

Appendix A

Reference Data

This appendix contains:

Item	Description	Page
A-02	QAP: Quality Assurance Plan	A-02
A-07	Email: Leo Fortin to Ernie Mileta, "Bruce A Divider Plate Sealing Skin ACAD DXF Files", April 02, 1997	A-07
A-08	Plots: Attachments to Email of April 02, 1997.	A-08
A-14	Email: Leo Fortin to Ernie Mileta, "Divider Plate Sealing Skin Mods, 26May97", May 28, 1997.	A-14
A-15	Plot: Attachment to Email of May 28, 1997.	A-15
A-16	Plots: Leo Fortin, "Sealing Skin Drawing Package", March 11, 1997	A-16

Quality Assurance Plan - COVER PAGE**Engineering Analysis Department**

Contract Manager: W.W. Teper	QAP Number: NK21-QAP-33115-975022
Contract Name: Bruce GS A Steam Generator - Primary Divider Plate - Skin Fix	Revision #: 00 - April 97
Customer Contact: Leo Fortin	PRS Number: D83501
Business Unit: Bruce NGS A	Date: April, 97
Scope of Work: (1) Prepare and Analyse Mini 2 panel model (2) Create Finite Element Model (3) Perform LOCA scenario Dynamic Analysis using ABAQUS Explicit (4) Documentation.	
Responsibilities: Analysis / Report - E.H. Mileta Review - W.W. Teper Approval - W.W. Teper	
List of QA Procedures: <ul style="list-style-type: none"> NQA-7 Design/Engineering Calculations & Analysis EAD-QAP-1883-01 Preparation of Calculations and Reports 	
List of QA Records: <ul style="list-style-type: none"> ERM Analysis Report No.: NK29-33115-975xxxERM Computer data input files attached with calculation reports Computer output files on DLT cartridge tape, EAD Tape No. D0016 	
Interfaces: <ul style="list-style-type: none"> Technical Services Integration Department - NTS Bruce 'A' Engineering Services - BNGSA 	
Prepared By: E.H. Mileta	Date: April, 1997
Approved By: W.W. Teper (At Start)	Date: April, 1997
Approved By: W.W. Teper (On Completion)	Date:

Date: April, 1997

Quality Assurance - WORK PLAN

Revision #: 0

Contract Name: Bruce GS A Steam Generator - Primary Divider Plate - Skin Fix						QAP Number: NK21-QAP-33115-975022	
Tasks				Verification required		Comments	Status
No	Description of Activity	Documents to be prepared	Responsibility person/section	Type/Procedure	Responsibility person/section		
1	Problem Definition	EAD-QAP-1883-1 (Section 5)	E.M.	Checking	W.T.		
2	Assumptions and Simplifications	EAD-QAP-1883-1 (Section 6)	E.M.	Checking	W.T.		
3	Collect Model Data	EAD-QAP-1883-1 (Section 8)	E.M.	Checking	W.T.		
4	Analyse Mini 2 Panel Model (Bolt Testing)		E.M.	Checking	W.T.		
5	Do LOCA Analysis Runs	EAD-QAP-1883-1	E.M.	Checking	W.T.		
6	Prepare Draft Report		E.M.	Checking	W.T.		
7	Prepare Final Report	EAD-QAP-1883-1	N/A	N/A	N/A		

Work Plan

1) Problem Definition

The identified need to reduce the leakage past/through the Bruce NGS-1 Steam Generator Primary Divider Plate Assembly has resulted in a proposed "fix" to address this issue. The proposed fix is to install an Inconel membrane over the plate and to install a clamping plate that covers the complete surface (Reference 6). New nuclear grade bolts would be installed in the process. Although this is projected to have a significant effect on the leakage for a relatively small cost, the impact on the LOCA safety analysis is unknown.

The effect of the new configuration is projected to make the divider plate stronger and stiffer but since the current analysis makes use of the flexibility of the divider plate to reduce the impact of LOCA transient conditions, the new "stiffer" divider plate may fail in a different mode or possibly reduce the benefit gained from crediting divider plate flexibility.

The "Sealing Skin" is designed to:

- Overlap all seat bar / divider plate joints by 3/8"
- Completely cover and isolate from the PHT flow by a new clamping design that will replace the current clamping bar arrangement
- Be fabricated from Inconel (0.030" Thick)

The new "Clamping Plate" design will:

- Overlap all seat bar / divider plate joints by 3/8" providing 100% coverage of the sealing skin, isolating it from direct contact with the PHT inlet flow
- Be fabricated from 1/2" CS plate (516 G70)
- Be bolted in place using the existing 126 threaded holes used for fastening the old clamping bars to the main divider plate sections with four additional threaded holes, that will be drilled and tapped during the installation
- Have all bolts (130 pcs) torqued to 25 ft-lbs. Locking tabs will be used.

The finite element model of the current divider plate design (Reference Report NK21-33115-55ERM) will be used with the following changes:

- The clamping bars will be removed
- The corner panel will be modified to include two additional bolt holes
- The new Sealing Skin will be added
- The new Clamping Plates will be added
- The new bolts and bolt material will be used

The initial assumptions and modeling techniques will be tested using smaller 2 panel models. The Test models will be run to approximate steady state and compared to the results using a 2 panel model of the original design. The test should verify that the modeling techniques used are appropriate and give some indication of the increase in overall stiffness.

The results of the test models will be used in generating the complete skin fix model. Once the complete model is generated the quasi-static load vs volume relationship (forward and backward loading) will be determined and an interactive ABAQUS/TUF analysis will be performed.

2) Mini 2 Panel Model Test

- Extract 2 panel model from Original BA Model
 - Model Skin and clamp bar
 - I. Floating Skin
 - Compression / Friction only boundary conditions
 - No symmetry boundary condition defined at symmetry plane
 - No Bolt Interaction
 - II. Clamp Bar - not symmetric therefore use Two Bounding Test Models
 - Two Models
 - 1 small central clamp bar
 - 1 large central clamp bar
 - Symmetry conditions at centre plane
 - Outer edges free
 - Run 3 models with moderately slow ramp to compare the “approximate” static limit
 - Model #1 - 2 Panel Model cut from original BA FE Model
 - Model #2 - 2 Panel Model - New Skin and simulating 1 small central clamp bar
 - Model #3 - 2 Panel Model - New Skin and simulating 1 large central clamp bar
2. Assumptions and Simplifications - Changes from the Reference Report (NK21-33115-55ERM)
- a) The Sealing Skin will be “floating”, using only Compression and Friction to hold it in place and no interaction with the bolts. This simplification will not affect the overall results as the skin does not contribute significantly to inplane strength of the the divider plate assembly.
 - b) The break in the sealing skin near the centre on the panel assembly will be moved to lie exactly at the centre line. This simplification will not affect the overall results as the skin does not contribute significantly to inplane strength of the the divider plate assembly.
 - c) The clamping plate that crosses the symmetry plane will be modelled with symmetry conditions at that plane. The break in the clamping plate near the symmetry plane cannot be moved to the symmetry plane since it is expected to affect the behaviour of the bolted joint. The test models will determine if it is more conservative to include the break (effectively creating a small central clamp bar) or not to (effectively creating a very large central clamp plate).
 - d) The edge of the sealing skin, where it overlaps the seat bars, will be modelled without the bend (i.e. Flat). This will not affect the overall behaviour of the divider plate assembly.

3) Model Data

The model data is assumed to be unchanged from the reference report (NK21-33115-55ERM) with the exception of the data provided by Leo Fortin (Sealing Skin Drawing Package, March 11/97) for the new components.

Note: Panel width dimensions do not match those used in the reference Bruce A Finite Element Model. The difference stems from the drawing (NK21-MN33110-1021 rev.4) where the width is provided as used in the sketches from Leo Fortin (as provided in the reference package above) and also provided as a calculation (Each panel division is an additional 10 degrees from centre along the arc of the Primary Head Seat Bar Bolts). The differences are extremely minor and will not affect the results.

4) Static Analysis

The relationship between a static load and displaced volume up to the static load carrying capacity of the divider plate assembly will be determined using the ABAQUS explicit code review of the LOCA analysis data. The intent is to extract an estimate of the static load and displaced volume based on the assumption that the backpressure generated during the analysis is significant and acts to maintain near static response for the assembly.

5) LOCA Analysis

Engineering judgement will be used to determine the sample LOCA case to be analyzed. The LOCA analysis will be performed using the same model as in the static analysis differing only in the method of load application. The load will be applied using the VDL user subroutine that links the structural analysis (ABAQUS) with the thermal-hydraulic analysis (TUF) by communicating to each displaced volume data and equivalent pressure loading (ie including backpressure and other thermal-hydraulic effects).

The reference LOCA case(s) will be run to verify that the strain limits on all components are not exceeded.

MILETA Ernie -NUCLEAR

From: Fortin,Leo
Sent: Wednesday, April 02, 1997 11:53 AM
To: MILETA, ERNIE
Subject: RE: BRUCE A DIVIDER PLATE SEALING SKIN ACAD DXF FILES

Ernie,

I have cleaned op the DXF files, again if you have any problems please call.

Leo.



ASSEMBLY.DXF



BOLTHOLE.DXF



CLMPPLT.DXF



DPEDGE10.DXF



INCOSKIN.DXF

From: MILETA, ERNIE
To: Fortin,Leo
Subject: RE: BRUCE A DIVIDER PLATE SEALING SKIN ACAD DXF FILES
Date: Tuesday, April 01, 1997 12:22PM

The files ASSEMBLY, BOLTHOLE, CLMPPLT, and INCOSKIN seem to be identicle. All Layers appear in each of the drawings when loaded locally. I am guessing that you indented only certain layers active for each of these plots.

Can you send me the appropriate list of layers I should activate for each of these plots?

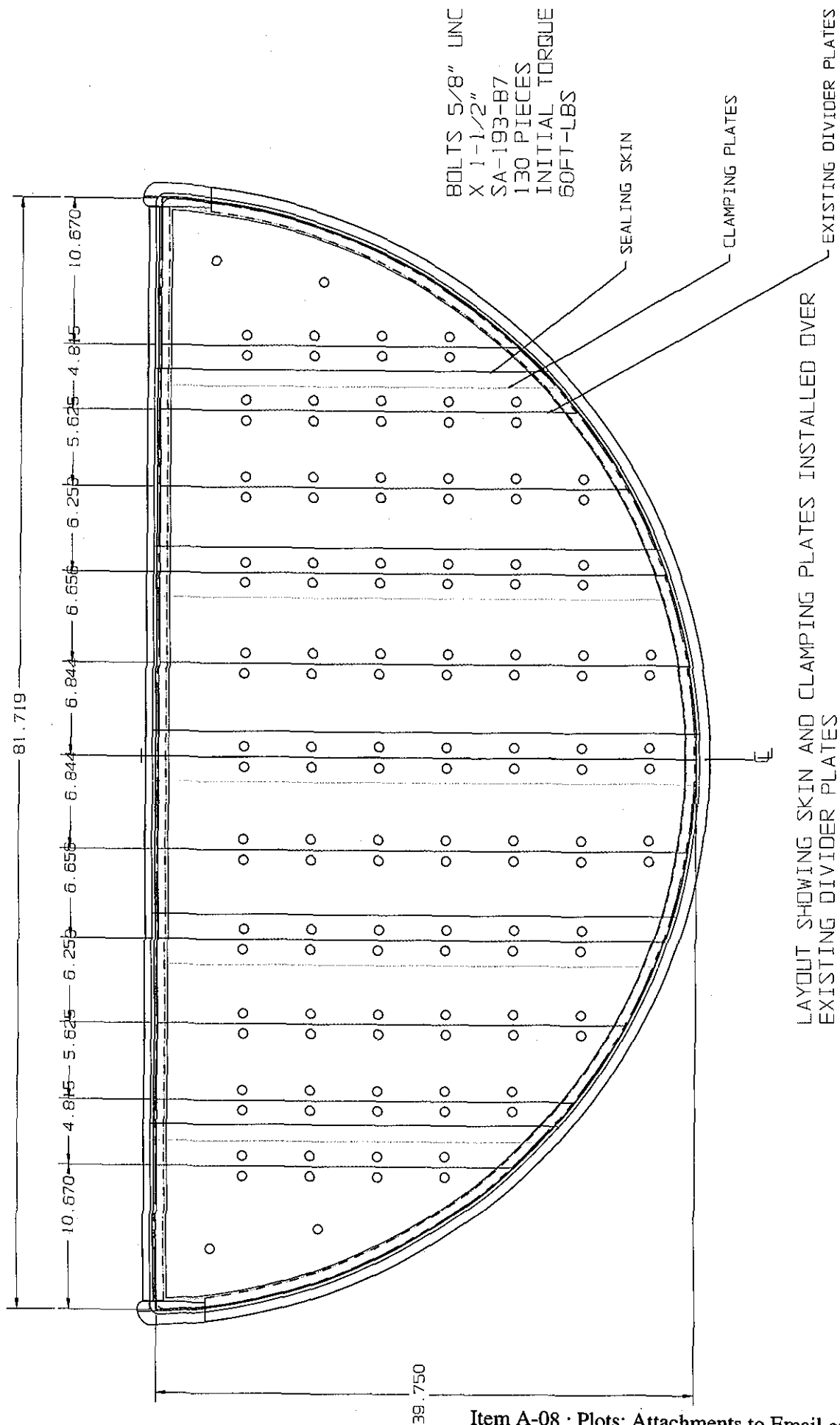
Ernest Mileta
 Nuclear Technology Services, Ontario Hydro
 700 University Ave., Toronto, Ontario, M5G 1X6, Mail Stop: H12C9
 Phone: (416)592-3309 Fax: (416)592-5322
 Mailto:Ernest.Mileta@Hydro.On.Ca Mmail: HOD1/NED1/MILETAE

From: Fortin,Leo
Sent: March 27, 1997 3:08 PM
To: Mileta,Ernie HOD1/NED1
Subject: BRUCE A DIVIDER PLATE SEALING SKIN ACAD DXF FILES

