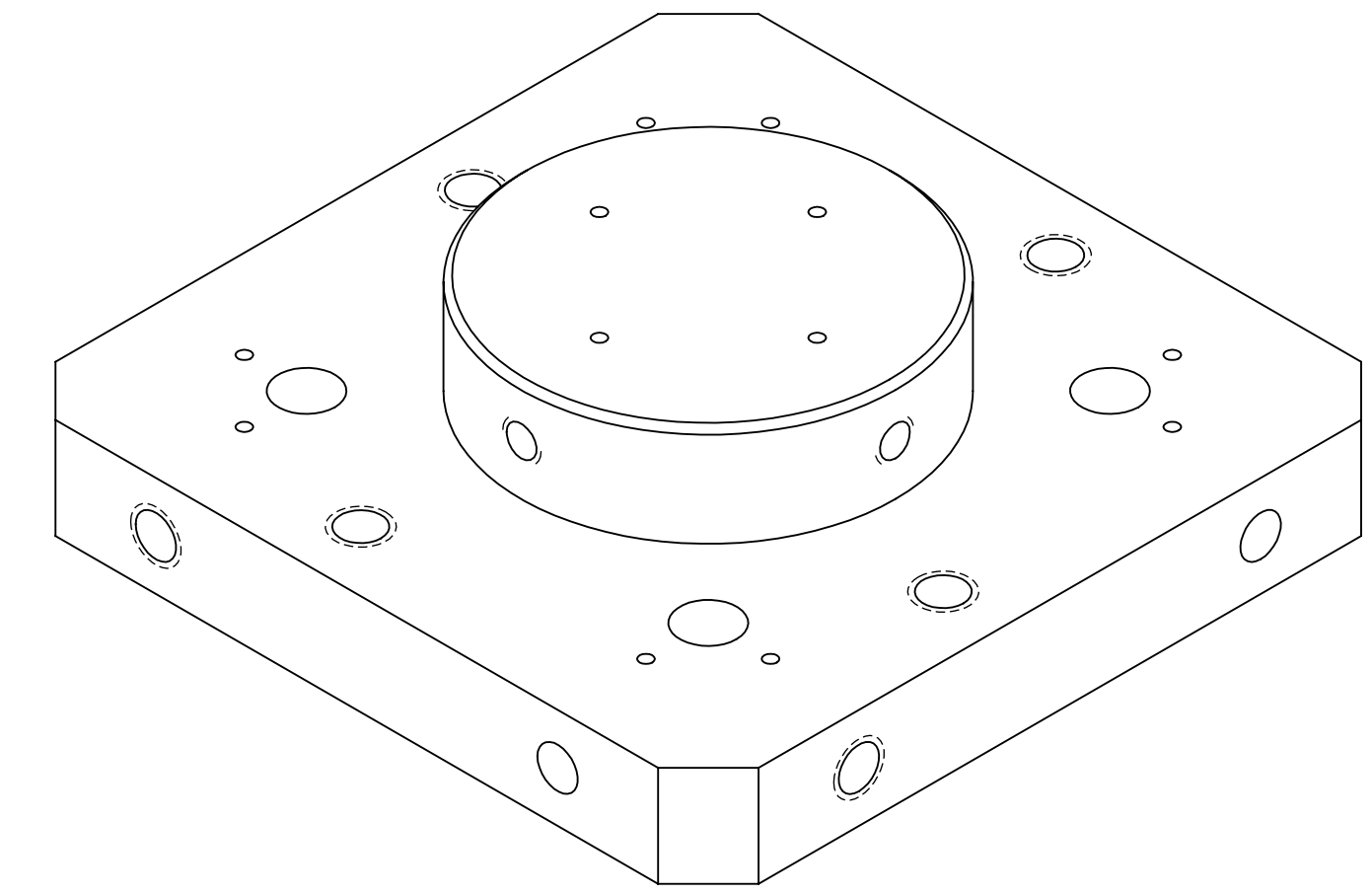
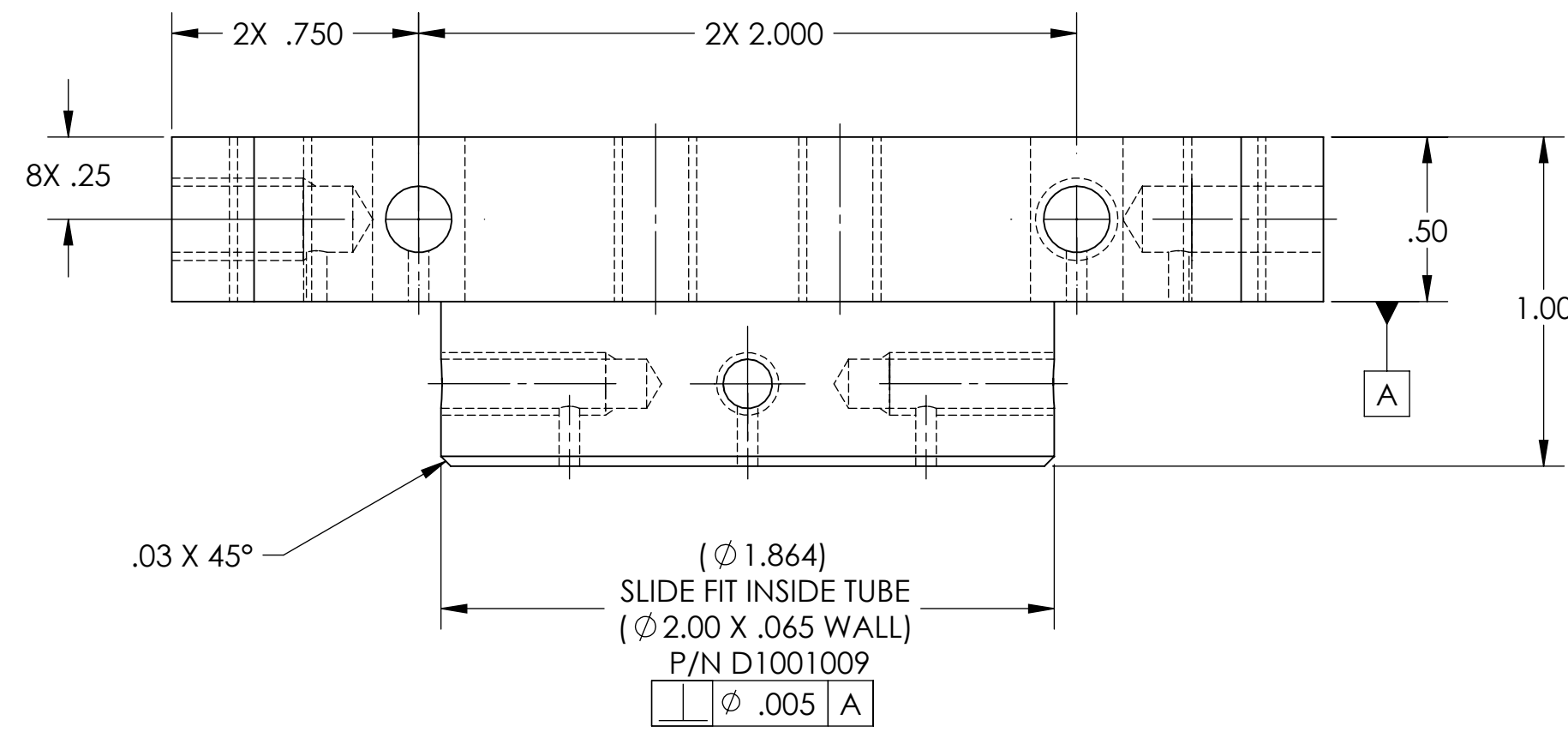
NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)	
1. INTERPRET DRAWING PER ASME Y14.5-1994.	
2. REMOVE ALL SHARP EDGES .005" TO 0.015".	
3. DO NOT SCALE FROM DRAWING.	
4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.	
DIMENSIONS ARE IN INCHES	
TOLERANCES: .XX $\pm .01$.XXX $\pm .005$	
ANGULAR $\pm 1.0^\circ$	
MATERIAL	FINISH
6061-T6 Al	63 μ inch

CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
SYSTEM	SUB-SYSTEM
ADVANCED LIGO	AOS
NEXT ASSY	
D1002563	

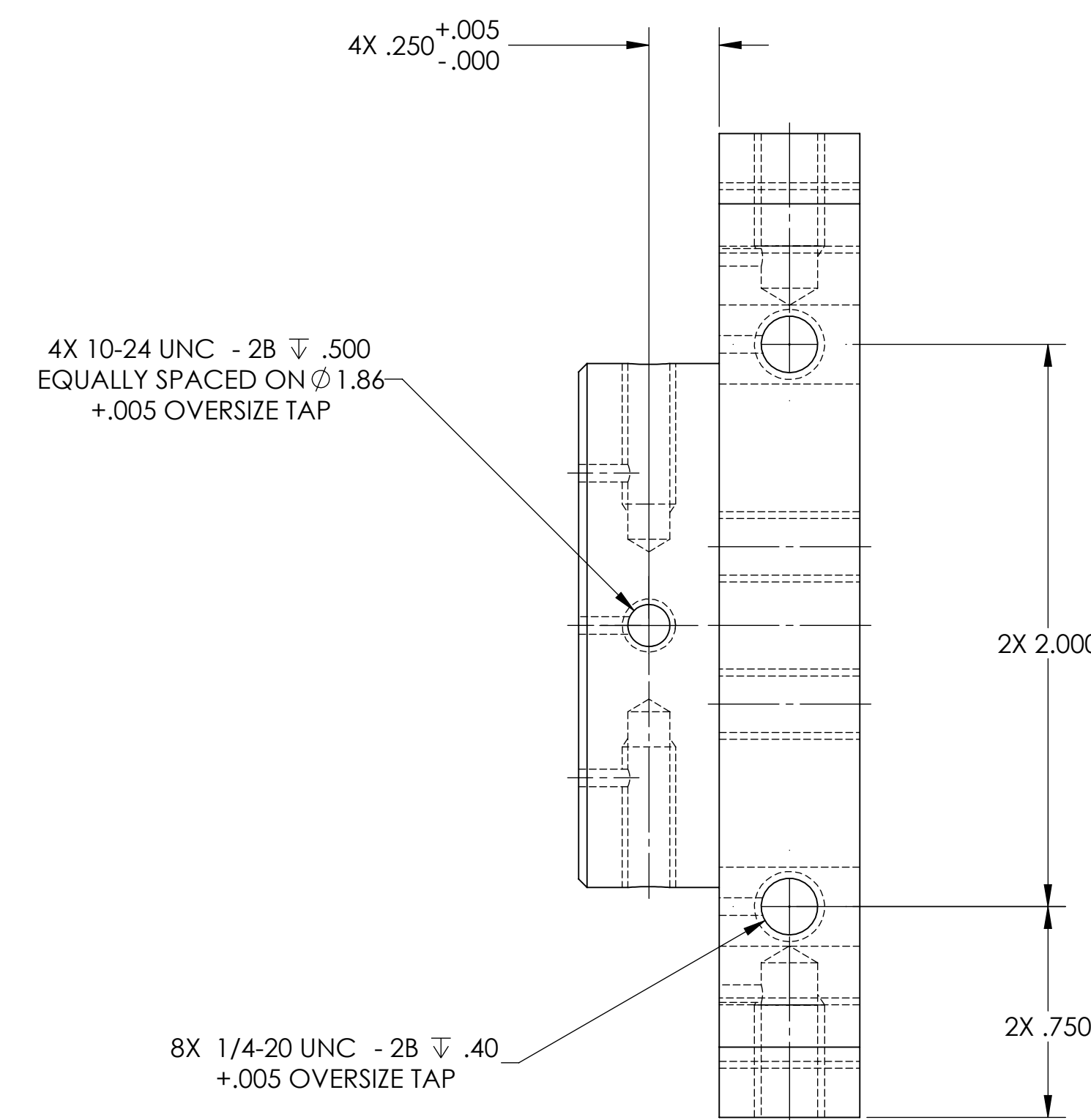
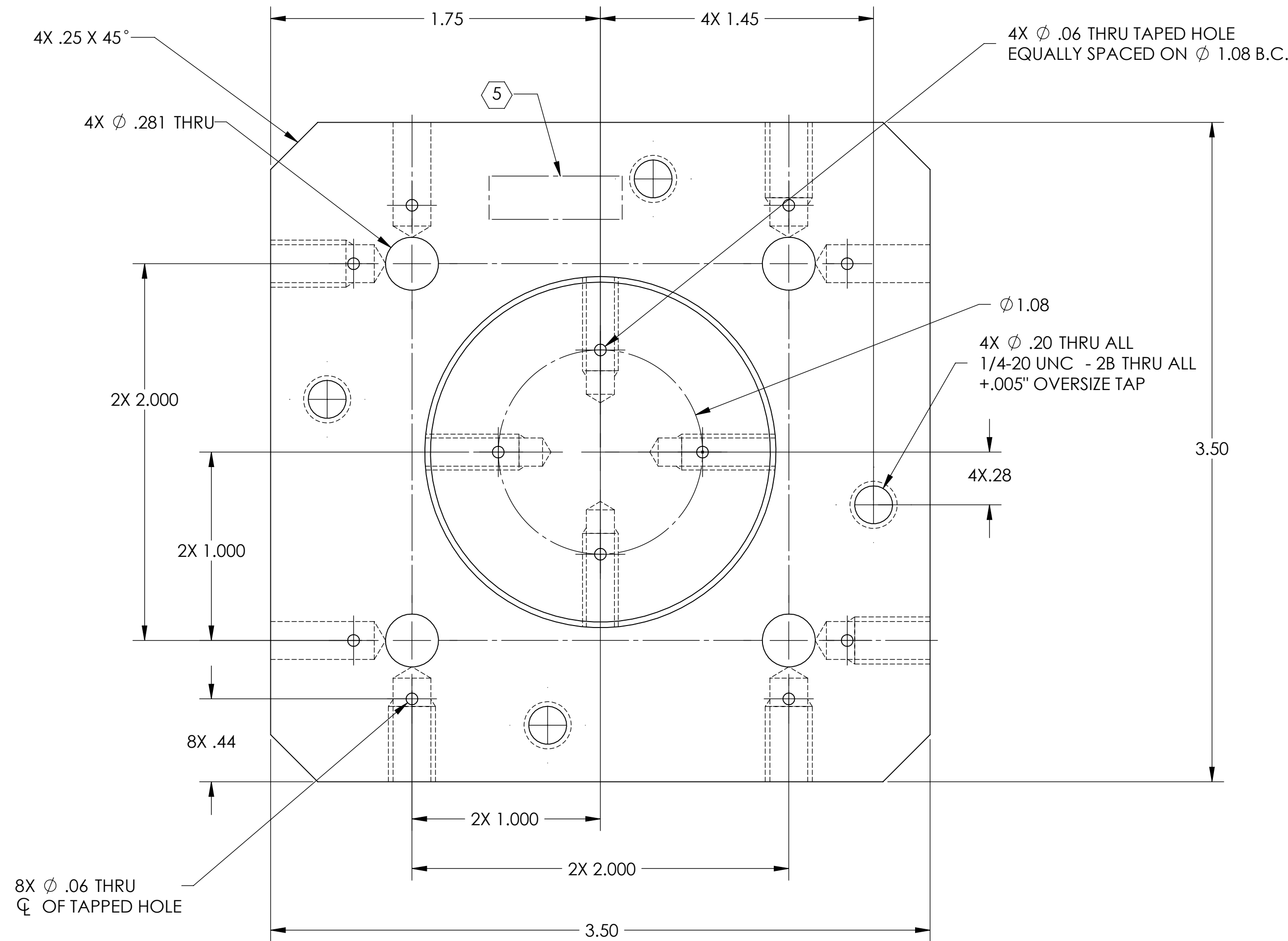
PART NAME		SIZE		DWG. NO.		REV.
SLC DAMPING TUBE LOWER PLATE		D		D1002617		v1
DESIGNER	N.Nguyen	01 Jun 2010				
DRAFTER	TG. NGUYEN	15 JUL 2010				
CHECKER	M. SMITH	01 NOV 2010				
APPROVAL	D. COYNE	10 NOV 2010	SCALE: 1:1	PROJECTION:		SHEET 1 OF 1

- 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 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: DXXXXX-VY, TYPE-XX, S/N XXX
 6. APPROXIMATE WEIGHT=0.687LB.
 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.

