CONTROLLED COPY NO. 873

LABORATORY NOTEBOOK

NOTEBOOK NO. 873

CONTINUED FROM NOTEBOOK NO. CONTINUED TO NOTEBOOK NO.

ASSIGNED TO:

NAME Kuang-Tsan K. Chiang

SIGNATURE K.T. Chiang DATE 4/30/07

DATE ISSUED April 30, 2007 BY

PHONE (210) 522-2308 EMAIL kchiang@swri.org

ORGANISATION Southwest Research Institute®

DEPARTMENT

ADDRESS 6220 Culebra Road

CITY San Antonio PROVINCE/REGION Texas

COUNTRY USA POSTAL CODE 78238

DATE NOTEBOOK COMPLETED NUMBER OF PAGES FILLED IN

NOTES: — Luis Ibarra — L.I.

K.T. Chiang KUANG-TSAN K. CHIANG KTC

DJP DANIEL J POMERENING DJP

TITLE PROJECT

Continued From Page

Initial Scientific Notebook Entry for Drip Shield – Waste Package Interaction Test.

Title: Angled (5 degrees, 15 degrees, 45 degrees drip shield) interaction tests, fixed boundary condition tests, free boundary condition tests, ambient temperature tests, elevated temperature test (150 degrees Celcius).

Test Performed by: Luis Ibarra, Daniel Pomerening, Karol Hricisak, Kuang-Tsan Kenneth Chiang

Objective: Study the interaction of drip shield material titanium Grade 5 alloy and waste package material Alloy 22.

Equipment: MTS tensile test machine. Tinius Olson Universal Test Machine KR 6/8/07

Materials: Titanium Grade 5, Alloy 22

Specimen Specifications: Titanium Grade 5 plate per ASTM B265, Hastelloy C22 plate per ASTM B575

Measurement Parameters: Mechanical properties as described in TOP-008. Temperature of environments ±2°C.

Required Level of Accuracy: Ultimate tensile strength ±0.1 ksi, 0.2% yield strength ±0.1 ksi, elongation ±1 percent, reduction in area ±1 percent

Uncertainty and Source of Error: The uncertainty and source of error shall be included in the test report.

Continued To Page

SIGNATURE K. T. Chiang DATE 4/30/2007

DISCLOSED TO AND UNDERSTOOD BY DATE

~~PROPRIETARY INFORMATION~~ 4/17/08 MP

TITLE

PROJECT

Requisition: **07013003**
Requisitioner: He, Xihua
Req Organization: 1.20.01.50
Phone: (210) 522-5194

SOUTHWEST RESEARCH INSTITUTE

Suggested Supplier: President Titanium
City/State: Hanson/MA
Contact: Fred Travers
Phone: 1-800-225-0304 Fax: 1-781-293-3753

Date Printed: 05/15/2007
Date Created: 02/05/2007
Requisition Date: 02/14/2007

Continued From Page Procurement Ti Grade 5 plate, 18 pieces 6"x8"x1 3/4"

Special Instructions: The procurement plan is attached

Line #	Item / Description	U/M	Need By Date	Requested Qty	Est Unit Cost	Estimated Costs
1	Titanium Grade 5 plates, thickness 1.75", dimensions 6" by 8", 18 pieces, 6 square feet total	LB	2/28/2007	259.00	58.04	15,032.36

Deliver To: Xihua He/Bldg. 57
Account: 704-000 Organization: 1.20.01 Project: 06002.01.342 Allocation Pct: 100.00
Total Estimated Cost: $15,032.36

Government Project?: YES Property Type: G1 Is Govt. Property being sent to supplier?: NO

Quality Assurance?: YES Costpoint QC Inspection Required: NO

Is this requisition for or does this requisition include a service (other than a repair)?: YES
Is the service to be performed on or off campus: OFF

To Be Used For: ENG2 mechanical tests

Approvals: Requestor: Xihua He 2/8/2007 11:07:31 AM
Department/Division Management: Asadul H Chowdhury 2/9/2007 8:28:51 AM
Sitakanta Mohanty 2/9/2007 5:14:17 PM Quality Assurance: Robert D Brient 2/9/2007 3:46:02 PM

Submitted By: Shirlee Garcia 2/14/2007 3:51:45 PM

Your organization will provide goods or services in accordance with the requirements of your quality system or that of the Geosciences and Engineering Division Quality Assurance Manual. Technical and quality assurance procedures required in the performance of your staff members' work will be identified in procurement documents. Documentation requirements shall be specified in the purchase order and will be supplied with the product. If scientific notebooks are utilized, they are subject t

SIGNATURE K. J. Cheng
DISCLOSED TO AND UNDERSTOOD BY
DATE 5/1/07
PROPRIETARY INFORMATION 4/17/08 np

Requisition: 07013003
Requisitioner: He, Xihua
Req Organization: 1.20.01.50
Phone: (210) 522-5194

SOUTHWEST RESEARCH INSTITUTE

Suggested Supplier: President Titanium
City/State: Hanson/MA
Contact: Fred Travers
Phone: 1-800-225-0304 Fax: 1-781-293-3753

Date Printed: 05/15/2007
Date Created: 02/05/2007
Requisition Date: 02/14/2007

Continued From Page

Line #	Item / Description	U/M	Need By Date	Requested Qty	Est Unit Cost	Estimated Costs

o periodic submittal and review and must be returned at the conclusion of work to the Geosciences and Engineering Division Quality Assurance or payment will be withheld. Your organization's product will be accepted based on an evaluation by Geosciences and Engineering Division staff and will be returned for rework at Seller's expense if the product does not meet requirements. Additionally, there shall be "right of access" to your facility to confirm effective implementation of the quality requirements with the possibility of audits, source inspections, or surveillances. The Seller shall notify Geosciences and Engineering Division Quality Assurance of any nonconformance to the requirements of this purchase order; further work shall not be done unless directed by Geosciences and Engineering Division Quality Assurance. If there are any Quality Assurance-related questions, please call the Director of Quality Assurance at (210) 522-5537.

MATERIAL CERTIFICATION SHALL ACCOMPANY EACH LOT OF ITEMS SHIPPED. CERTIFICATION SHALL STATE CONFORMANCE TO THE PARTICULAR SPECIFICATION(S) AND INCLUDE REFERENCES TO THE APPLICABLE HEAT NUMBER, LOT/BATCH NUMBER OR DATE CODE WHEN APPLICABLE. THE SUPPLIER SHALL NOTIFY INSTITUTE QUALITY SYSTEMS OF ANY DEFICIENCIES DISCOVERED SUBSEQUENT TO THE DELIVERY OF THIS ITEM.

MILL TEST REPORT SHALL ACCOMPANY EACH LOT OF ITEMS SHIPPED. TEST REPORT SHALL BE IN THE FORM OF A PRODUCTION BATCH ANALYSIS OR LADLE ANALYSIS. CHEMICAL AND/OR PHYSICAL TEST DATA SHALL BE PROVIDED. MATERIAL SHALL BE IDENTIFIED BY HEAT NUMBER, IF APPLICABLE.