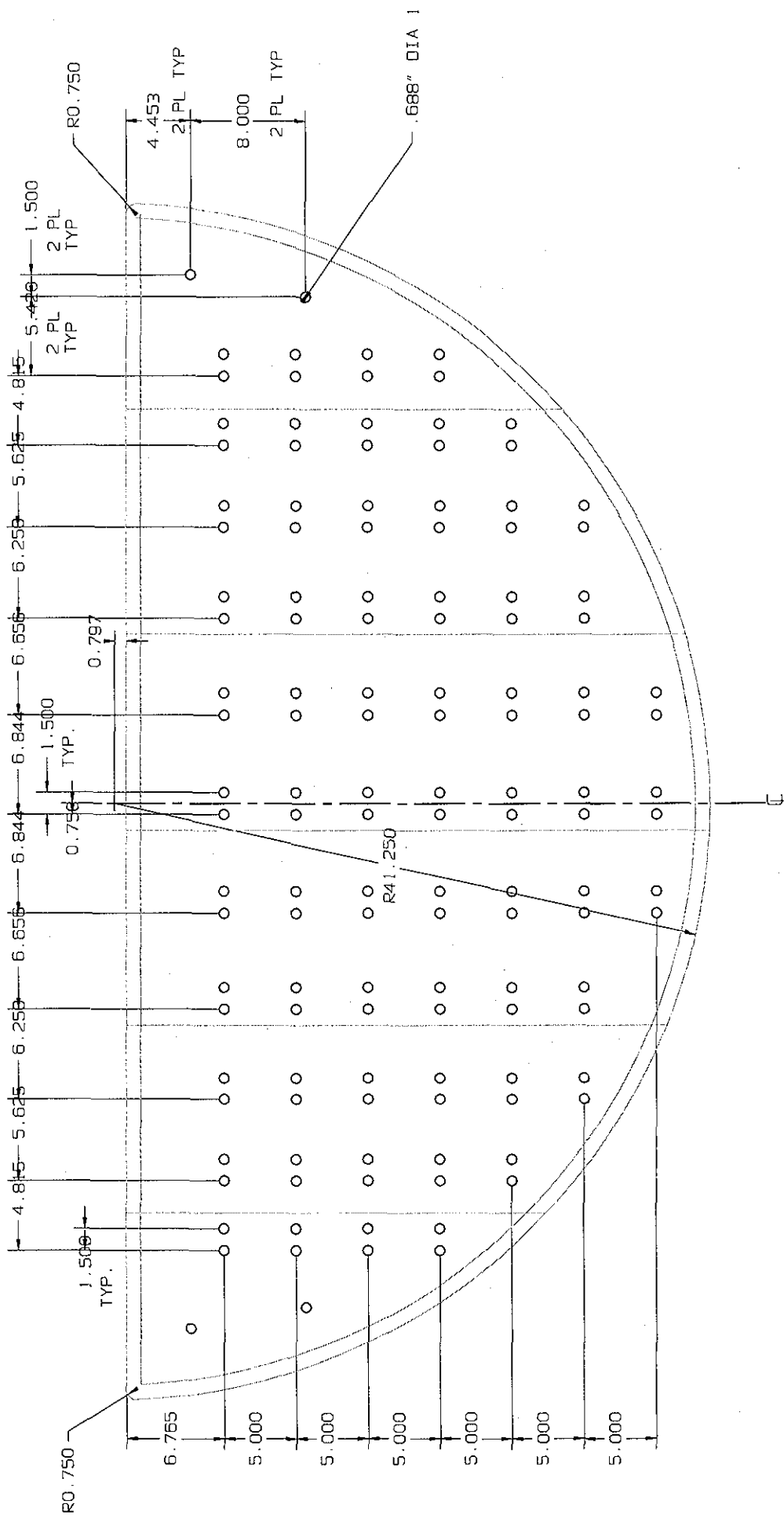
Ernie,

The following are the acad files that are available produced by myself.
 All the detail will not appear in the files so to fill in the gaps I will be sending an info package.

Leo Fortin



LAYOUT SHOWING SKIN AND CLAMPING PLATES INSTALLED OVER EXISTING DIVIDER PLATES



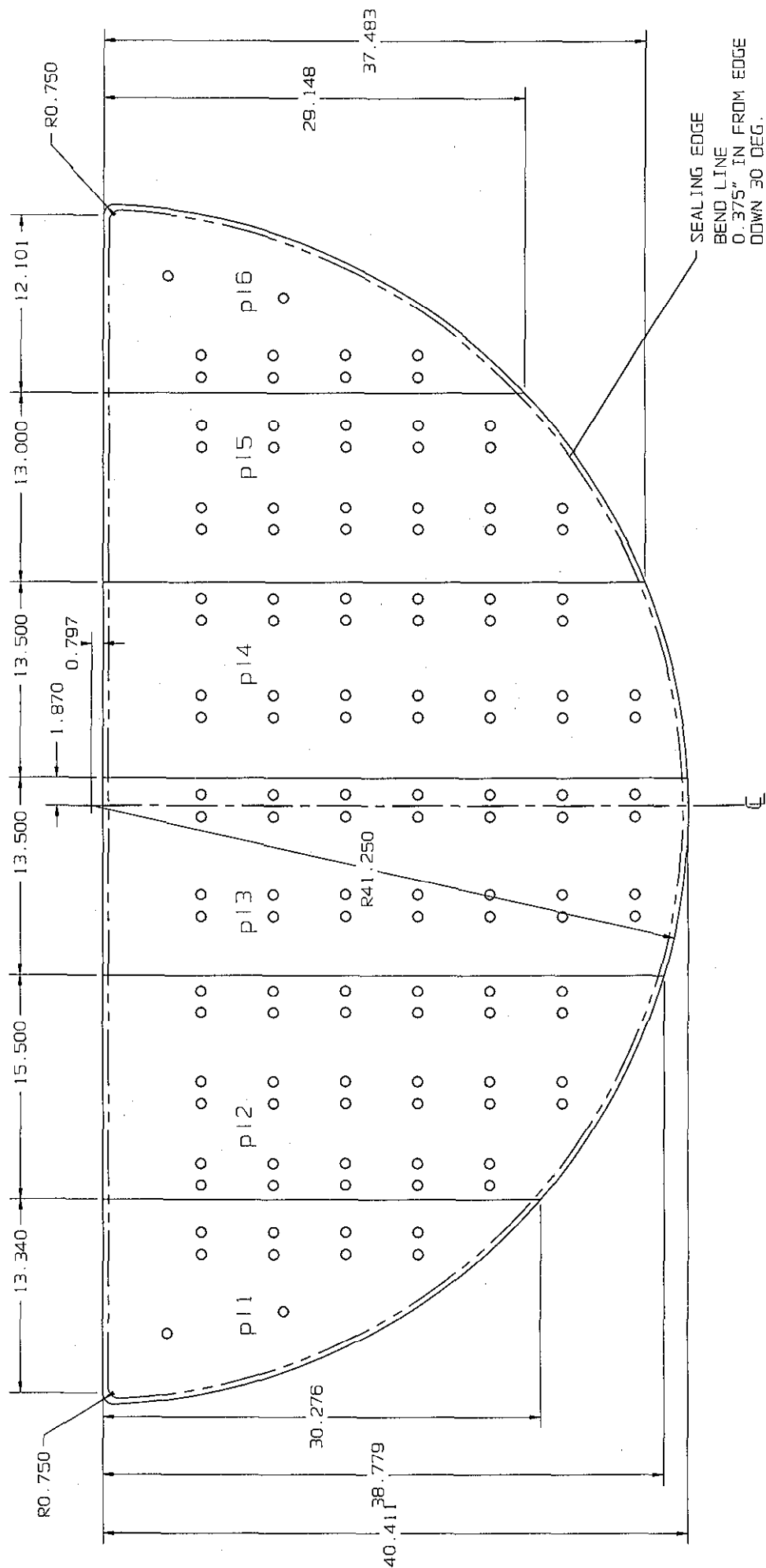
SEALING SKIN AND CLAMPING PLATE BOLT HOLE PATTERNS

Technical drawing of a dome structure, showing a grid of points (circles) and dimensions. The drawing includes a central vertical axis and a horizontal axis. The dome is defined by a curved outer boundary and a straight inner boundary. The dimensions are as follows:

- Horizontal dimensions (from left to right): 12.101, 13.000, 13.500, 13.500, 13.500, 15.500, 13.340.
- Vertical dimensions (from bottom to top): 1.878, 0.727.
- Radius dimensions: R0.750 (at the bottom left and top left corners), R41.250 (at the bottom right corner).

The grid consists of points arranged in a pattern that follows the curvature of the dome. The points are represented by small circles. The drawing is a technical representation of a dome structure, likely for a building or a container.

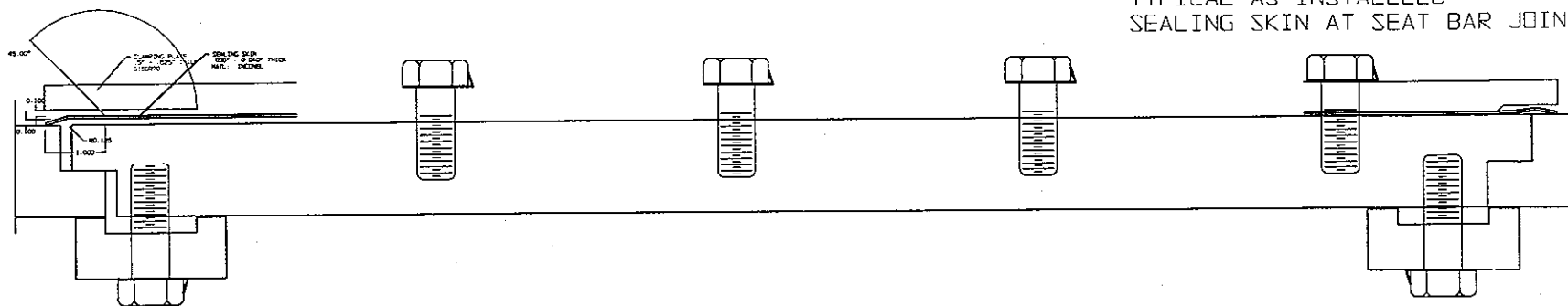
CLAMPING PLATE SEGMENT DIMENSIONS
MATL: 5/8" THICK 516GR70 CS PLATE



SEALING SKIN SECTION DIMENSIONS
 MATL: INCONEL 625, ASME SB-443
 0.030" THICK SHEET.