REV.	DATE	DCN #	DRAWING TREE #
v1	10 OCT 2010	E1000285	



ISO VIEW



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)	
1. INTERPRET DRAWING PER ASME Y14.5-1994. 2. REMOVE ALL SHARP EDGES 0.005" TO 0.015". 3. DO NOT SCALE FROM DRAWING. 4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.	
DIMENSIONS ARE IN INCHES	
TOLERANCES: .XX ± .01 .XXX ± .005	
ANGULAR ± 1.0°	
MATERIAL	6061-T6 Al
FINISH	63 μinch

CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY	
SYSTEM	ADVANCED LIGO
SUB-SYSTEM	AOS
NEXT ASSY	D1001007

PART NAME			
SLC TUBE LOWER CONNECTOR PLATE			
DESIGNER	N.Nguyen	01 Jun 2010	SIZE DWG. NO.
DRAFTER	TG. NGUYEN	19 JUL 2010	D
CHECKER	M. SMITH	01 NOV 2010	D1002618
APPROVAL	D. COYNE	10 NOV 2010	SCALE: 1:1
PROJECTION:		SHEET 1 OF 1	

D1002618_A03_SLC Tube Lower Connector Plate - PART PDM REV: X-005 - DRAWING PDM REV: X-019

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

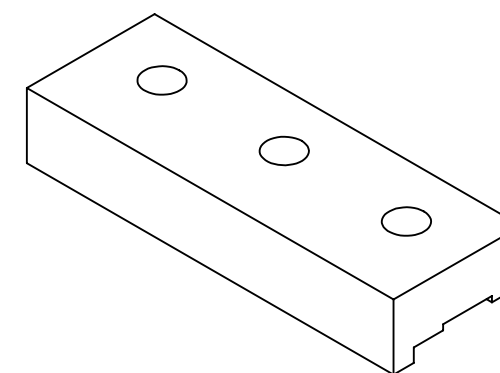
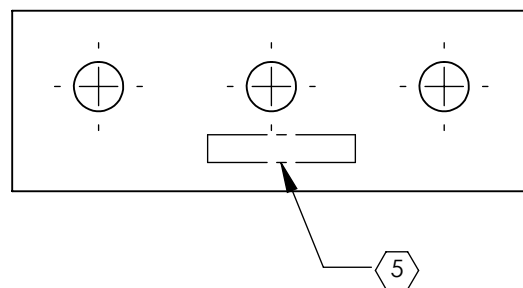
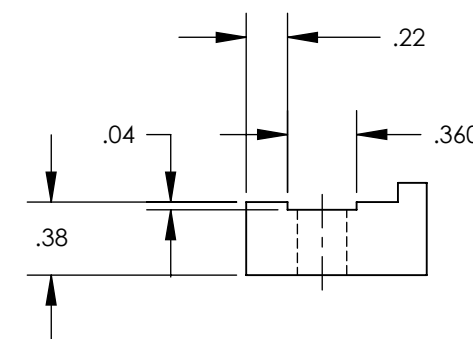
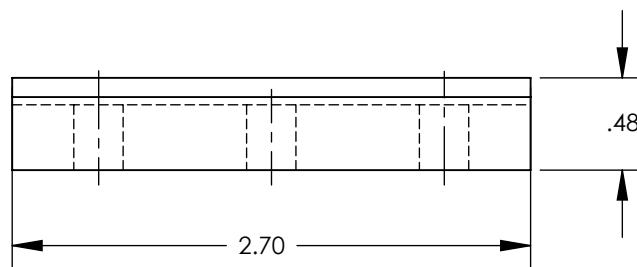
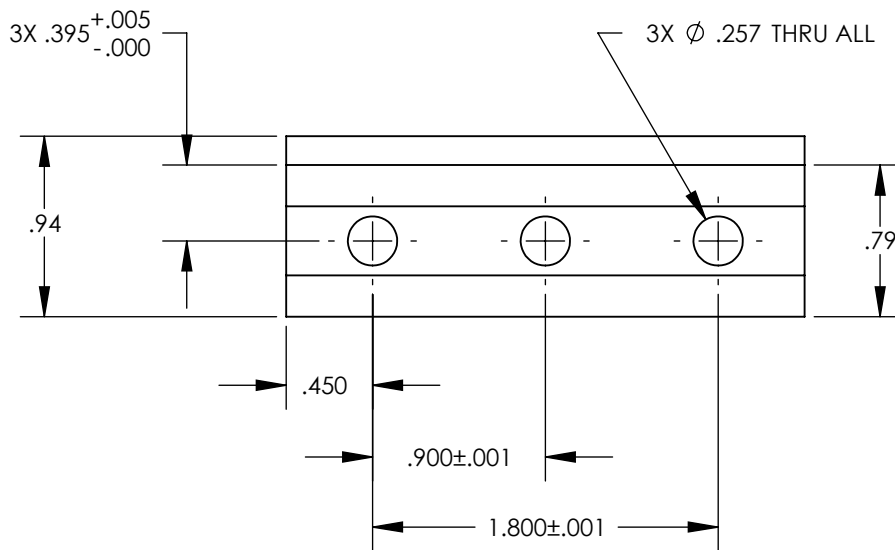
6. APPROXIMATE WEIGHT = .264 LB.