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DATE 5/1/07
PROPRIETARY INFORMATION 4/17/08 np

TITLE

PROJECT

Continued From Page Material Receiving Record

Titanium Grade 5, 1 3/4" x 6" x 8", 18 pieces

```
                    B I L L   O F   L A D I N G              No:   LAX 14445
Ship From:                                   Ship Date  12Mar07 at 17:57 From 800
TITANIUM INDUSTRIES, INC                     Probill 821-9985449-1
SANTA FE SPRINGS SERVICE CENTER              Via    ROADWAY
10020 FREEMAN AVENUE                         FOB    SANTA FE SPRINGS, CA
SANTA FE SPRINGS, CA  90670                  Frt    COLLECT
Tel: 562-906-8188 Fax: 562-906-8198          Route   0-  0 Manifest
                                             Vhcle              Trailer
                                             Slp    PAULA MONTES
Consigned To: (001)                          Sold To:  (  4625)
SOUTHWEST RESEARCH INSTITUTE                 SOUTHWEST RESEARCH INSTITUTE
9503 WEST COMMERCE                           P.O. DRAWER 28510
SHIPPING & RECEIVING BUILDING 242            SAN ANTONIO, TX  78228-0510
SAN ANTONIO, TX  78227-1301
Tel: 210-522-5829 Fax: 210-522-3964
==============================================================================
                    B I L L   O F   L A D I N G
1) Our Order TEX-    317-  1 Your PO # 764783G
TITANIUM AERO PLATE 6AL-4V ASTM B265 GRADE 5
1.750" X 6.0000"(+.125/-0) X 8.0"(+.125/-0)
CONTRACT: NRC0202012
AOP: 704-000  1.20.01
        Heat Number      Tag No                        PCS        Wt LBS
        A21A(1.750")     21780                           6            87
        A21A(1.750")     21780C                          6            86
        A21A(1.750")     21780D                          6            85
                         Total:                         18           258
------------------------------------------------------------------------------
                                             Tags      Pcs        Wt LBS
                             TOTAL:             3       18           258

      SHIPPING:
(1) BOX @ 274 LBS GROSS
(18) PCS @ 258 LBS NET      HEAT# A21A
TARE: 16 LBS
DIMS: 10"X 9"X 48" LONG
*************************************************
******************COLLECT************************
*************************************************

DIM /  QTY /  PCS /  WT /  TRS /  P/C  /QCS
CLASS 70 RELEASE VALUE @ $.40/LB
```

Ht#

RECEIVED, subject to the classifications and tariffs in effect on the date of receipt by the carrier of the property described in the Original Bill of Lading...

1 .... Last

THIS MEMORANDUM is an acknowledgement that a bill of lading has been issued and is not the Original Bill of Lading, nor a copy or duplicate, covering the property named herein, and is intended solely for filing or record.

SIGNATURE OF CONSIGNOR	CARRIER	FREIGHT
X	AGENT PER (Driver's Signature) X	Prepaid ☐ Collect ☒ COD ☐ $
If charges are to be prepaid, write or stamp here, "To be Prepaid." RECEIVED	To apply in payment of the charges On the property described herein. AGENT OR CASHIER	CHARGES ADVANCED $

Continued To Page

SIGNATURE K. J. Chiang DATE 5/2/07

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TITLE

PROJECT

Continued From Page Certification

Customer Southwest Research Institute
PO# 764783G
SO# TEX-317
Wgt. 258 Pcs. 18

Page 1 of 5

CERTIFICATE OF TEST

Traveler(s)		Heat #	Ingot#
37485	B	A21A	

Prof Rev 1

ALLVAC
P.O. Box 460 530 34th Avenue, SW
Albany, OR 97321-0580
Phone (541) 967-9000

Customer Name	Purchase Order	Size	Alloy
TITANIUM INDUSTRIES, INC.	CRP-26609	SEE BELOW	ALLVAC 6-4

Rockaway Service Center 18 Green Pond Road
Rockaway, NJ

PCS 1 Weight 2115 lbs.

Completion Date: 03/06/2007 Quality Auditor: Todd Langer *Todd E Langer*

SPECIFICATIONS

AMS 2631	B	CLASS A1		AMS 4911	J		
AMS-STD-2154	09/05	TYPE 1	CLASS A	AMS-T-9046	A	CODE AB-1	COND. A
ASTM B265	2006B	GRADE 5		ASTM F1472	2002A		
BS 2TA11	1974			BS 7252 PART 3	05/01/97	ALLOY 6-4	
BS TA56	1974	AM.1		DMS 1592	G		
ISO 5832-3	3	ALLOY 6-4		LN 9297	91	AMD A1	
MIL-STD-2154	09/30/82	TYPE 1	CLASS A	MIL-T-9046	J AM2	CODE AB-1	COND. A
S-1000	01/03/2005			S-400	09/01/2006		

PLATE ID / DIMENSIONS:
A2 - 1.750" X 51.3125" X 143.375"

TI QA 15

HEADER REMARKS

THIS PLATE WAS MANUFACTURED AND TESTED UNDER LOT# 37485A. IT HAS BEEN TRANSFERRED TO THIS TRAVELER FOR THE PURPOSE OF SHIPMENT.

Continued To Page

SIGNATURE K. J. Chiang DATE 5/2/07

DISCLOSED TO AND UNDERSTOOD BY DATE

HEADER REMARKS

This material was manufactured and tested as rolled plate in accordance with the requirements of the plate product specification(s) called out by the purchase order for said material. The test data reported for this product, or portions cut/sectioned from this product, also demonstrates the products capability of meeting the testing requirements of the bar product specification(s) called out by the purchase order for said material; as they may be applicable to and capable of the product sizes provided. Required test specimen orientations and locations are limited to the dimensions of the parent rolled plate product.

CHEMISTRY

CR EQ = Chromium Equiv Cb = Nb

	C	C Tested At	Si	Mn	Mo	Ti	Al	Ti+Al	V	Fe	Cu	XRF Tested At
TOP	.016	WAH CHANG	.02	<.01	<.01	BAL	6.12	-	3.99	.20	<.01	WAH CHANG
BOTTOM	.016	WAH CHANG	.01	<.01	<.01	BAL	6.12	-	3.88	.16	<.01	WAH CHANG

	B	B Tested At	Zr	Y	Y Tested At	O	N	O/N Tested At	Sn	Sn Tested At	Cr	Cb	Ta	Ni
TOP	<.01	WAH CHANG	<.01	<.0005	WAH CHANG	.1770	.0052	WAH CHANG	<.01	WAH CHANG	.02	<.01	<.01	.02
BOTTOM	<.01	WAH CHANG	<.01	<.0005	WAH CHANG	.1930	.0058	WAH CHANG	<.01	WAH CHANG	.02	<.01	<.01	.01

H

PLATE A2 .0082

CHEMISTRY REMARKS

Chemistry tested at ALLVAC unless otherwise noted.

BETA TRANSUS CALCULATED BY CHEMISTRY:
TOP = 1811F
BOTTOM = 1824F

Wah Chang/GE Aircraft Engine Code 91974 applies.

Continued To Page

SIGNATURE K. J. Chiang DATE 5/2/07

PROPRIETARY INFORMATION 4/17/08 mp

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Continued From Page

Certification

TITLE PROJECT

BOOK - 6 PAGE

CHEMISTRY REMARKS

Note: Metallics are analyzed by ICP, gases are analyzed by inert gas fusion or combustion.