A-11

TYPICAL AS INSTALLED
SEALING SKIN AT SEAT BAR JOINT

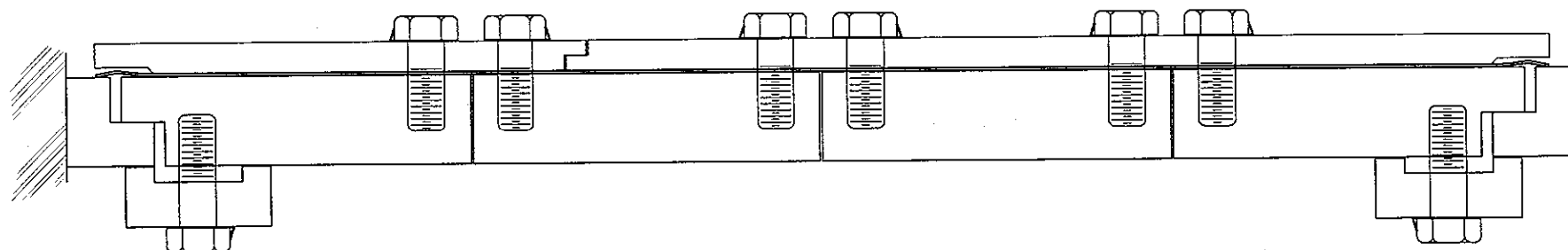


TUBESHEET

TYPICAL VERTICAL VIEW

HEAD

TYPICAL SEALING SKIN TO SEALING SKIN JOINT
TYPICAL CLAMPING PLATE TO CLAMPING PLATE JOINT



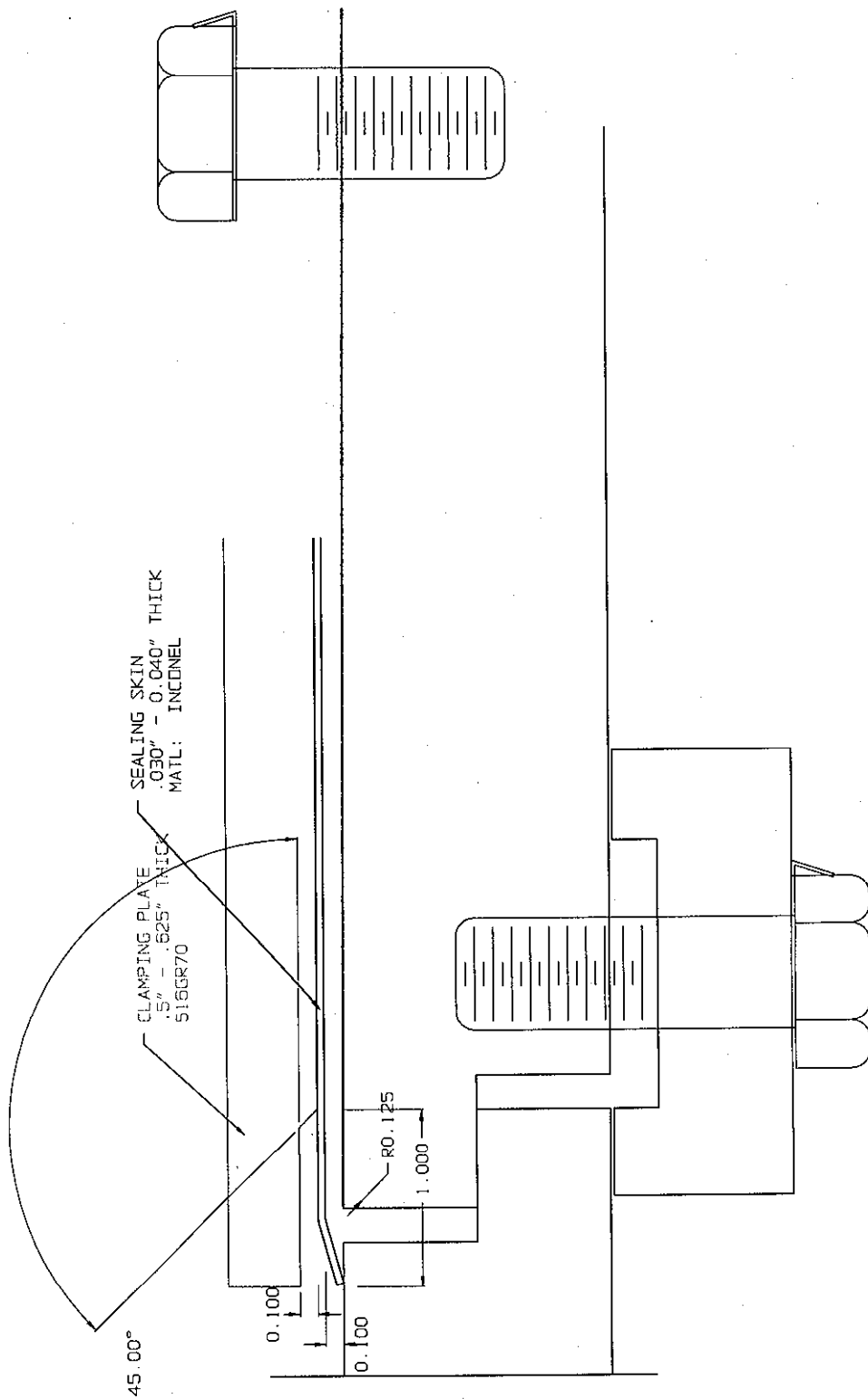
HEAD

TYPICAL HORIZONTAL VIEW

HEAD

SECTION A-A
DIVIDER PLATE EDGE VIEW
DETAIL REDUCED FOR PRESENTATION.

17-12



TUBESHEET

MILETA Ernie -NUCLEAR

From: Fortin,Leo
Sent: Wednesday, May 28, 1997 3:54 PM
To: Mileta,Ernie HOD1/NED1
Cc: Teper,W Mr HOD1/NED1
Subject: DIVIDER PLATE SEALING SKIN MODS, 28MAY97.

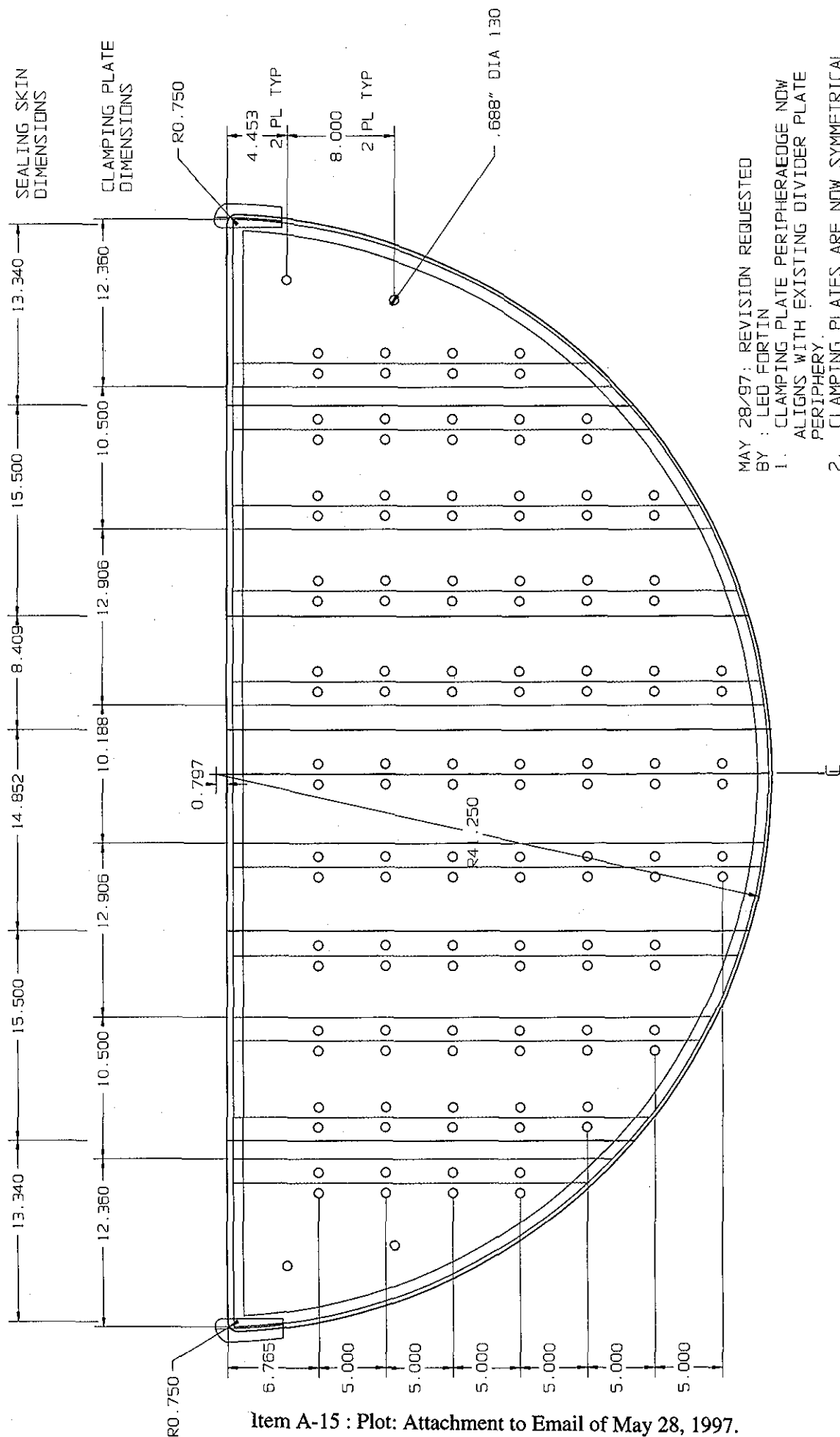
Ernie,

Attached please find the latest revisions for the divider plate sealing skins and clamping plates. Note, the clamping plate is now symmetrical about the divider plate centre line and the sealing skin as close as I can get to being symmetrical. If you have any question please call.

Leo Fortin



DPSS0528.DXF



MAY 28/97: REVISION REQUESTED
BY : LED FORTIN

1. CLAMPING PLATE PERIPHERAEAGE NOW ALIGNS WITH EXISTING DIVIDER PLATE PERIPHERY.
2. CLAMPING PLATES ARE NOW SYMMETRICAL ABOUT THE EXISTING OP CENTRE LINE
3. CLAMPING PLATE IS NOW 7 SEGMENTS IS WAS PREVIOUSLY 6.
4. SEALING SKIN SEAM LOCATIONS MOVED

Item A-15 : Plot: Attachment to Email of May 28, 1997.



820654
new 87-11

ERNIE,

IF YOU HAVE ANY QUESTIONS PLEASE A-16
CALL ME AT GSA EXT 2377

file notes

subject	SEALING SKIN DRAWING PKG	page	1	of	14
		file no.			
	LEO FORTIN	date	MARCH 11/97		

Pg.

DESCRIPTION

2

ISO OF EXISTING DIV. PLT. ARRANGEMENT.

3

PLAN VIEW OF DIVISION PLATES, WITH DIMENSIONS

4

EDGE VIEW OF EXISTING DIV. PLATES.

5

EXPLODED VIEW OF NEW SEALING SKIN, CLAMPING PLATE
INSTALLATION

6

ISO OF NEW SEALING SKIN / CLAMPING PLATE INSTALLATION.

7

PLAN VIEW OF SEALING SKIN / CLAMPING PLATE (REF ONLY).

8

PLAN VIEW OF CLAMPING PLATES.

9

PLAN VIEW OF SEALING SKIN

10

PLAN VIEW OF TYPICAL BOLT HOLE PATTERN / LOCATIONS.

11

EDGE VIEW OF CLAMPING PLATE / SEALING SKIN INSTALLATION

12

SECTION B-B, TYPICAL CLAMPING PLATE JOINT DETAIL.