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 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	03 AUG 2010	E1000285	



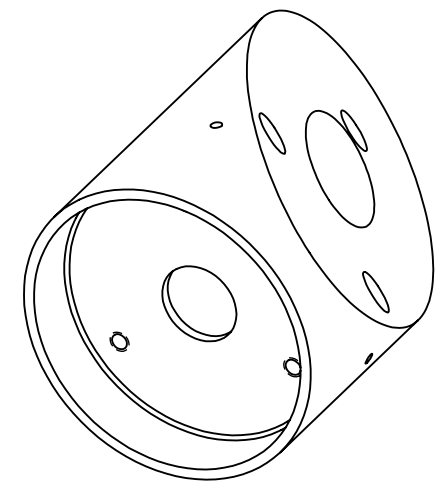
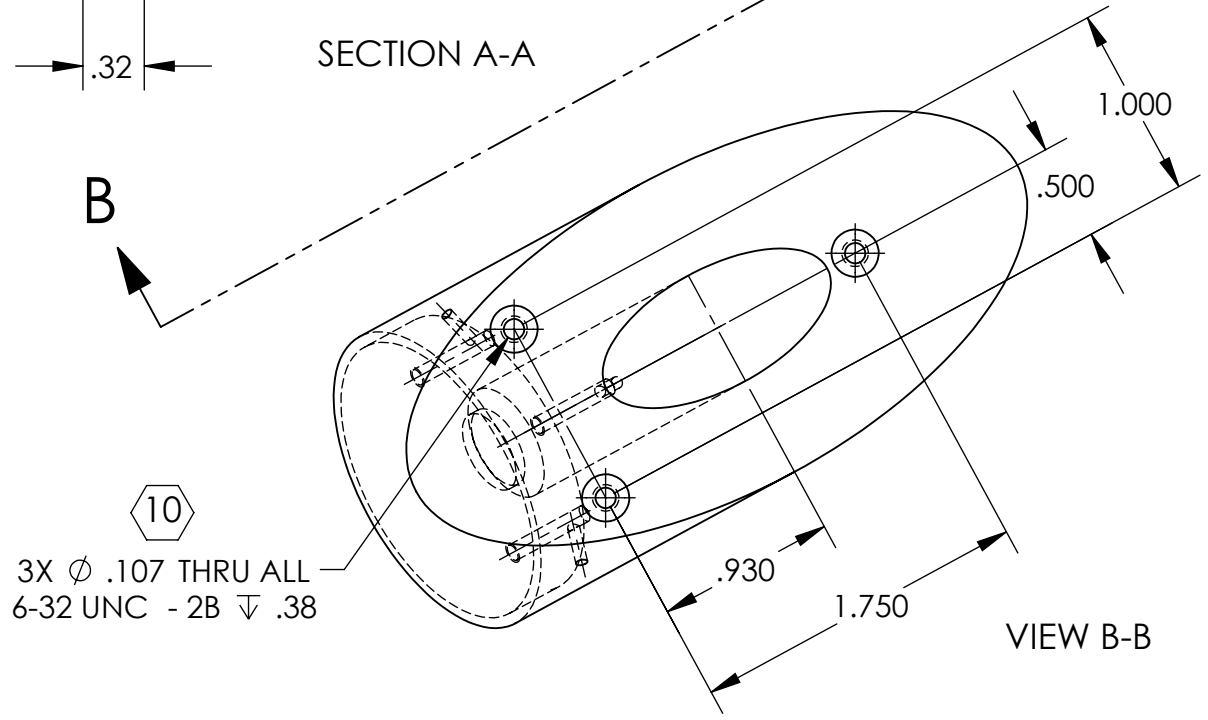