As Shipped Tensile Test

Operation	Ingot	Heat Treat Code	Test Dir	Temp F	UTS ksi	.2% Yield ksi	.02% Yield ksi	%EL 4D	%EL 5D	%RA	Gage Length 4D	Gage Length 5D	Tensile Diameter	Tested At
		VCF2	LM	ROOM	145.4	136.3		18.9		31.4	1.001		0.2535	ALLVAC MONROE
		VCF2	LTM	ROOM	146.5	137.0		14.5		26.2	1.001		0.248	ALLVAC MONROE
		VCF2	LM	ROOM	142.4	133.7			20.6	35.0		1.107	0.2245	ALLVAC MONROE
		VCF2	LTM	ROOM	143.3	135.4			16.7	35.1		1.107	0.221	ALLVAC MONROE

Test Dir: L = Longitudinal, T = Transverse, ST = Short Transverse, LT = Long Transverse,
TC = Transverse Center At Size, TM = Transverse Mid-Radius At Size,
PC = Pancake, DB = Drawbar, PD = Paddle, TT = Top Transverse At Size,
BT = Bottom Transverse At Size, LC = Long Center, TX = Top Transverse Mid-Radius At Size,
LM = Longitudinal Mid Radius, LS = Longitudinal Surface, TS = Transverse Surface
Operation: SUPER = Crosshead Sep Rate of .10 inches/minute

TENSILE/STRESS RUPTURE HEAT TREATMENT

HT Code: VCF2

Location	Temp F	Hours	Mins	Furnace Cool Rate Per Hrs (F)	Cool Code	
PLANT	1450	6		FC	VCF 6 HRS. MIN.	

METALLOGRAPHY

Microstructure evaluated in accordance with the referenced specifications and found acceptable.
Microstructure evaluated and found acceptable to to ETTC-2 Figures A5, & A6.
Material evaluated and determined to be free of alpha case.

CONDITION SHIPPED

Continued To Page

SIGNATURE K. J. Chiang DATE 5/2/07

PROPRIETARY INFORMATION 4/17/08 mp

DISCLOSED TO AND UNDERSTOOD BY

Continued From Page

TITLE PROJECT

BOOK - 7 PAGE

Continued From Page

Traveler(s) 37485 B | Heat # A21A | Ingot#

ALLVAC P.O. Box 460 530 34th Avenue, SW Albany, OR 97321-0580 Phone (541) 967-9000

CONDITION SHIPPED

HEAT TREATMENT: VCF ANNEALED AT 1450F (+/- 25F) FOR 6 HOURS MINIMUM
SURFACE CONDITION: DESCALED
Hot Rolling performed at Allgheny Ludlum (Washington, PA)
Heat Treatment and Final Inspection performed at Rome Metals (Monaca, PA)

REMARKS

Material has been produced, sampled, inspected, and tested in accordance with the customer purchase order and referenced specifications and conforms to the requirements unless otherwise noted in this certificate of test.

Any deviations to specification or customer purchase order requirements relative to testing, test values, hot working fixed practices, have been resolved in writing with customer prior to shipment.

The recording of false, fictitious, or fraudulent statements or entries on this document may violate Federal statutes, including but not limited to Title 18, Chapter 47 of the United States Code, and may be punishable as a felony.

If customer purchase order does not specifically reference a revision to a specification, Allvac will work to the latest revision on file and in effect at time of order placement.

Test methods are per the latest ASTM Standards, currently recognized industry practices; or as agreed upon between Allvac and customer.

Any chemical elements analyzed and found to have values below the actual limits of detection may be reported as < less than or reported at the detection level.

When values are reported to the significant places called for in the specifications, rounding will be done in accordance with ASTM E-29.

This is to certify that during manufacturing, handling, testing and inspection, this material did not come in direct contact with mercury or any device employing a single boundary of containment.

This Certificate of Test shall not be reproduced except in full, without the written approval of Allvac Quality.

No weld repair has been performed on this material.

Material Safety Data Sheets (MSDS) - View or print from our site: www.allvac.com. Printed copies available on request from the Allvac Sales Department.

Continued To Page

DISCLOSED TO AND UNDERSTOOD BY

SIGNATURE K. J. Church

DATE 5/2/07

PROPRIETARY INFORMATION
4/17/08 MP

Continued From Page

Traveler(s) 37485 B | Heat # A21A | Ingot#

ALLVAC P.O. Box 460 530 34th Avenue, SW Albany, OR 97321-0580 Phone (541) 967-9000

Allvac products have not come in contact with radioactive, fertile or fissionable materials during manufacturing or processing.

Melt source in compliance with DFAR 252.225-7014, Alternate 1.

SPECIAL REMARKS

Material melted and manufactured in the United States of America.

INGOT SOURCE: ATI ALLVAC (ALBANY, OR)

Allvac Laboratories approved to S400 (Certified Materials Test Laboratory - Metallic Materials).
VENDOR NO. 87012

This material has been produced and qualified in accordance with the manufacturing and approval requirements of DMS 1592 and DMS 2442.

Continued To Page

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SIGNATURE K. J. Church

DATE 5/2/07

PROPRIETARY INFORMATION
4/17/08 MP

TITLE Alloy 22 plate, 6"x3"x 3/4" PROJECT

Requisition: **07016662**
Requisitioner: Chiang, Kuang-Tsan K
Req Organization: 1.20.25.10
Phone: (210) 522-2308

SOUTHWEST RESEARCH INSTITUTE

Suggested Supplier: Haynes International, Inc.
City/State: Houston/TX
Contact: Joy Lucas
Phone: 713-937-7597 Fax: 713-937-4596

Date Printed: 05/15/2007
Date Created: 03/08/2007
Requisition Date: 03/19/2007

Special Instructions: Material certification shall be supplied with the material.

Line #	Item / Description	U/M	Need By Date	Requested Qty	Est Unit Cost	Estimated Costs
1	Hastelloy C-22 plate (B575), 3/4"x3"x6"	EA	3/23/2007	18.00	146.03	2,628.54

Deliver To: B/57

Account: 704-000 Organization: 1.20.01.55 Project: 06002.01.342 Allocation Pct: 100.00

Total Estimated Cost: $2,628.54

Government Project?: YES Property Type: G1 Is Govt. Property being sent to supplier?: NO

Quality Assurance?: YES Costpoint QC Inspection Required: NO Inspection Criteria: Procurement Plan requires confirmatory analysis

To Be Used For: Waste package/drip shield interaction study.

Approvals: Requestor: Kuang-Tsan K Chiang 3/8/2007 1:10:14 PM
Department/Division Management: Asadul H Chowdhury 3/9/2007 10:56:47 AM
Sitakanta Mohanty 3/9/2007 3:39:10 PM Quality Assurance: Robert D Brient 3/9/2007 8:40:39 AM

Submitted By: Shirlee Garcia 3/19/2007 8:47:13 AM

Your organization will provide goods or services in accordance with the requirements of your quality system or that of the Geosciences and Engineering Division Quality Assurance Manual. Technical and quality assurance procedures required in the performance of your staff members' work will be identified in procurement documents. Documentation requirements shall be specified in the purchase order and will be supplied with the product. If scientific notebooks are utilized, they are subject to periodic submittal and review and must be returned at the conclusion of work to the Geosciences and Engineering Division Quality Assurance or payment will be withheld. Your organization's product will be accepted based on an evaluation by Geosciences and Engineering Division staff and will be returned for rework at Seller's expense if the product does not meet requ

SIGNATURE K. T. Chiang DISCLOSED TO AND UNDERSTOOD BY
DATE 5/4/07
PROPRIETARY INFORMATION 4/17/08 mp

Continued From Page

TITLE

Requisition: **07016662**
Requisitioner: Chiang, Kuang-Tsan K
Req Organization: 1.20.25.10
Phone: (210) 522-2308

SOUTHWEST RESEARCH INSTITUTE

Suggested Supplier: Haynes International, Inc.
City/State: Houston/TX
Contact: Joy Lucas
Phone: 713-937-7597 Fax: 713-937-4596

Date Printed: 05/15/2007
Date Created: 03/08/2007
Requisition Date: 03/19/2007

Line #	Item / Description	U/M	Need By Date	Requested Qty	Est Unit Cost	Estimated Costs

irements. Additionally, there shall be "right of access" to your facility to confirm effective implementation of the quality requirements with the possibility of audits, source inspections, or surveillances. The Seller shall notify Geosciences and Engineering Division Quality Assurance of any nonconformance to the requirements of this purchase order; further work shall not be done unless directed by Geosciences and Engineering Division Quality Assurance. If there are any Quality Assurance-related questions, please call the Director of Quality Assurance at (210) 522-5537.