13

SECTION E-C, EDGE SEAL DETAIL

14

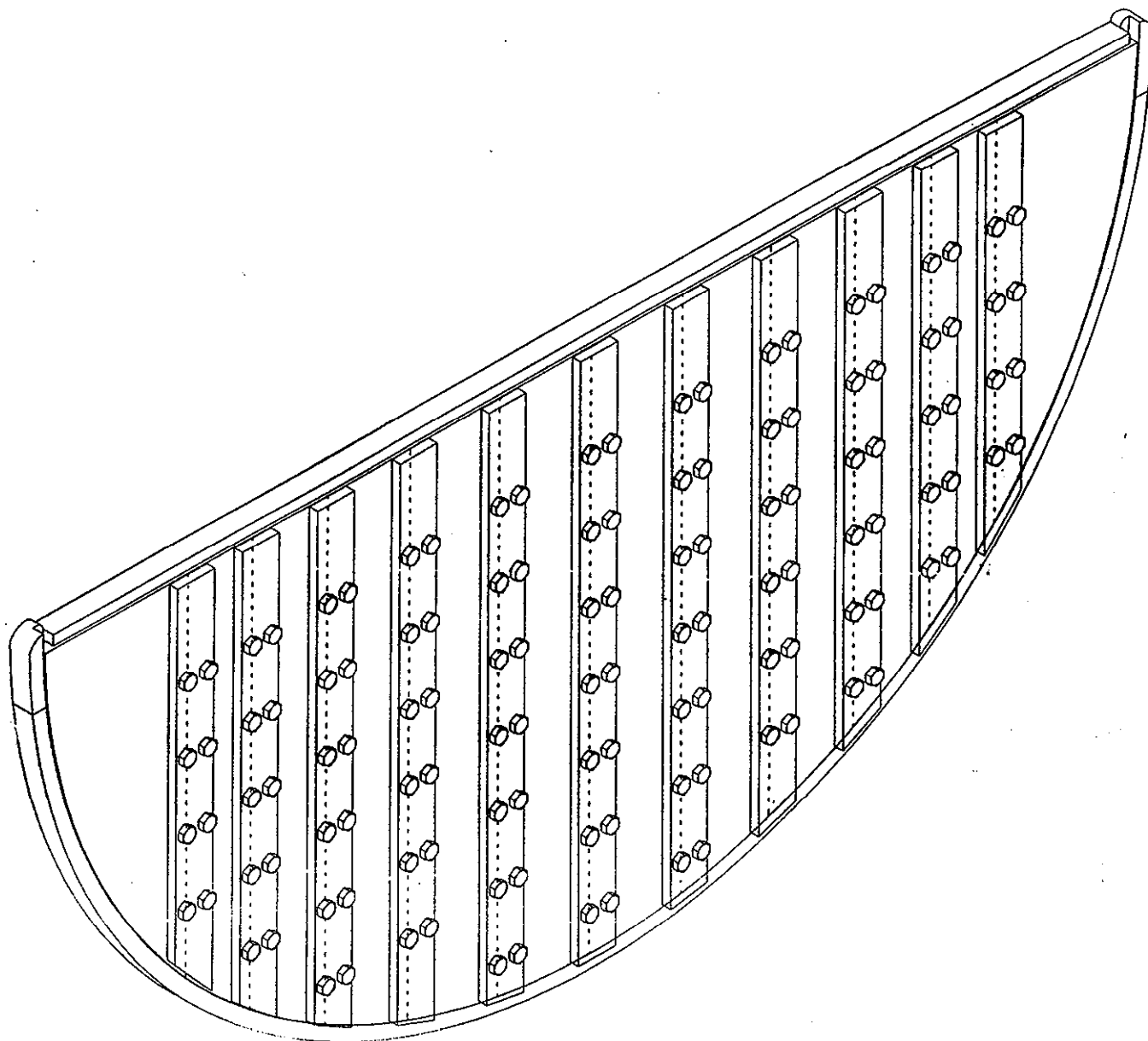
1. EDGE SEAL DETAIL

15

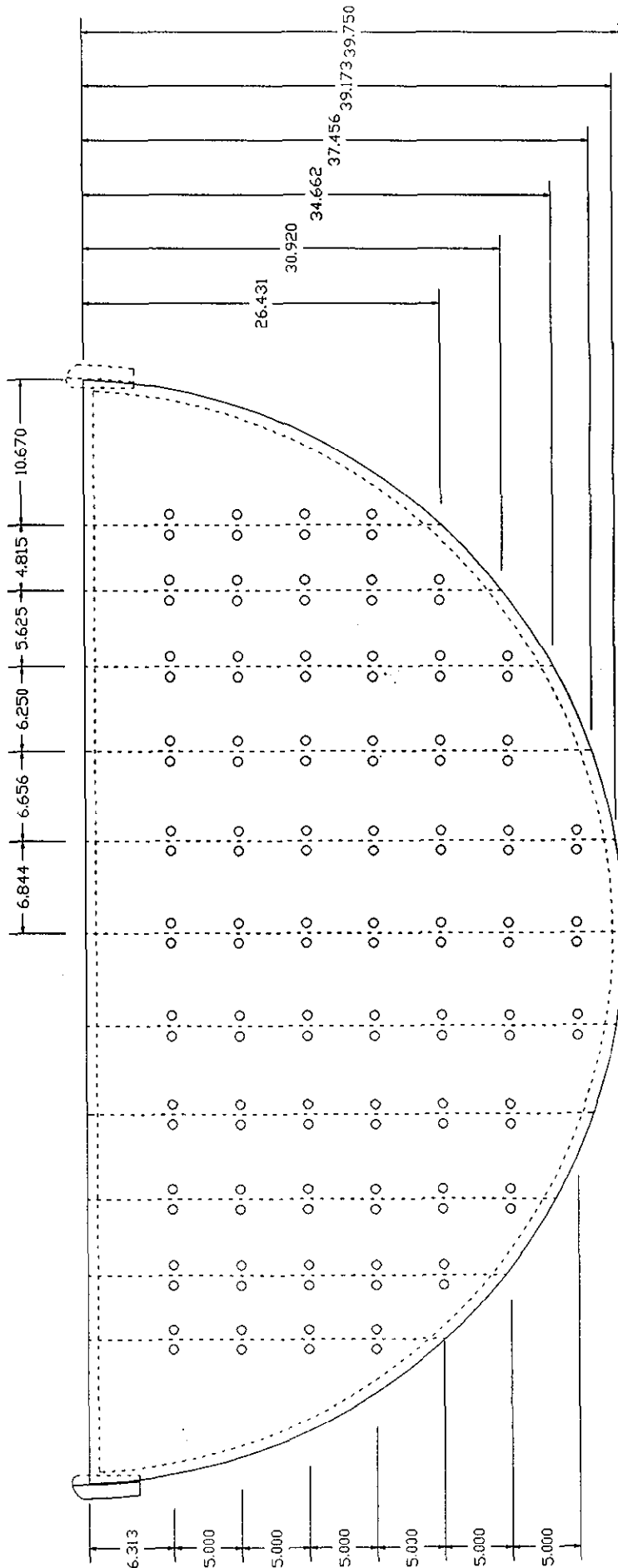
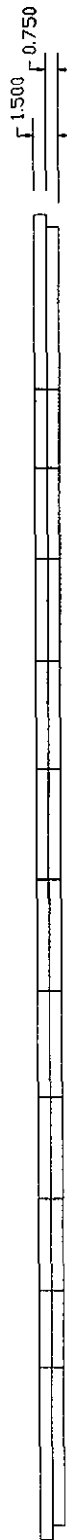
1. SEALING SKIN EDGE BEND DETAIL

16

1. AS INSTALL SEALING EDGE DETAIL.

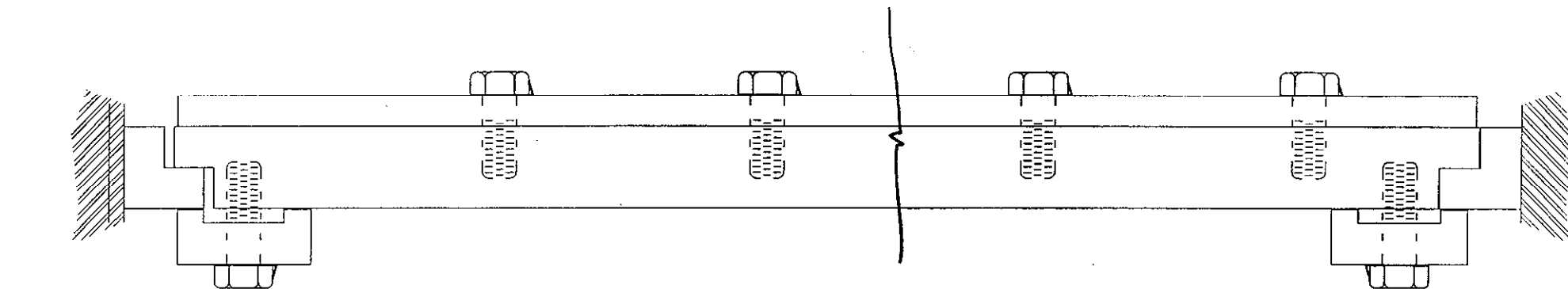


BAND Unit Steam Generators
Existing Divider Plate Arrangement



A-18

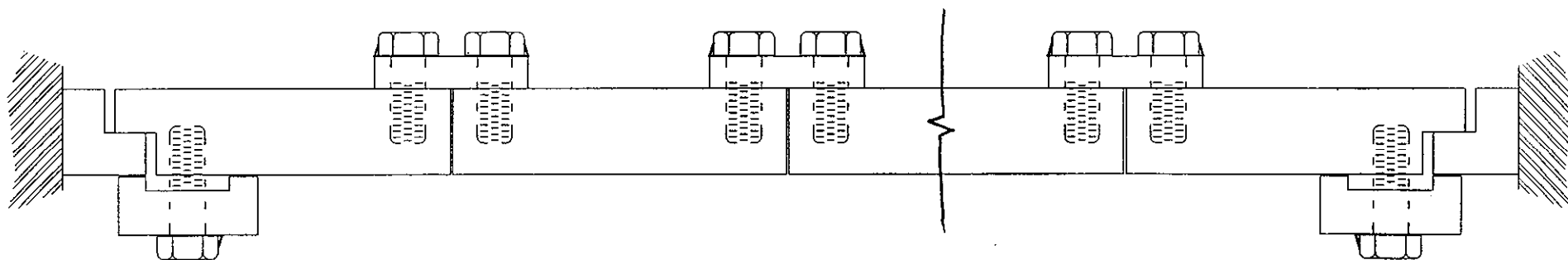
EXISTING DIVIDER PLT LESS CLAMPING BARS.