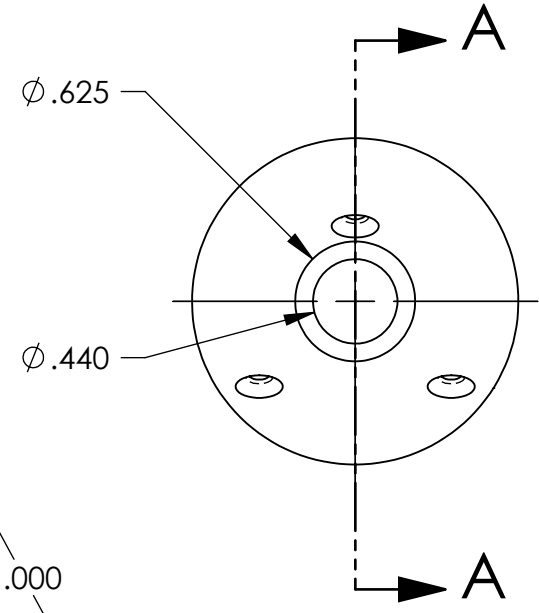
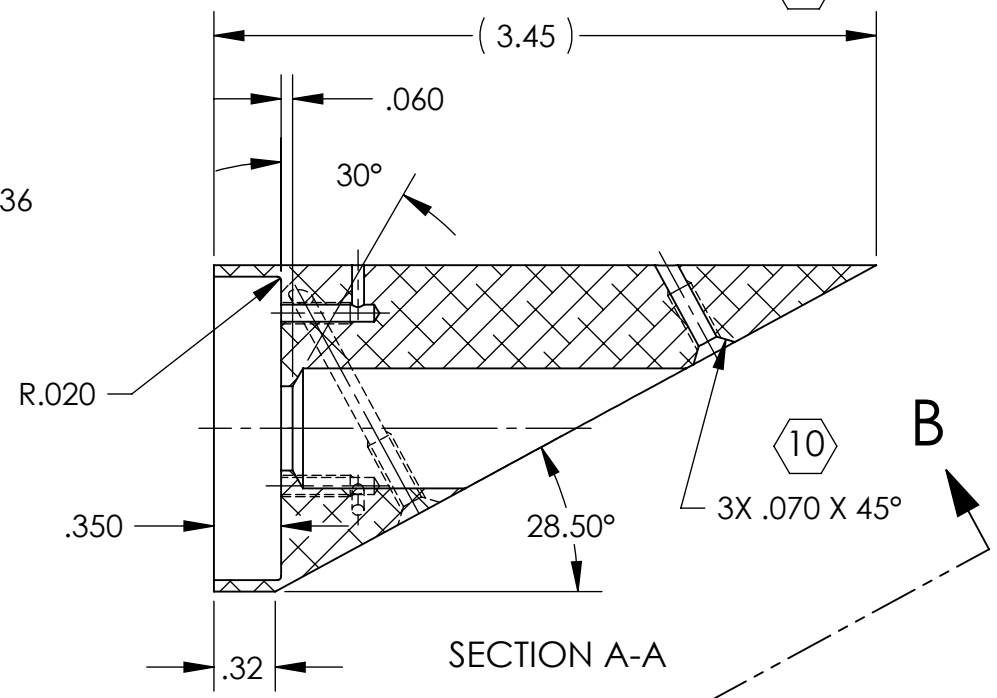
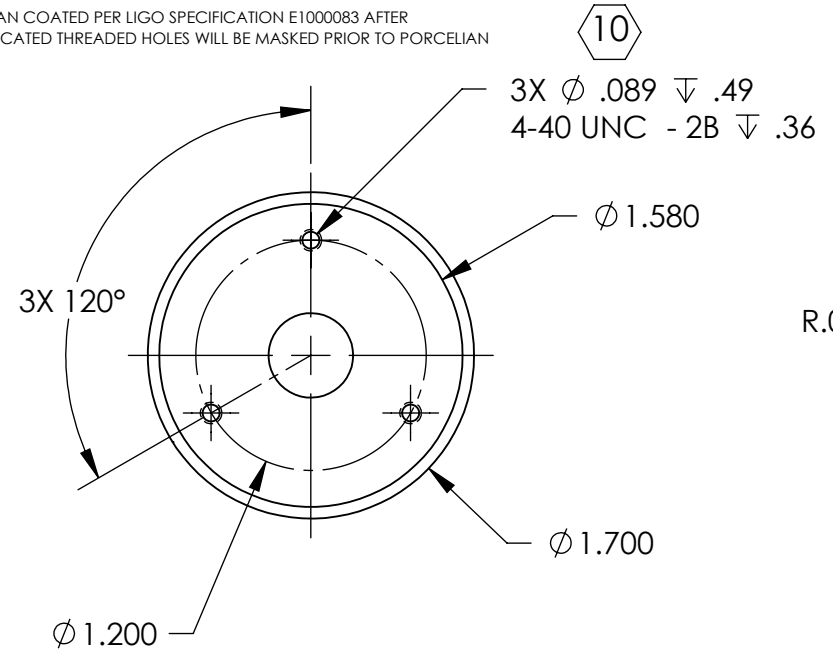
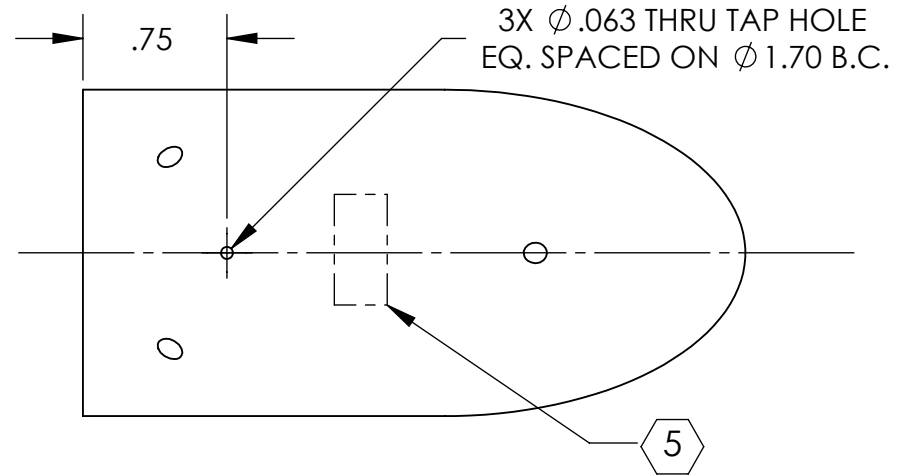
D1002844_AdlIGO_AOS_SLC_ACB Blade Clamp, PART PDM REV: X-002, DRAWING PDM REV: X-002