MATERIAL CERTIFICATION SHALL ACCOMPANY EACH LOT OF ITEMS SHIPPED. CERTIFICATION SHALL STATE CONFORMANCE TO THE PARTICULAR SPECIFICATION(S) AND INCLUDE REFERENCES TO THE APPLICABLE HEAT NUMBER, LOT/BATCH NUMBER OR DATE CODE WHEN APPLICABLE. THE SUPPLIER SHALL NOTIFY INSTITUTE QUALITY SYSTEMS OF ANY DEFICIENCIES DISCOVERED SUBSEQUENT TO THE DELIVERY OF THIS ITEM.

MILL TEST REPORT SHALL ACCOMPANY EACH LOT OF ITEMS SHIPPED. TEST REPORT SHALL BE IN THE FORM OF A PRODUCTION BATCH ANALYSIS OR LADLE ANALYSIS. CHEMICAL AND/OR PHYSICAL TEST DATA SHALL BE PROVIDED. MATERIAL SHALL BE IDENTIFIED BY HEAT NUMBER, IF APPLICABLE.

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DATE 5/4/07
PROPRIETARY INFORMATION 4/17/08 mp

Continued To Page

PROJECT

TITLE C-22 Plate, Receiving Record **PROJECT**

Continued From Page

03/27/2007

SOUTHWEST RESEARCH INSTITUTE
RECEIPT TRAVELER
Warehouse: REC

Page 1

Receipt ID: RC-0319505
Receipt Date: 03/27/2007
PO: 764987G Rel: 0

Packing Slip: 491664-1-0
Change Ord: 0

Receiver: Rios, Ignacio R.
Vendor: 509360 HAYNES INTERNATIONAL, INC

Receipt Notes: UPS-34-35

Line: 1 TSAN KUANG Chiang
Item: Hastelloy C-22 plate (B575), 3/4"x3"x6"
Unit Cost: $146.0300
Planner:

U/M: EA
QC Reqd: N
Cert of Conf Reqd: N
Source Insp Reqd: N
Insp Type:
Hazmat:
Deliver To: B57
Order Ref: G1
Requisition: 0701 6662
Qty Rcv: 18.0000
Qty Accpt: 18.0000
Qty Rej:
Location:
Location:
Location:
Lot Reqd: 20/57
Serial Reqd:

Prime Contract	Priority	Project	Organization	Account
NRC0202012	NONE	06002.01.342	1.20.01.55	704-000

Notes:

INSPECT YOUR SHIPMENT NOW!
UNLESS YOU NOTIFY RECEIVING (ext. 5618) OF ANY DISCREPANCIES WITHIN SEVEN WORK DAYS OF THE RECEIPT DATE SHOWN AT THE TOP LEFT, PAYMENT WILL BE PROCESSED AND COSTS POSTED TO YOUR ACCOUNT.
REJECTION CODE ________
(IN CASE OF DISCREPANCY)

Continued To Page

SIGNATURE K. T. Chiang DATE 5/5/07
DISCLOSED TO AND UNDERSTOOD BY DATE

~~PROPRIETARY INFORMATION~~ 4/17/08 [initials]

TITLE C22 Certification **PROJECT**

Continued From Page

HAYNES International

CUSTOMER COPY
Haynes International
1020 West Park Avenue
PO Box 9013
Kokomo, Indiana, 46902

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestelldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
491664001-0	03/21/07	764987G	20070323053	1 Of 4

Sold To • Client • Bestellaranschrift
SOUTHWEST RESEARCH INSTITUTE
6220 CULEBRA RD
SAN ANTONIO
TX 782280510 USA

Ship To • Destinataire • Bestellmenge
SOUTHWEST RESEARCH INSTITUTE
9503 W COMMERCE
SAN ANTONIO
TX 78277 USA

Product Description • Description Produit • Material Beshreibung
0.750 x 3 x 6
HASTELLOY(R) C-22 (R) ALLOY - PLATE
Nadcap CERTIFICATE NUMBER 0089
S400 9/01/2006, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered / Quantite Commandee / Bestellemenge	Quantity Shipped / Quantite Expediee / Liefermenge
ASME-SB-575, 04, UNS# N06022; ASTM-B-574, 06, UNS# N06022	18 PC	18 PC

Chemical Analysis • Analyse Chimique • Chemische Analyse

Heat Number / Numero De Coulee / Charge Nr	Al	B	C	Cb+Ta (Nb+Ta)	Co	Cr	Cu	Fe	Mn	Mo	Ni	P	S	Si	Ti	V	W
2277 6 3120			0.004		0.55	21.30		3.70	0.26	13.20	BAL	0.006	0.004	0.02		<0.01	2.90

Heat Number	Cb(Nb)	Ta	Zr	Bi	Se	La	C+N+Cb+V	Pb	Mg	Y	Ag	N	Ca	Al+Ti	Ni+Co	Ni+Mo
2277 6 3120																

Certified By • Certifie Par • Bescheinigt Durch: Tamara Mains 3/23/2007
Certification Technician
[signature]

THE DATA CONTAINED HEREIN WAS OBTAINED FROM SAMPLES THAT ARE REPRESENTATIVE OF THE PRODUCTS IN THE SUBJECT SHIPMENT. THIS MATERIAL MEETS THE REQUIREMENTS OF THE LISTED SPECIFICATION(S), MODIFIED BY ANY EXCEPTIONS OR PURCHASE ORDER REQUIREMENTS. THE RECORDING OF FALSE, FICTITIOUS OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHED AS A FELONY UNDER FEDERAL STATUTES INCLUDING FEDERAL LAW, TITLE 18, CHAPTER 47. THIS DOCUMENT SHALL NOT BE REPRODUCED, EXCEPT IN FULL, WITHOUT THE WRITTEN CONSENT OF HAYNES INTERNATIONAL, INC. SPECIFICATION MARKING REQUIREMENTS MAY BE WAIVED ON ORDERS REQUIRING MULTIPLE MATERIAL SPECIFICATIONS.

Continued To Page

SIGNATURE K. T. Chiang DATE 5/5/07
DISCLOSED TO AND UNDERSTOOD BY DATE

~~PROPRIETARY INFORMATION~~ 4/17/08 [initials]

Continued From Page

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestdldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
491664001-0	03/21/07	764987G	20070323053	2 Of 4

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Kokomo, Indiana, 46902

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SAN ANTONIO
TX 782280510 USA

Ship To • Destinataire • Bestellmenge
SOUTHWEST RESEARCH INSTITUTE
9503 W COMMERCE
SAN ANTONIO
TX 78277 USA

Product Description • Description Produit • Material Beshreibung
0.750 x 3 x 6
.
HASTELLOY(R) C-22 (R) ALLOY - PLATE
Nadcap CERTIFICATE NUMBER 0089
S400 9/01/2006, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation
ASME-SB-575, 04, UNS# N06022; ASTM-B-574, 06, UNS# N06022

Quantity Ordered / Quantite Commandee / Bestellemenge	Quantity Shipped / Quantite Expediee / Liefermenge
18 PC	18 PC

Tensile Test at Room Temperature • Essai De Traction A Temp. Ambiante • Zugversuch Bei Raum Temp.