TUBESHEET

TYPICAL VERTICAL VIEW

HEAD



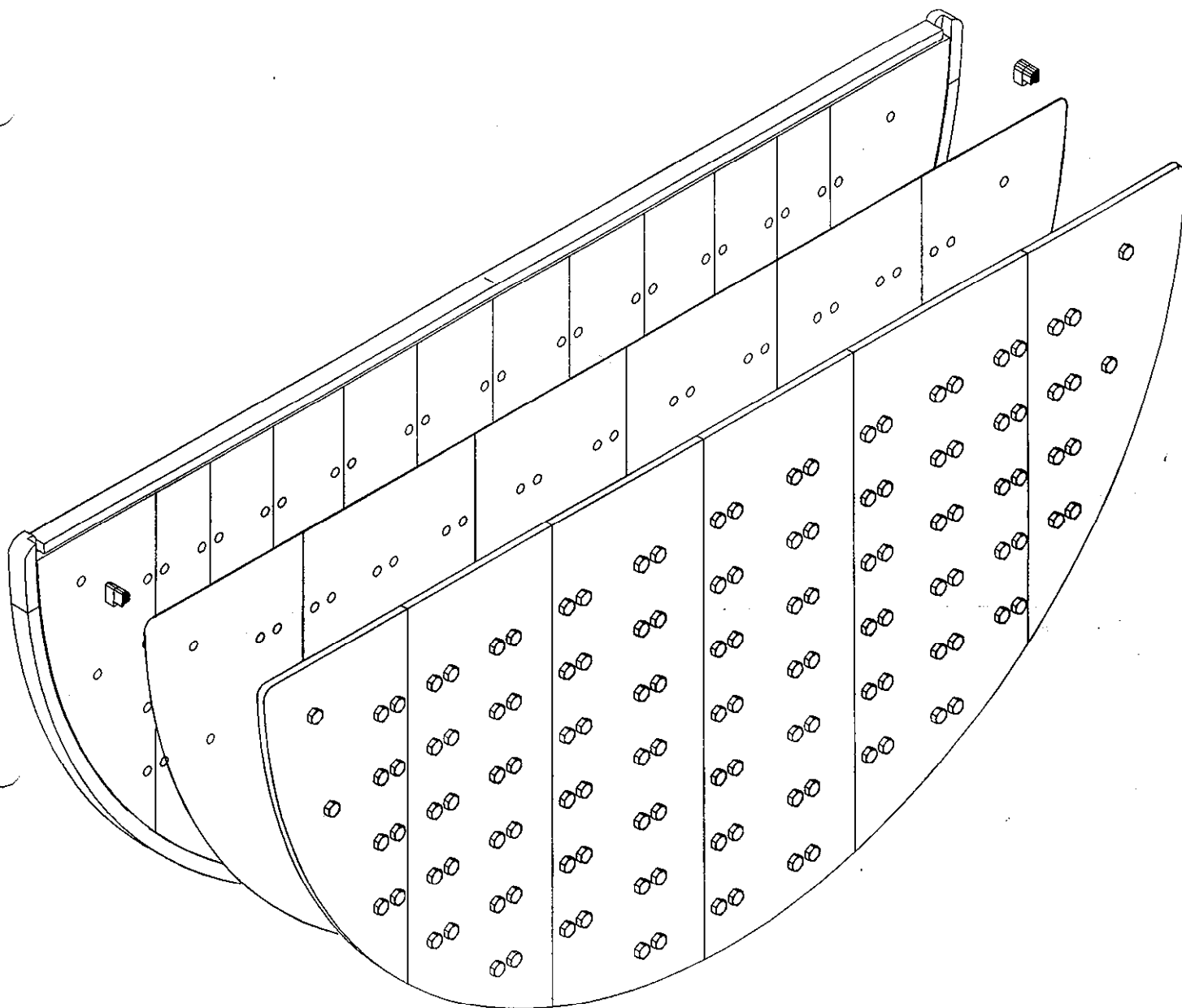
HEAD

TYPICAL HORIZONTAL VIEW

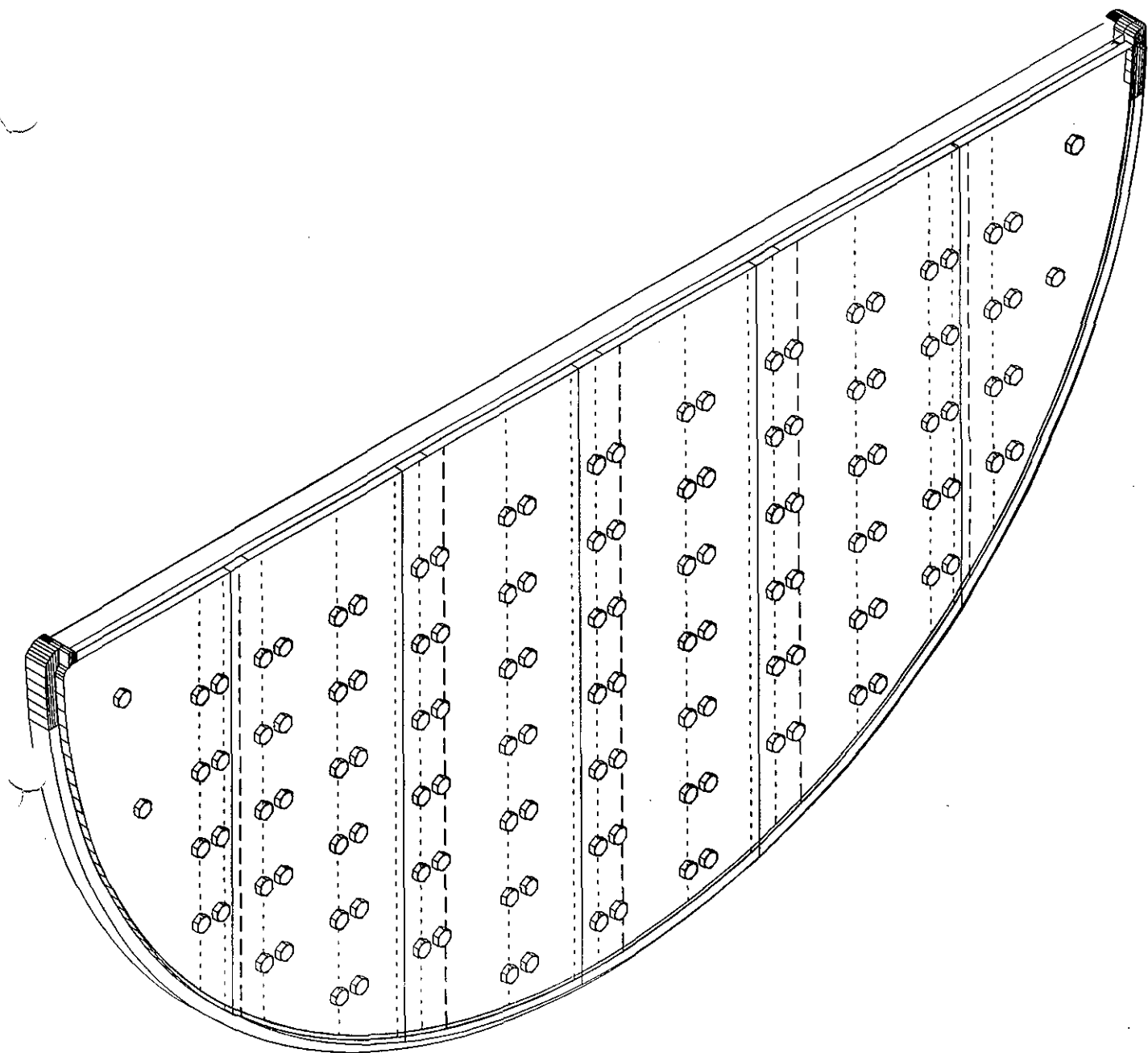
HEAD

TYPICAL PARTIAL DETAIL OF EXISTING
BRUCE A DIVIDER PLATES

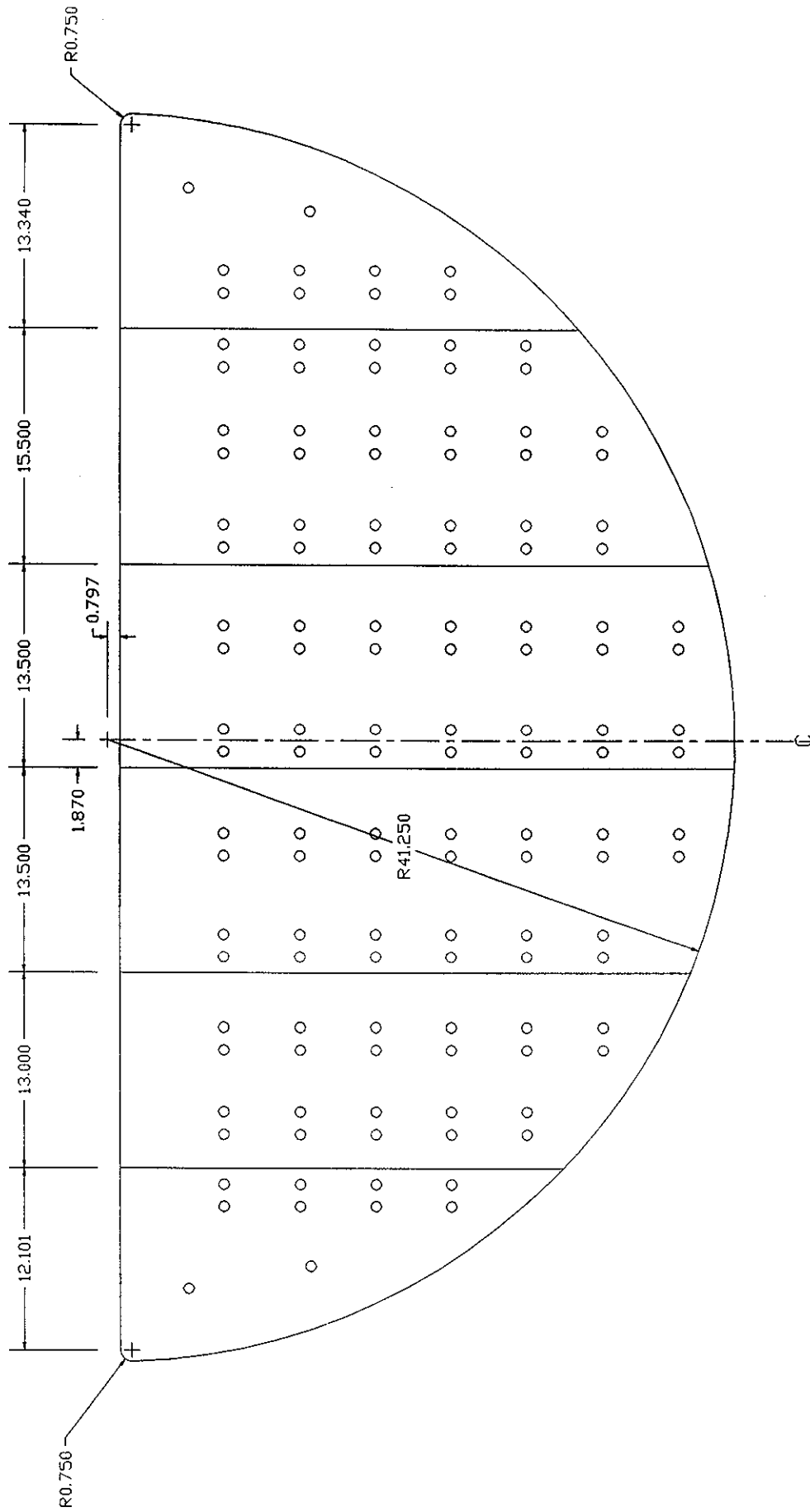
SECTION A-A
DIVIDER PLATE EDGE VIEW
DETAIL REDUCED FOR PRESENTATION.



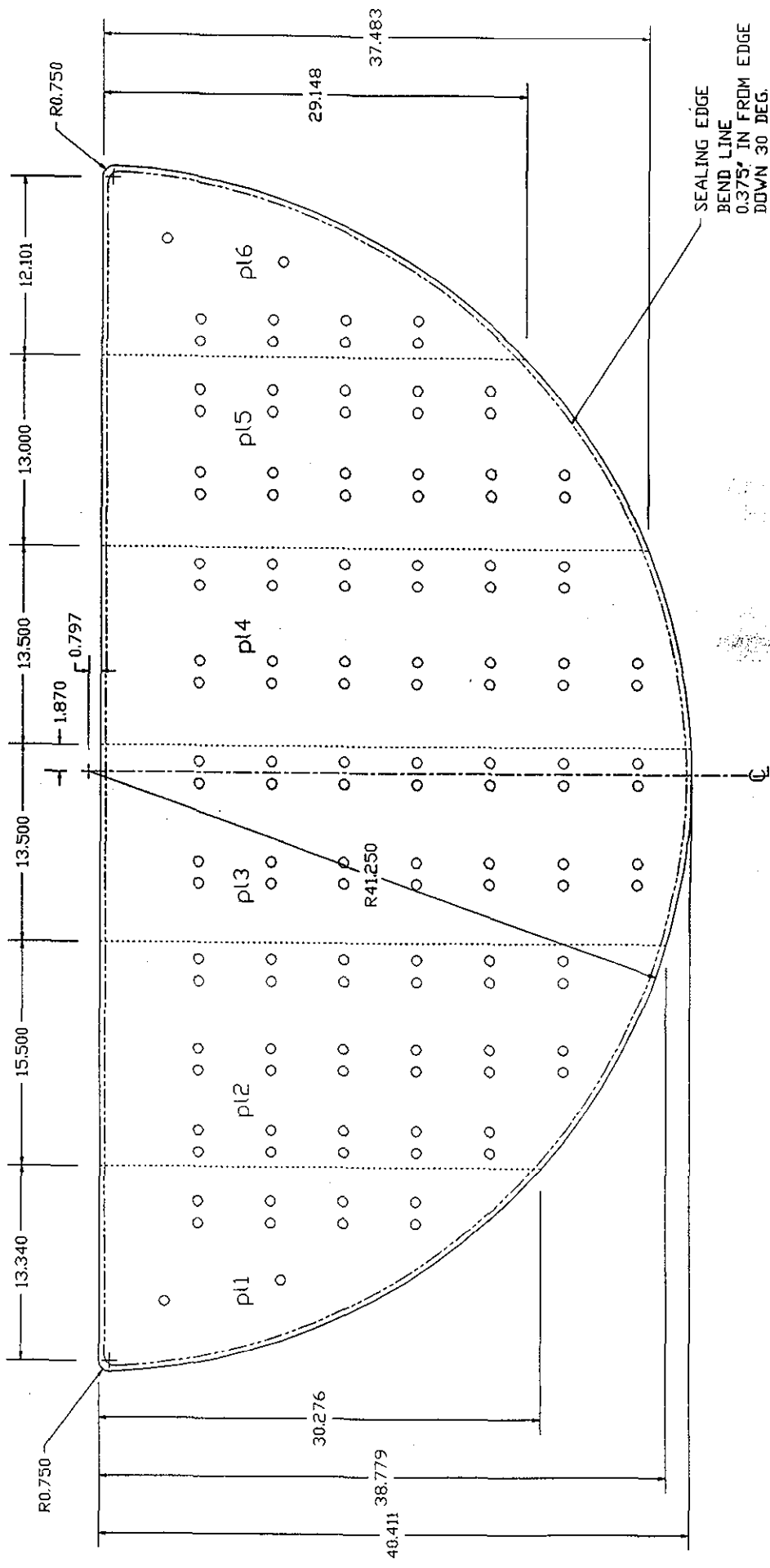
BAND STEAM GENERATOR DIVIDER PLATE
WITH SEALING SKIN AND CLAMPING PLATE INSTALLED



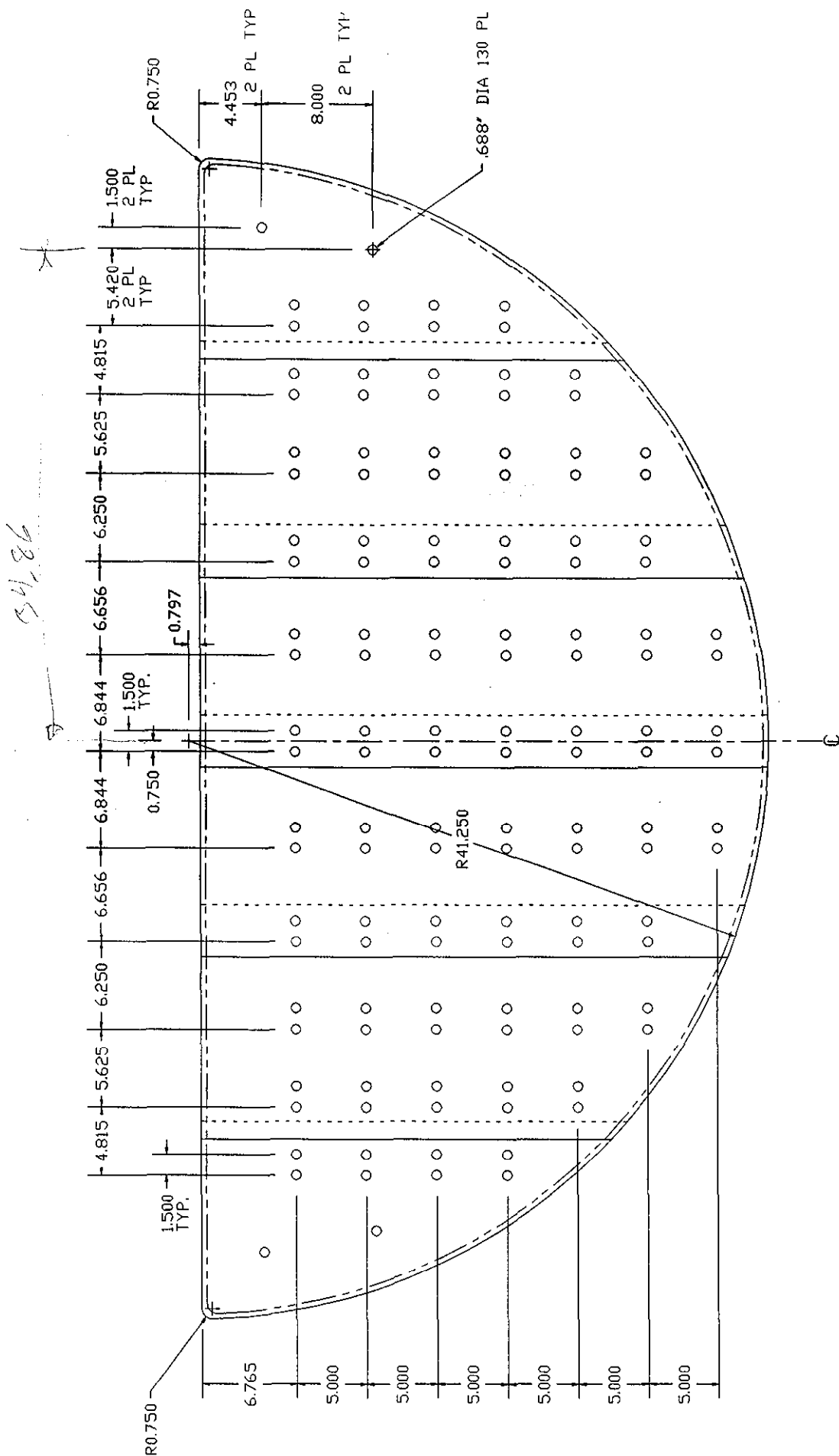
BAND STEAM GENERATOR DIVIDER PLATE
WITH SEALING SKIN AND CLAMPING PLATE INSTALLED



CLAMPING PLATE SEGMENT DIMENSIONS



SEALING SKIN SECTION DIMENSIONS

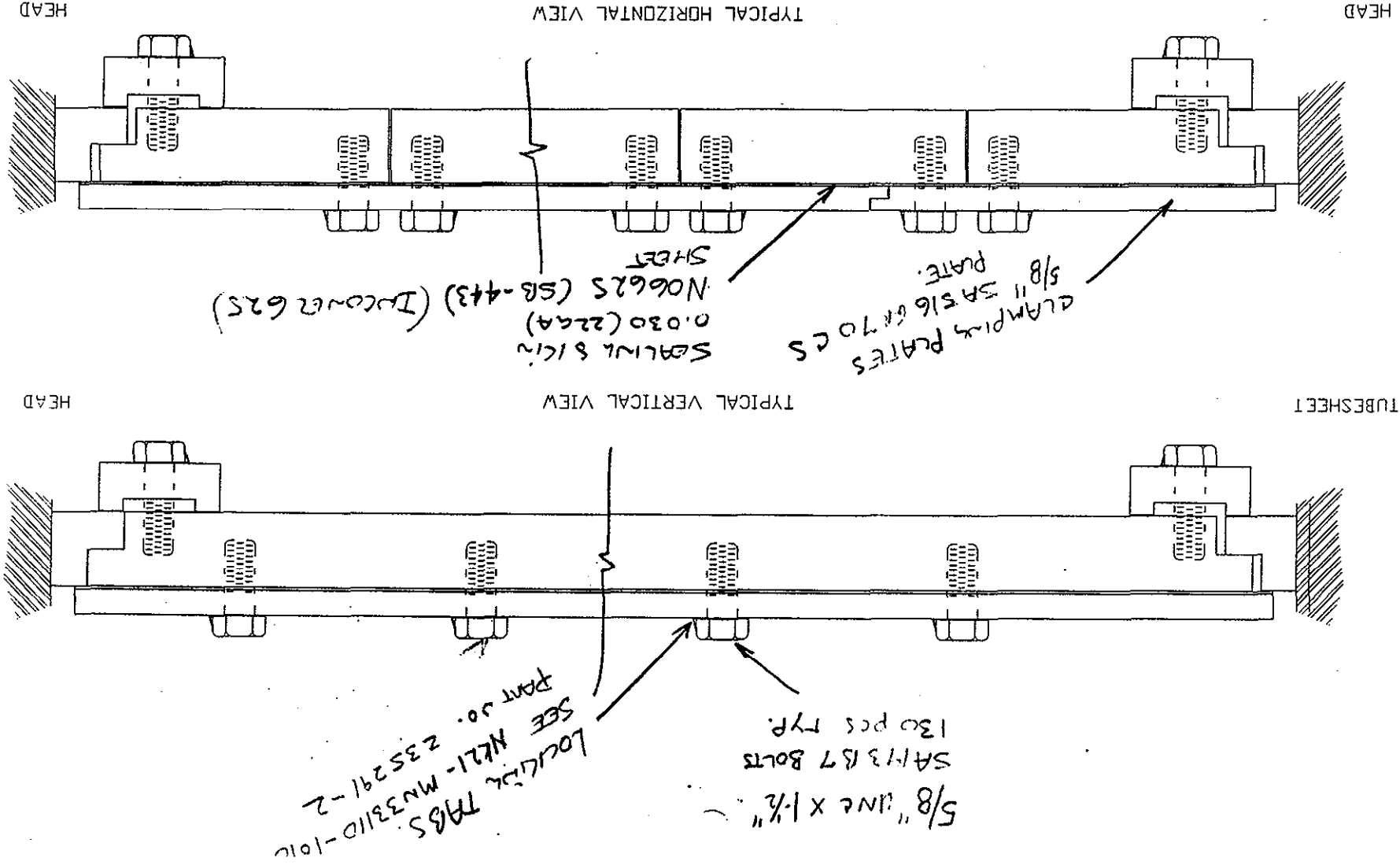


SEALING SKIN AND CLAMPING PLATE BOLT HOLE PATTERNS

A-26

9150 11

SECTION A-A
DIVIDER PLATE EDGE VIEW
DETAIL REDUCED FOR PRESENTATION



TYPICAL CLAMPING PLATE
JOINT DETAIL
+ SKIN JOINT DETAIL

SCALING SKIN SECTIONS 625
0.030 INCHES.