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME	
DIMENSIONS ARE IN INCHES				ADVANCED LIGO		SLC ACB BLADE CLAMP	
TOLERANCES: .XX ± .01 .XXX ± .005				SUB-SYSTEM AOS		DESIGNER N.Nguyen 01 Jun 2010	
ANGULAR ± 1.0°				MATERIAL 304 SSTL		DRAFTER TQ. NGUYEN 25 MAY 2010	
FINISH 63 μinch				NEXT ASSY D1001005		CHECKER M. SMITH 30 JUN 2010	
						APPROVAL D. COYNE 10 SEP 2010	
						SIZE DWG. NO. B D1002844	
						REV. v1	
						SCALE: 1:1 PROJECTION: SHEET 1 OF 1	

NOTES: UNLESS OTHERWISE SPECIFIED

1. INTERPRET DRAWING PER ASME Y14.5-1994.
2. REMOVE ALL SHARP EDGES 0.005" TO 0.015".
3. DO NOT SCALE FROM DRAWING.
4. ALL MACHINING FLUIDS MUST BE FULLY SYNTHETIC, FULLY WATER SOLUBLE AND FREE OF SULFUR, SILICONE, AND CHLORINE. REFER TO LIGO E0900237 FOR LIST OF APPROVED COOLANTS.
5. SCRIBE, ENGRAVE OR MECHANICALLY STAMP (NO DYES OR INKS) A UNIQUE THREE DIGIT SERIAL NUMBER & REVISION NUMBER ON EACH PART. SERIAL NUMBERS START 001 FOR THE FIRST ARTICLE AND PROCEED CONSECUTIVELY .020 DEEP WITH MINIMUM .156 HIGH CHARACTER. BAG AND TAG PARTS WITH THEIR DRAWING PART NUMBER, REVISION, VARIANT OR "TYPE" (IF APPLICABLE), AND QUANTITY. IF PARTS ARE TOO SMALL TO SCRIBE, BAGGING AND TAGGING ALONE IS SUFFICIENT.
EXAMPLE: DXXXXXX-VY, TYPE-XX, S/N XXX
6. APPROXIMATE WEIGHT =0.894 LB.
7. MACHINE ALL SURFACES TO REMOVE OXIDES AND MILL FINISH. USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED. REFER TO LIGO-E0900364.
8. PART 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. PART WILL BE PORCELAIN COATED PER LIGO SPECIFICATION E1000083 AFTER FABRICATION. THE INDICATED THREADED HOLES WILL BE MASKED PRIOR TO PORCELAIN COATING.

REV.	DATE	DCN #	DRAWING TREE #
v1	18 NOV 2010	E1000285	-
-	-	-	-
-	-	-	-



NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)

DIMENSIONS ARE IN INCHES

TOLERANCES:
.XX \pm .01
.XXX \pm .005
ANGULAR \pm 0.5°

MATERIAL	304 SSSL	FINISH	63 μ inch
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LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME	
SYSTEM	ADVANCED LIGO	SUB-SYSTEM	AOS
NEXT ASSY	D1003013		

DESIGNER			N. Nguyen			17 Nov 2010			SIZE DWG. NO.			REV.					
DRAFTER			N. Nguyen			20 Nov 2010			B			D1003025			v1		
CHECKER			M. Smith			01 Dec 2010			SCALE: 1:1			PROJECTION:			SHEET 1 OF 1		
APPROVAL			D Coyne			10 Dec 2010											

D1003025_AdlIGO_AOS_SLC Photodetector Housing, PART PDM REV: X-019, DRAWING PDM REV: X-022