Ultimate / Zugfestigkeit	1% Yield Lim. Elast. A 1% / 1% Strieckgrenze	0.2% Yield Lim. Elast. A 0.2% / 0.2% Strieckgrenze	% Elong In / % Allong EN / % Dehnung 4D	%RA / %RA	
108000 PSI	52000 PSI	49000 PSI	70 %	81.5 %	1) A)

Tensile Test at Elevated Temperature • Essai De Traction A Hte.Temp. / Warm Zugversuch

Test Essai / Versuch Temp:	Ultimate / Zugfestigkeit	1% Yield Lim. Elast. A 1% / 1% Strieckgrenze	0.2% Yield Lim. Elast. A 0.2% / 0.2% Strieckgrenze	% Elong In / % Allong EN / % Dehnung	%RA / %RA	

Stress Rupture Temperature • Essai A Charge De Rupture Zeitstandversuch

Test Essai / Versuch Temp:	Stress Constrainte / Spannung	Hours Heures / Stunden	% Elong In / % Allong EN / % Dehnung	% RA / % RA	

Certified By • Certifie Par • Bescheinigt Durch: Tamara Mains 3/23/2007
Certification Technician

1) 2744566901

Continued To Page

SIGNATURE K. J. Christ
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DATE 5/5/07
PROPRIETARY INFORMATION 4117108 mp

TITLE
Continued From Page

CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

Sales Order No / Reference Commande / Bestellungs Nr	Date Entered / Date De Commande / Bestelldatum	Customer Reference / Reference Client / Kundenbestdldaten	Report No. / Rapport No / Zeugnis Nr	Pages of Pages / Page de Pages / Anzahl der Seiten
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.
HASTELLOY(R) C-22 (R) ALLOY - PLATE
Nadcap CERTIFICATE NUMBER 0089
S400 9/01/2006, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation
ASME-SB-575, 04, UNS# N06022; ASTM-B-574, 06, UNS# N06022

Quantity Ordered / Quantite Commandee / Bestellemenge	Quantity Shipped / Quantite Expediee / Liefermenge
18 PC	18 PC

Annealed Hardness / Durette Recuit / Geglueht Haerte	Aged Hardness / Durette Vieilli / Gealtert Haerte	Grain Size / Grosseur De Grain / Korngroesse						IGA	Uniformity	Corrosion Rate		Oxidation Rate	Charpy Impact Test				Creep Rupture					
		Grain Size	Predominant Grain Size	Recry. Grain	Unrecry. Grain %	ALA	P&W Figure Number	Attack Depth		Corrosion / MPY	Test Method		Toughness Avg / Ft. Lbs.	Toughness 1 / Ft. Lbs.	Toughness 2 / Ft. Lbs.	Toughness 3 / Ft. Lbs.	Test Essai / Versuch Temp:	Stress Constrainte / Spannung PSI	Hours Heures / Stunden	% Elong In / % Allong EN / % Dehnung	% Elong @ 15 Hrs	
90 HRB	1) A)	2																				

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Certification Technician

1) 2744566901

Continued To Page

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TITLE
PROJECT

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CERTIFICATION OF TESTS • RAPPORT D'ESSAIS CERTIFIE • WERKSZEUGNIS

Sales Order No Reference Commande Bestellungs Nr	Date Entered Date De Commande Bestelldatum	Customer Reference Reference Client Kundenbestdldaten	Report No. Rapport No Zeugnis Nr	Pages of Pages Page de Pages Anzahl der Seiten
491664001-0	03/21/07	764987G	20070323053	4 Of 4

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SOUTHWEST RESEARCH INSTITUTE 6220 CULEBRA RD SAN ANTONIO TX 782280510 USA	SOUTHWEST RESEARCH INSTITUTE 9503 W COMMERCE SAN ANTONIO TX 78277 USA	0.750 x 3 x 6 HASTELLOY(R) C-22 (R) ALLOY - PLATE Nadcap CERTIFICATE NUMBER 0089 S400 9/01/2006, S1000 1/3/2005, EN 10204 3.1, AS9100

Specification • Specification • Spezifikation	Quantity Ordered Quantie Commandee Bestellemenge	Quantity Shipped Quantitie Expediee Liefermenge
ASME-SB-575, 04, UNS# N06022; ASTM-B-574, 06, UNS# N06022	18 PC	18 PC

All tests and inspections have been performed and results meet specification requirements.
THIS MATERIAL IS FREE FROM MERCURY, CADMIUM, RADIUM, AND ALPHA SOURCE CONTAMINATION.
THIS MATERIAL WAS MELTED AND MANUFACTURED IN THE UNITED STATES.
Mill Orders Used: 2744566901 (18 PC)
A) 2000 °F to 2100 °F

Certified By • Certifie Par • Bescheinigt Durch: Tamara Mains 3/23/2007
Certification Technician

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PROPRIETARY INFORMATION 4/17/08 mo

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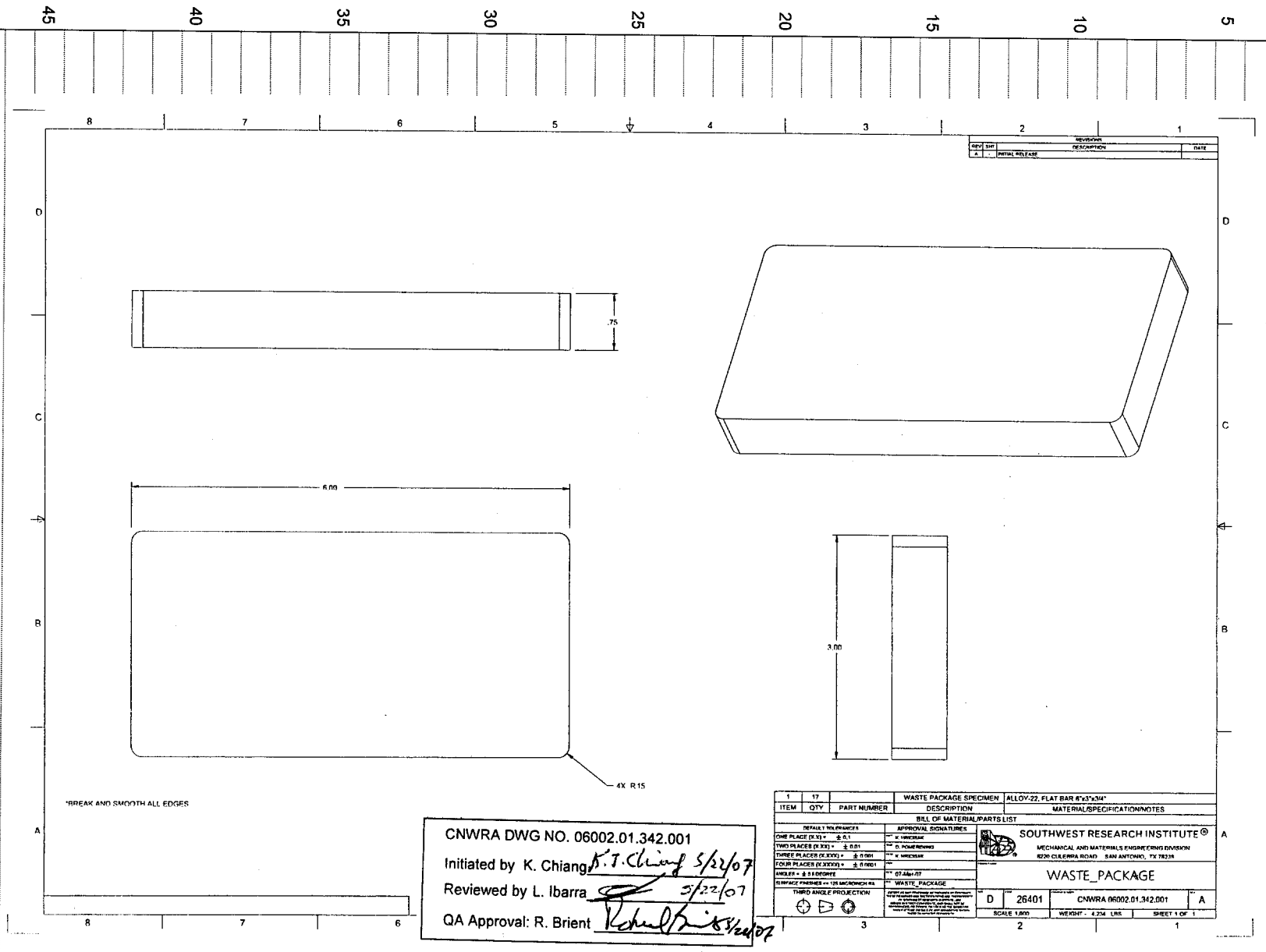