LAMPING
RATES
SECTIONS
5/8" OS

0.010
↓
—
↑
—

DIVIDER PLATE SECTIONS

SECTION B-B

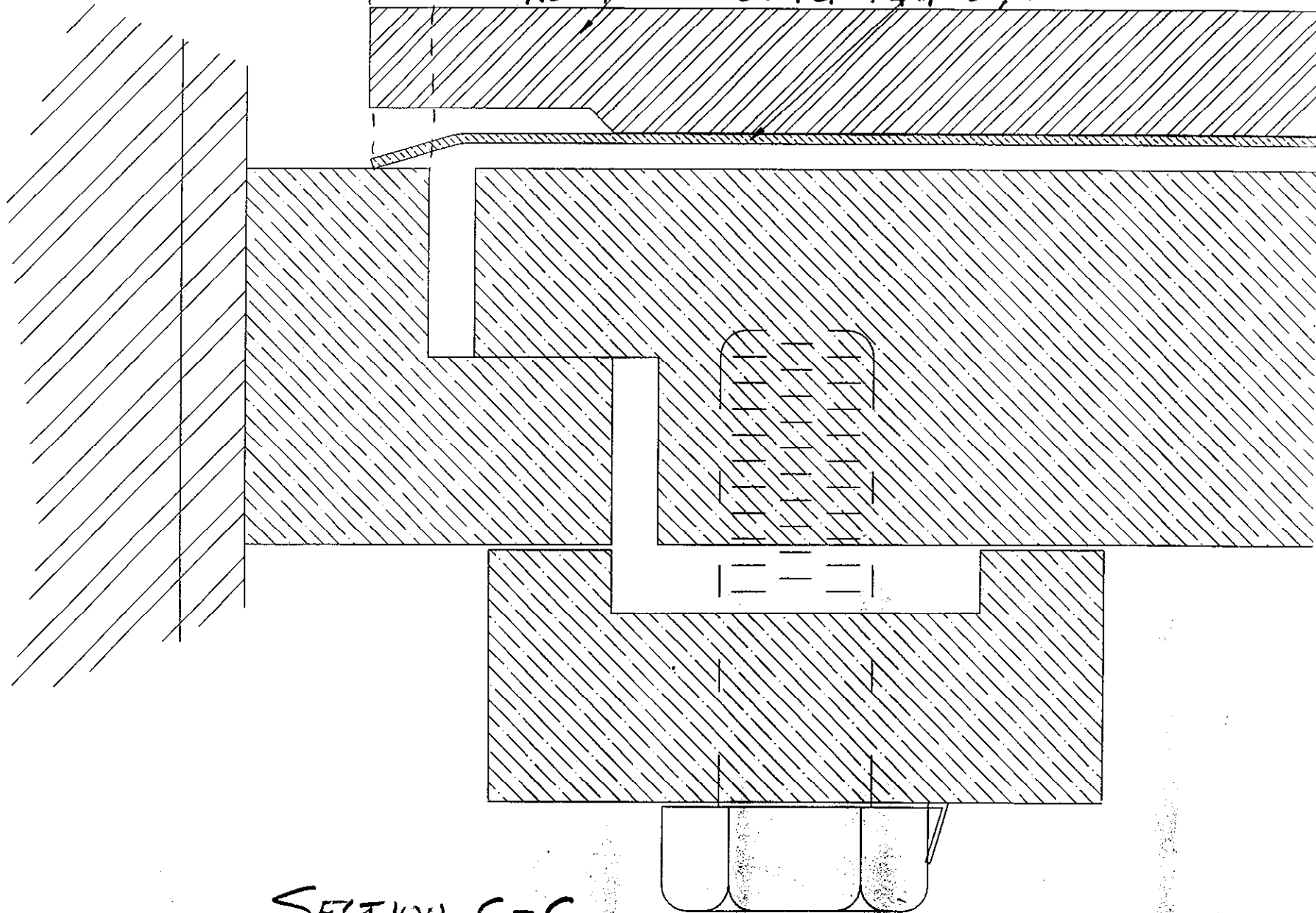
A-27

12 of 16

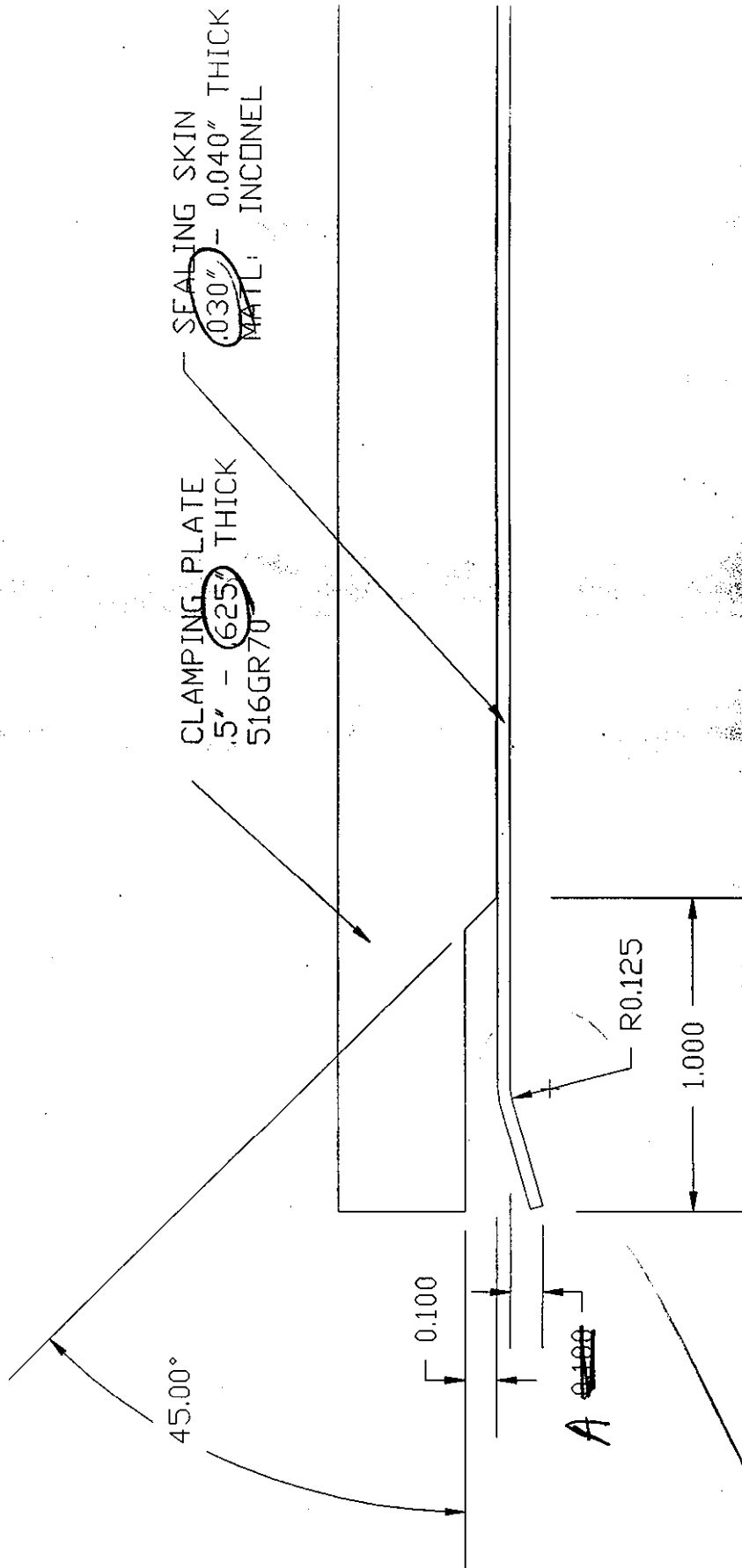
CLAMPING PLATE
.5" - .625" THICK
516GR70

SEALING SKIN
.030" - .040" THICK
MATERIAL: INCONEL

$\frac{1}{4}"$ TYP
ALL AROUND DIV. PLT. PERIPHERY.



SECTION C-C



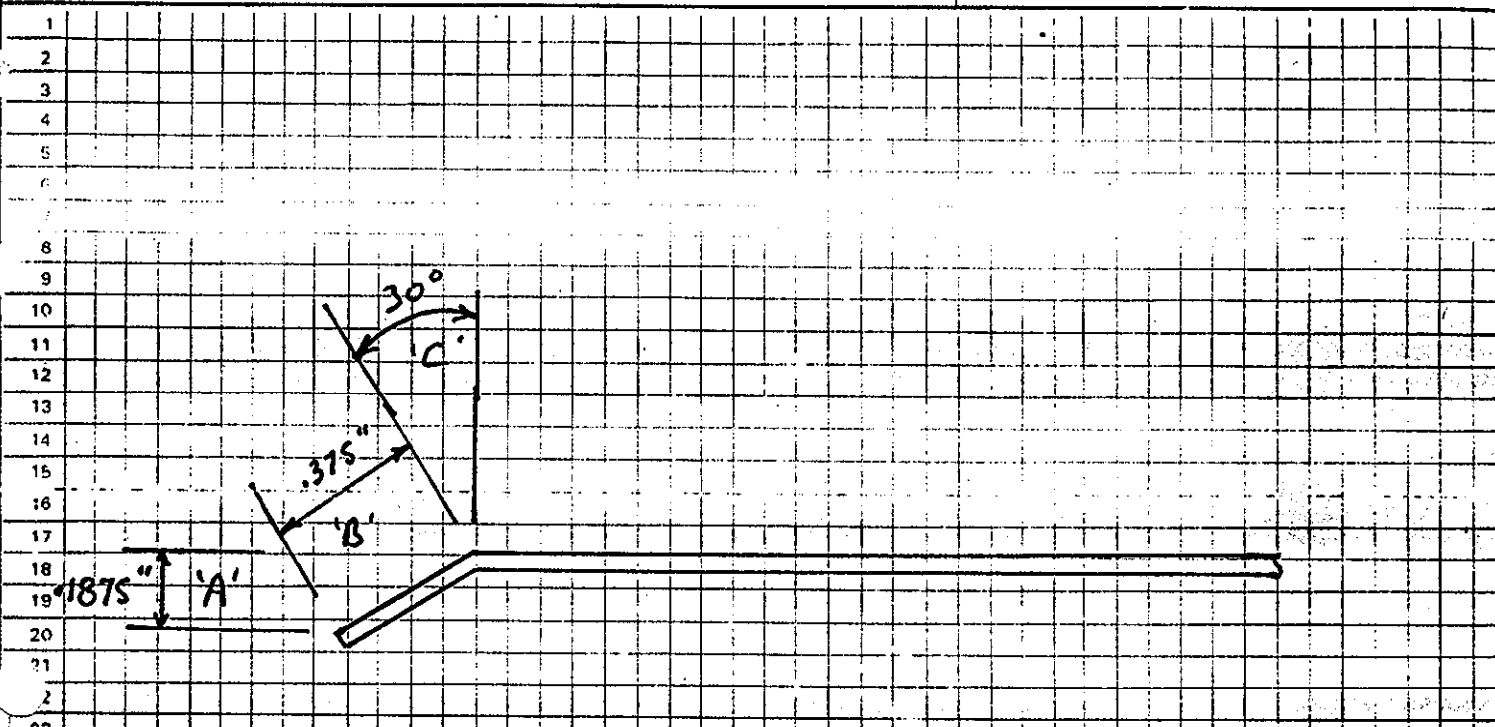
SEE SKIN BOND DETAIL



information sheet
design notes

file no.	sheet no.
date	FEB 14 1997
computed by	L. FONTIN (2377)
checked by	

project	Sealing Skin Mockup	w.o.
description of	DETAIL 'A' SEALING SKIN EDGE BEND.	
references		