8

7

6

5

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3

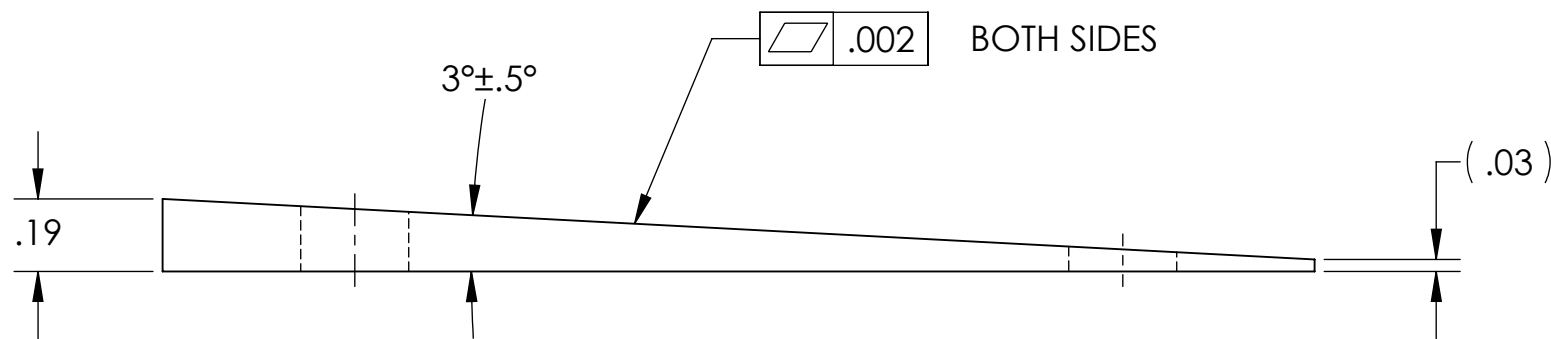
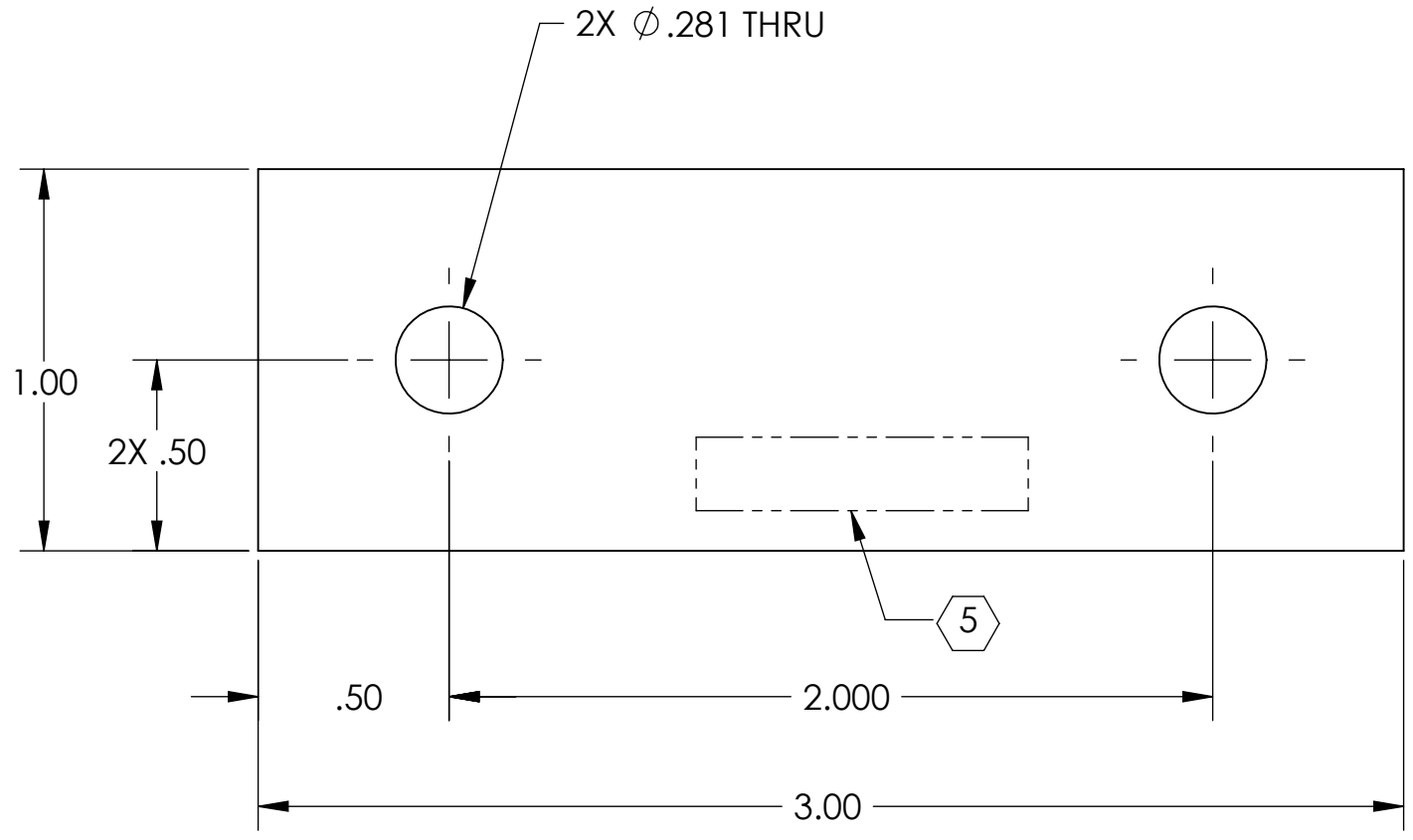
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1

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 = 0.092 LB.
- 7. MACHINE ALL SURFACES TO REMOVE OXIDES AND MILL FINISH. USE OF ABRASIVE REMOVAL TECHNIQUES IS NOT ALLOWED.
- 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 OR PLUGS) UNLESS APPROVED IN ADVANCE IN WRITING BY LIGO, REFER TO LIGO-E0900364.
- 10. 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 SHOULD BE MADE WITH VIRGIN MATERIAL. SPECIAL CIRCUMSTANCES CAN BE REVIEWED IF / WHEN BROUGHT TO THE ATTENTION OF LIGO CONTRACTING OFFICER'S REPRESENTATIVE (COIR) THROUGH A MATERIAL REVIEW BOARD (MRB) PROCESS, REFER TO LIGO-E0900364.

REV.	DATE	DCN #	DRAWING TREE #
v1	22 FEB 2011	E1000285	-
-	-	-	-
-	-	-	-



D1100243_AdlIGO_ACB Hinge Shim, PART PDM REV: X-003, DRAWING PDM REV: X-003

NOTES AND TOLERANCES: (UNLESS OTHERWISE SPECIFIED)				LIGO CALIFORNIA INSTITUTE OF TECHNOLOGY MASSACHUSETTS INSTITUTE OF TECHNOLOGY		PART NAME	
DIMENSIONS ARE IN INCHES				ADVANCED LIGO		ACB HINGE SHIM	
TOLERANCES: .XX ± .01 .XXX ± .005				SUB-SYSTEM AOS		DESIGNER N.Nguyen 09 Feb 2011	
ANGULAR ± 1.0°				NEXT ASSY D1002173		DRAFTER N. KILPATRICK 22 FEB 2011	
MATERIAL 304 SSSL				FINISH 63 μinch		CHECKER	
						APPROVAL	
						SCALE: 2:1 PROJECTION: SHEET 1 OF 1	
						SIZE DWG. NO. B D1100243	
						REV. v1	