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TITLE

PROJECT

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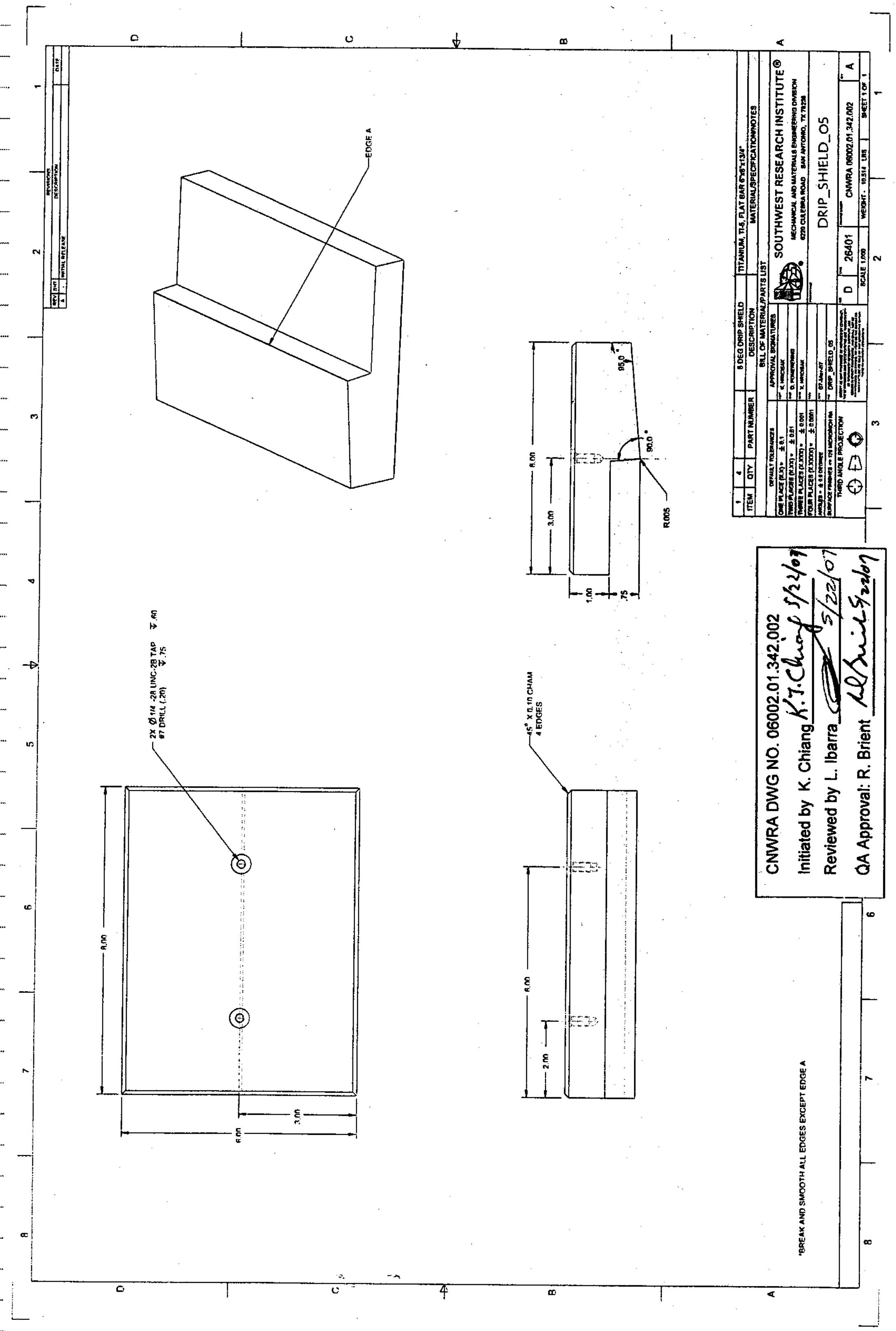
EDGE A
2X Ø1/4 -28 UNC-2B TAP ⊽.60
#7 DRILL (.20) ⊽.75
45° X 0.10 CHAM
4 EDGES
R.005
90.0°
95.0°
*BREAK AND SMOOTH ALL EDGES EXCEPT EDGE A
5 DEG DRIP SHIELD
TITANIUM, TI-5, FLAT BAR 6"x8"x1 3/4"
SOUTHWEST RESEARCH INSTITUTE®
DRIP_SHIELD_05
26401
CNWRA 06002.01.342.002
CNWRA DWG NO. 06002.01.342.002
Initiated by K. Chiang K.T. Chiang 5/22/07
Reviewed by L. Ibarra 5/22/07
QA Approval: R. Brient 5/22/07