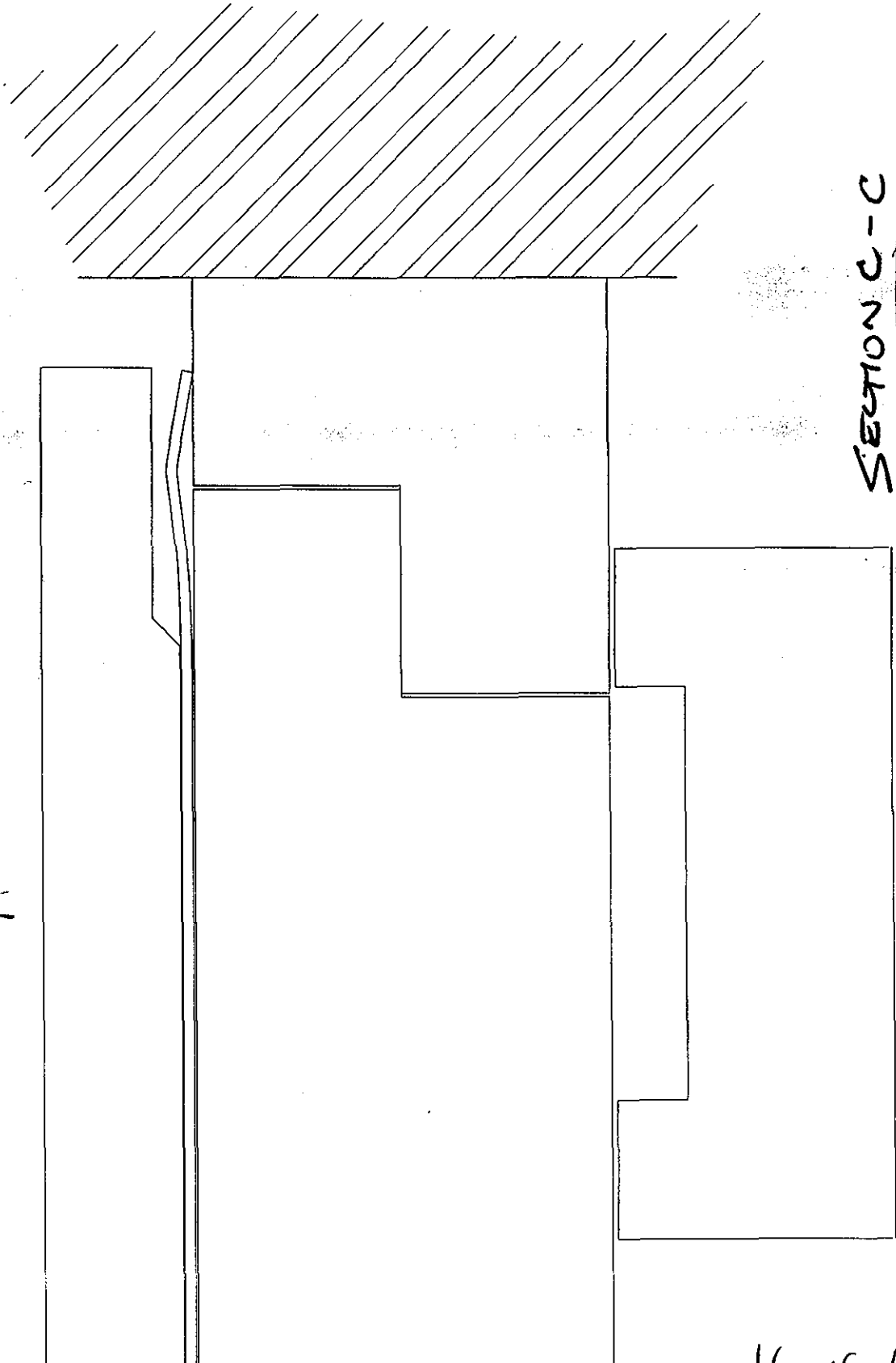
BEND ALONG 13" LENGTH

ITEM	A	B	C
1	1.875	.375	30°
2	.2652	.375	45°
3	.1283	.375	20°

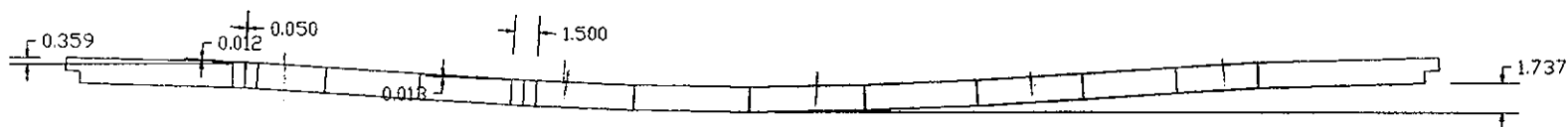
lt.

DETAIL 'A'
EDGE BEND DETAIL

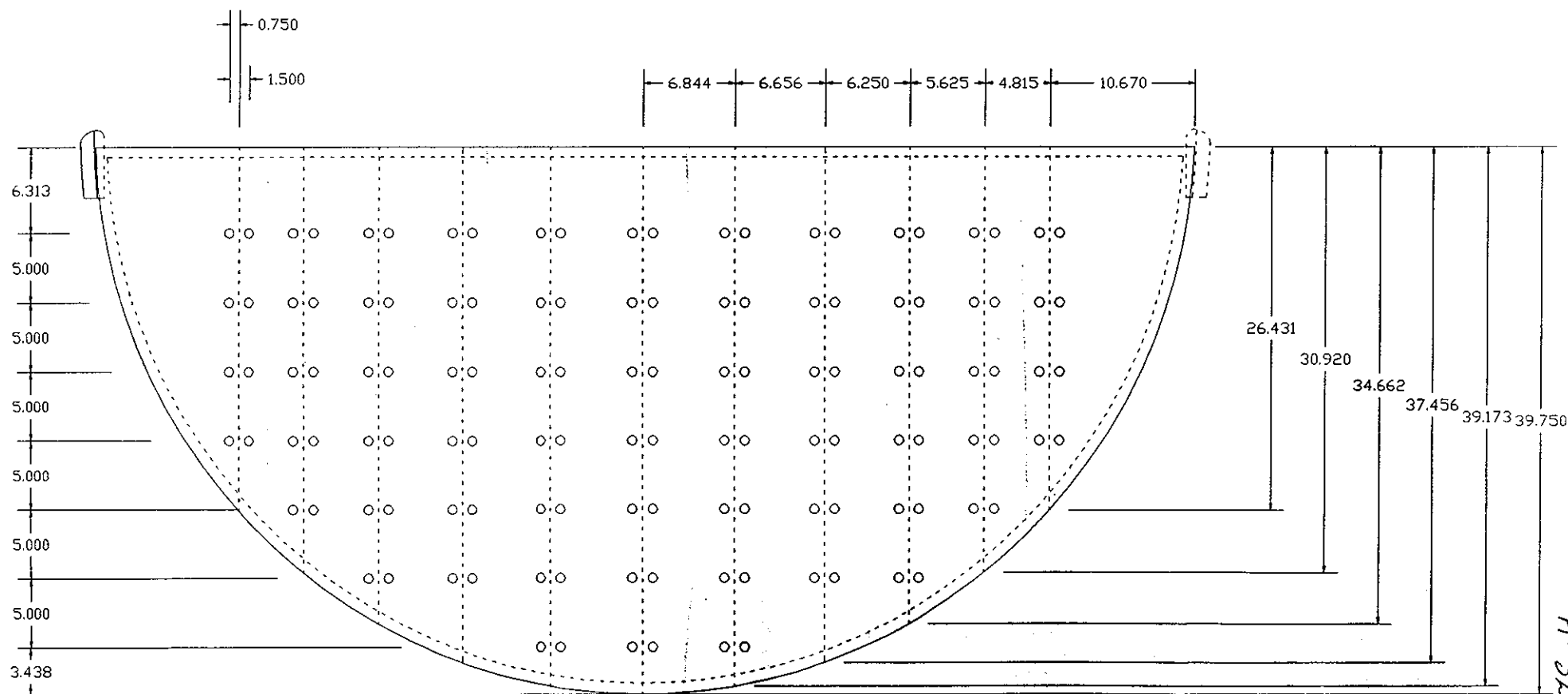
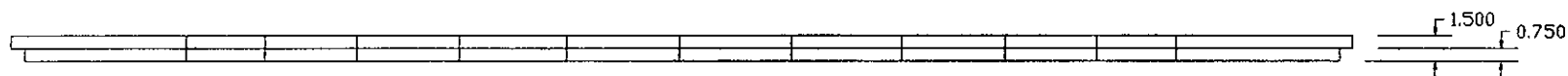
AS INSTALLED

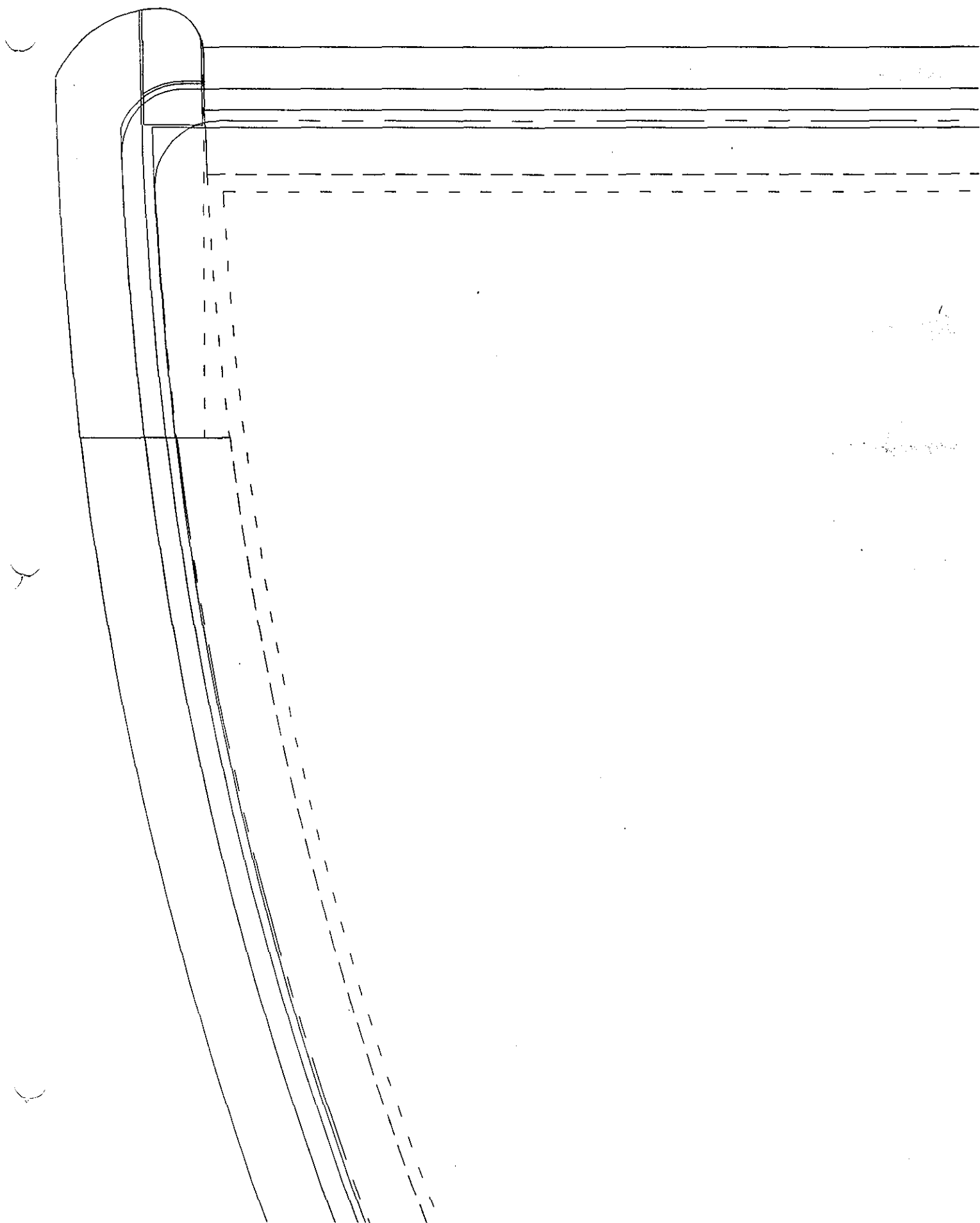


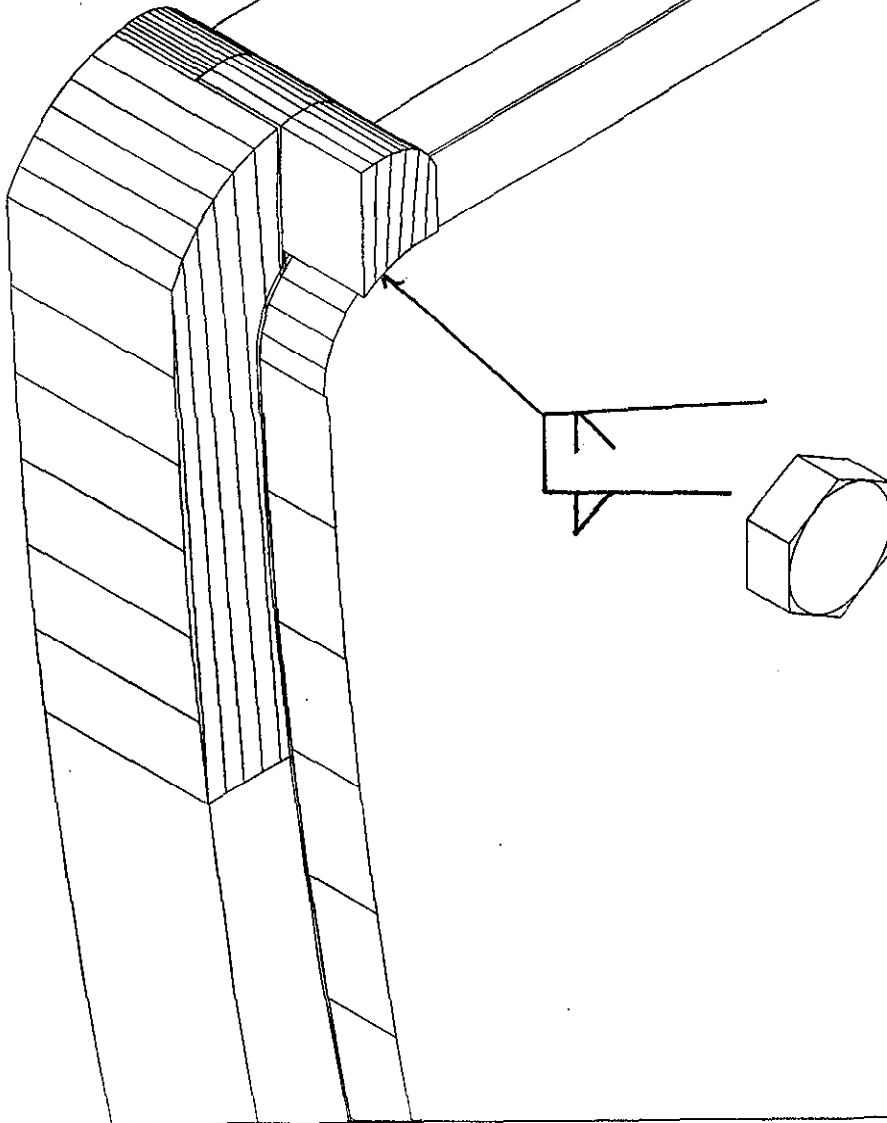
SECTION C-C



deflection under normal operating pressure
53psi note: deflections are multiplied by 10x
for display purposes