Continued To Page

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DATE 5/22/07

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TITLE

PROJECT

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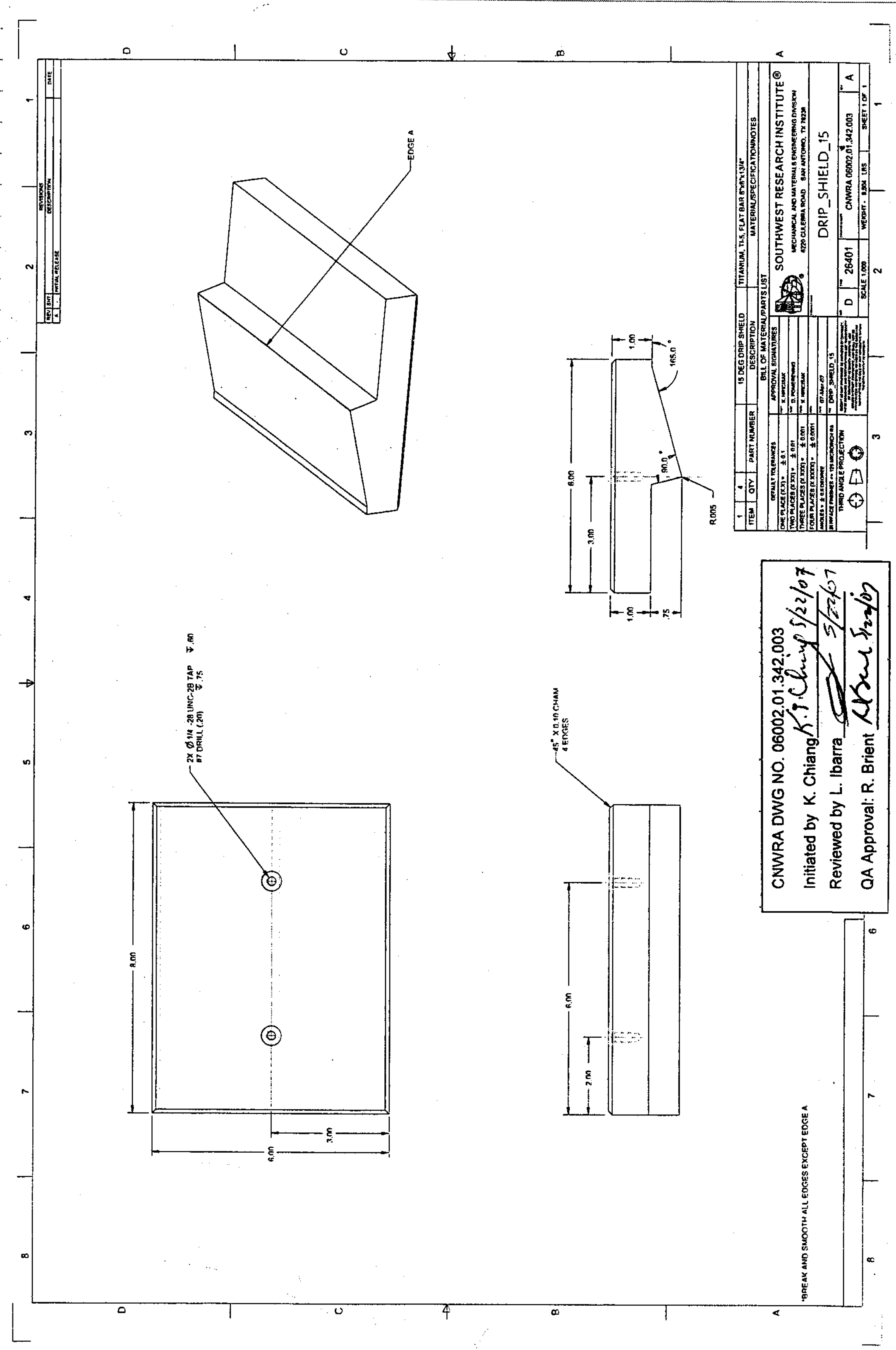
EDGE A
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#7 DRILL (.20) ⊽.75
45° X 0.10 CHAM
4 EDGES
R.005
90.0°
165.0°
*BREAK AND SMOOTH ALL EDGES EXCEPT EDGE A
15 DEG DRIP SHIELD
TITANIUM, TI-5, FLAT BAR 6"x8"x1 3/4"
SOUTHWEST RESEARCH INSTITUTE®
DRIP_SHIELD_15
26401
CNWRA 06002.01.342.003
CNWRA DWG NO. 06002.01.342.003
Initiated by K. Chiang K.T. Chiang 5/22/07
Reviewed by L. Ibarra 5/22/07
QA Approval: R. Brient 5/22/07

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TITLE **PROJECT**

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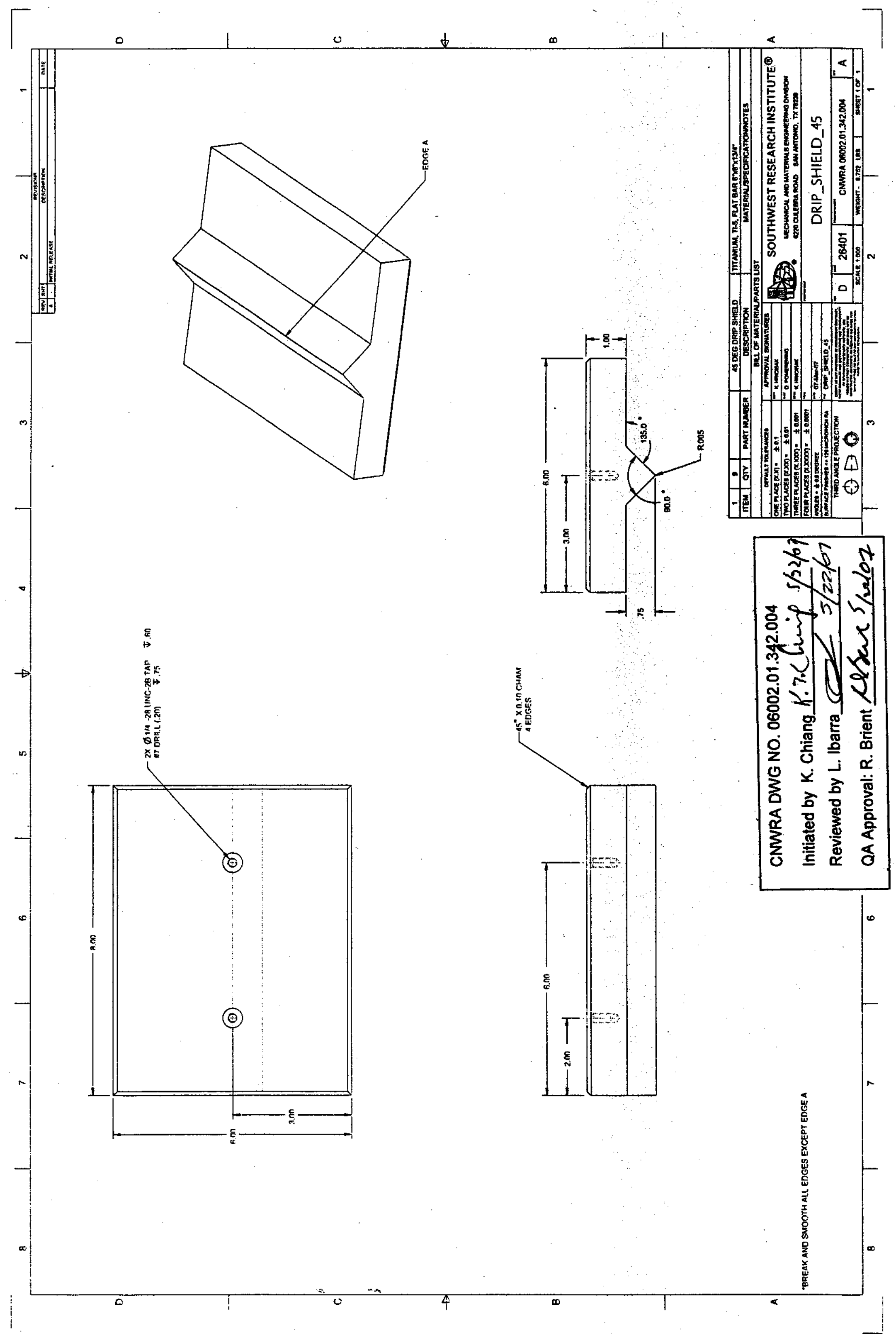