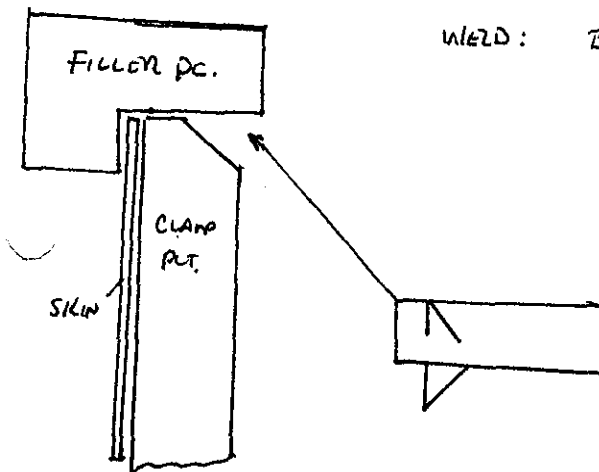


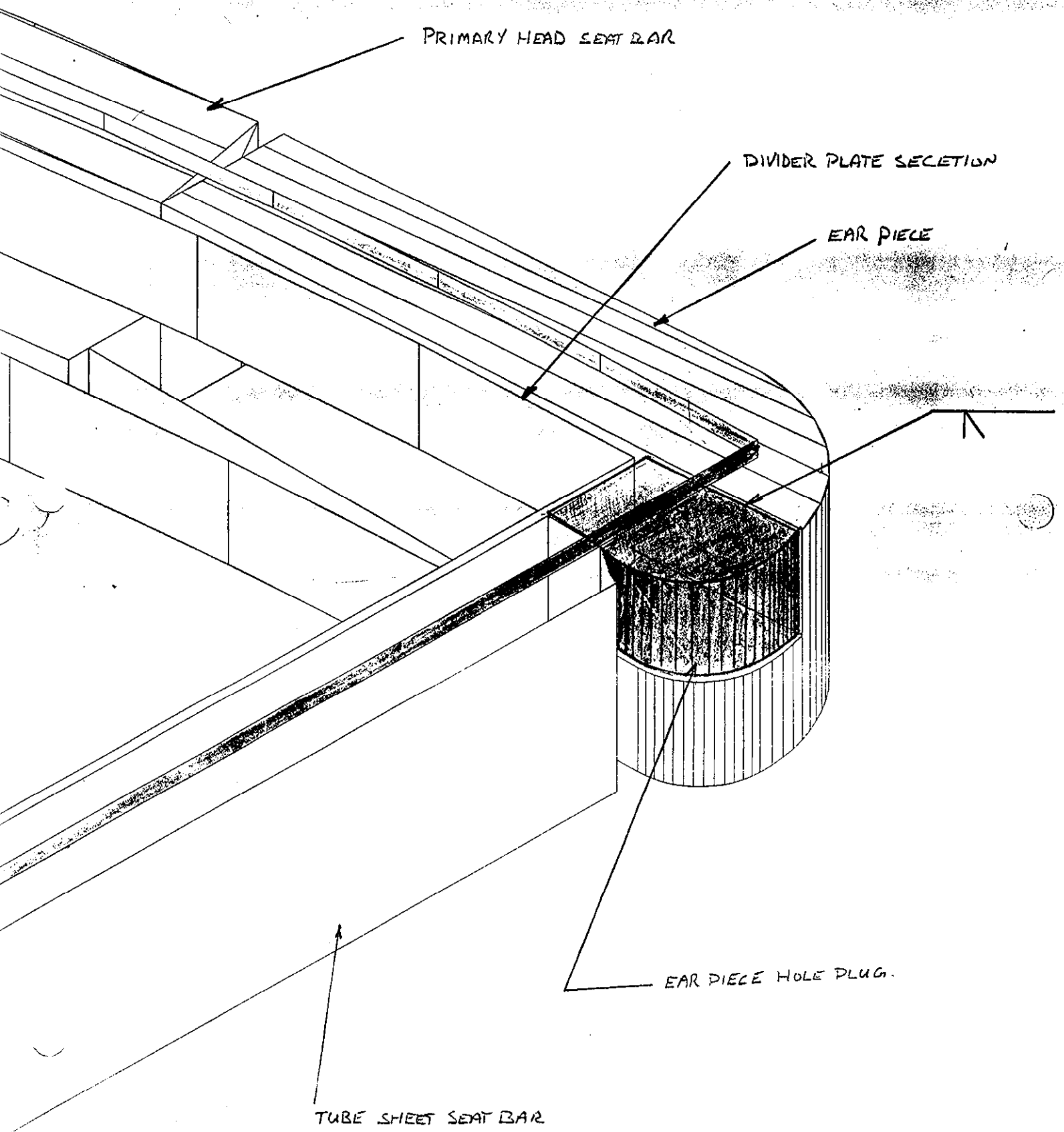
PEAR 13/97. LF

DIVIDED PLATE SEALING SKIN INSTALLATION
SHOWING EAR PIECE PLUG. (FILLER PC.)

NOTE: WELD PREP. BY GRINDING BEVEL IN
CLAMP PLATE

WELD: BEVEL WELD WITH FILLET CAP TO FINISH.



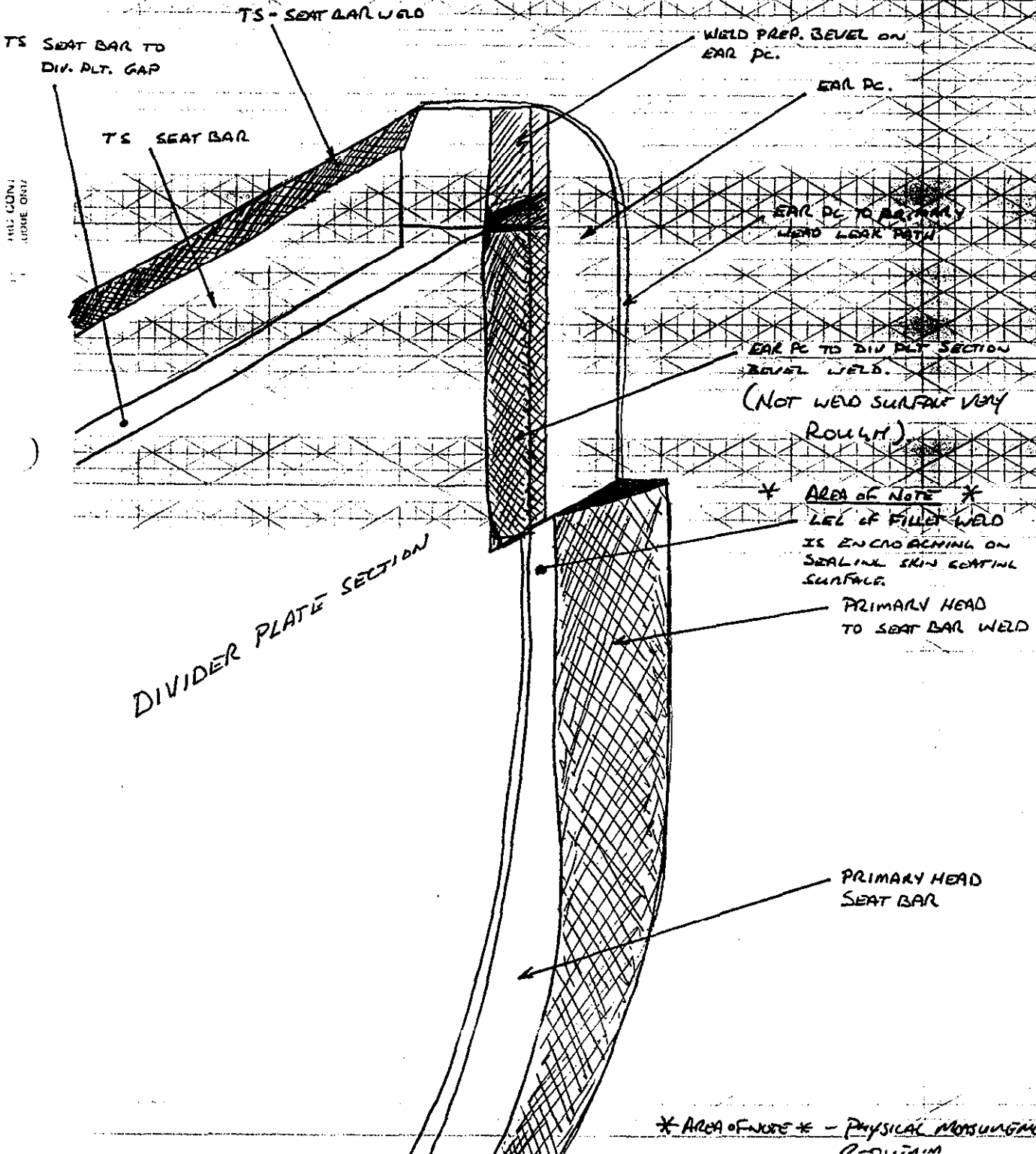


OBSERVATIONS DURING MARCH 13/97

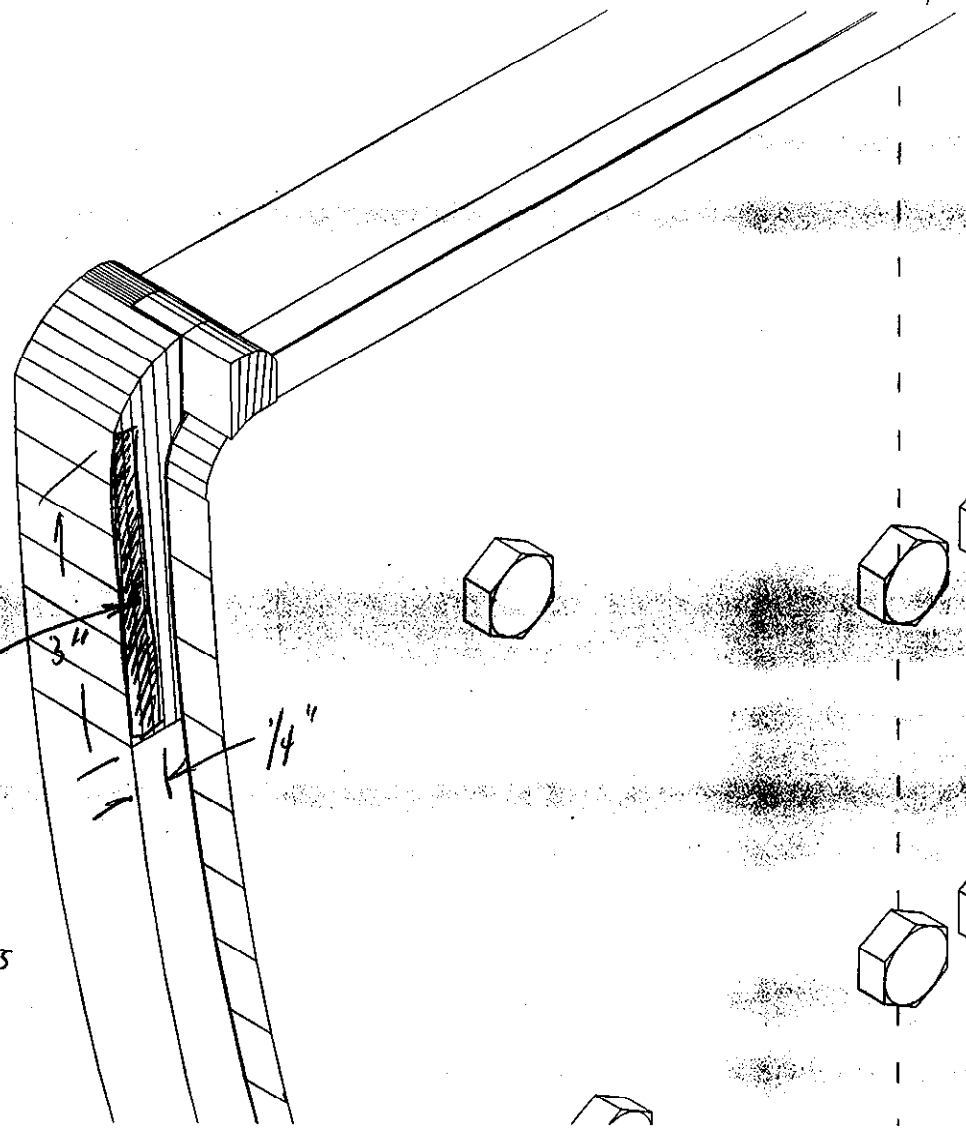
UNIT 2, BO 3 PRIMARY HEAD

HOT LEL DIV. PLT. INSPECTION

LF



A-37



SHIELDING
SUPPORT
CONTACT POINTS
ALLOWED.

AREA (3" X 1/4")

... (DQNA)
... (DQNA)