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TITLE **PROJECT**

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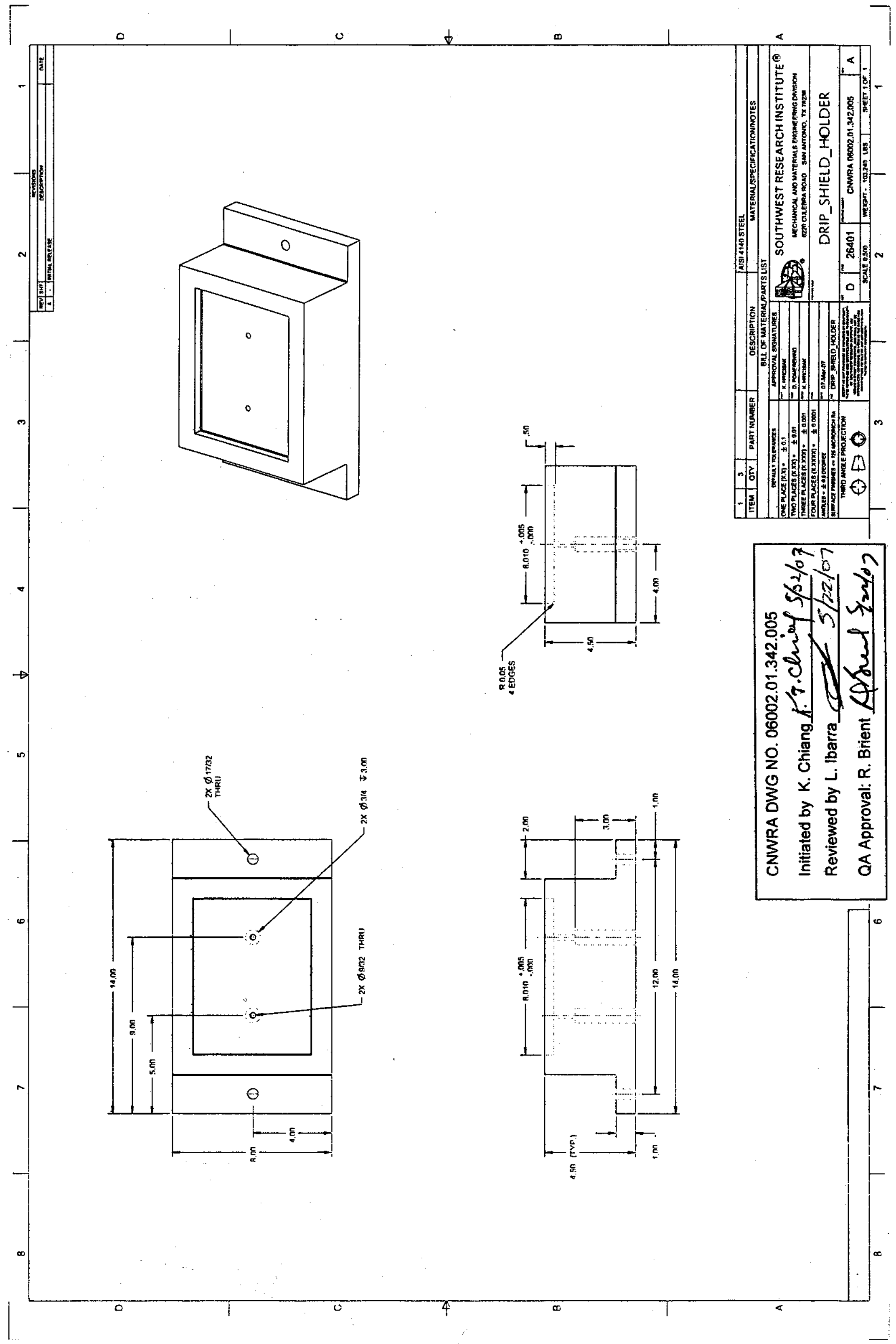

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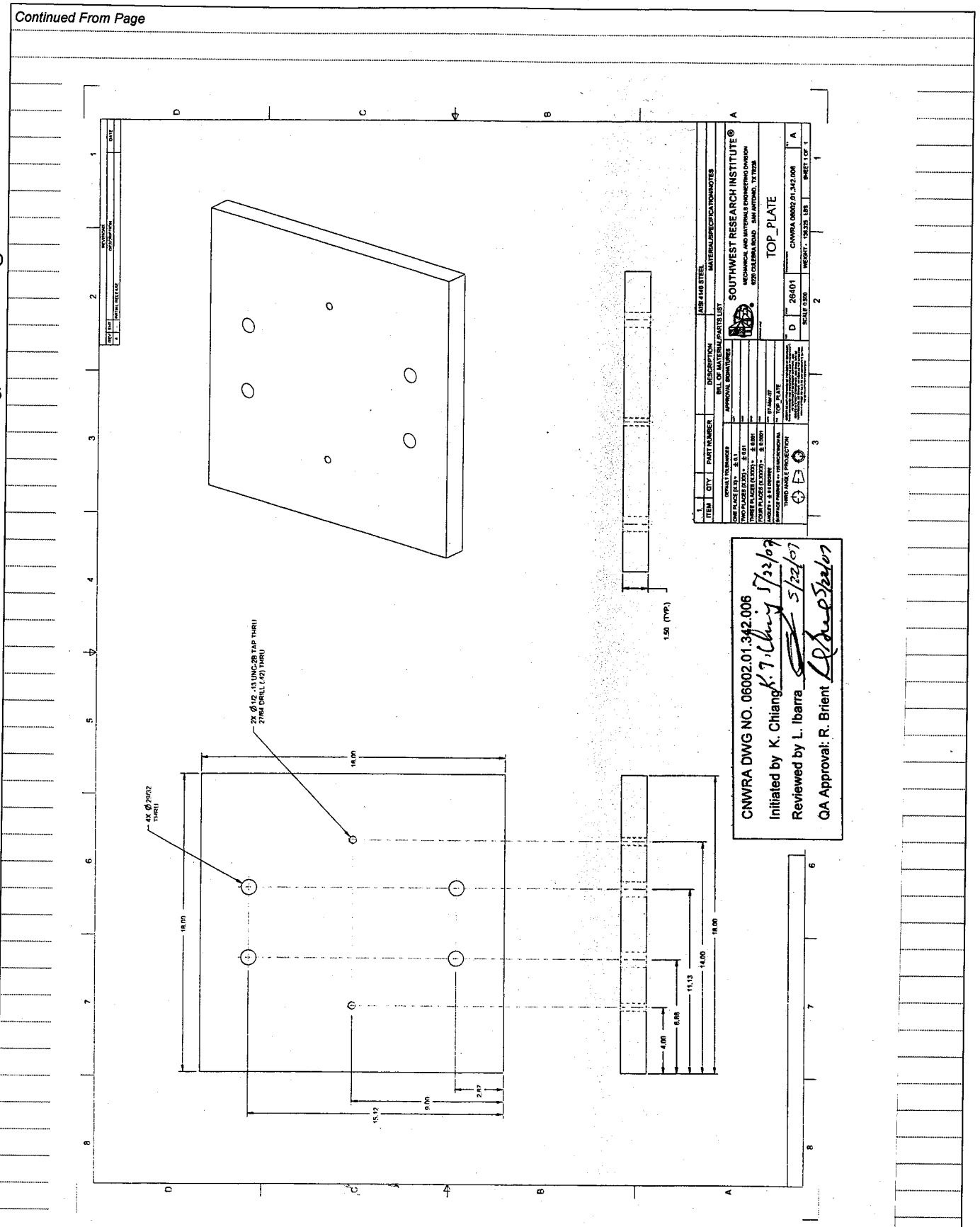

CNWRA DWG NO. 06002.01.342.006
Initiated by K. Chiang K.T. Chiang 5/22/07
Reviewed by L. Ibarra 5/22/07
QA Approval: R. Brient L. Bruce Brient

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PROJECT

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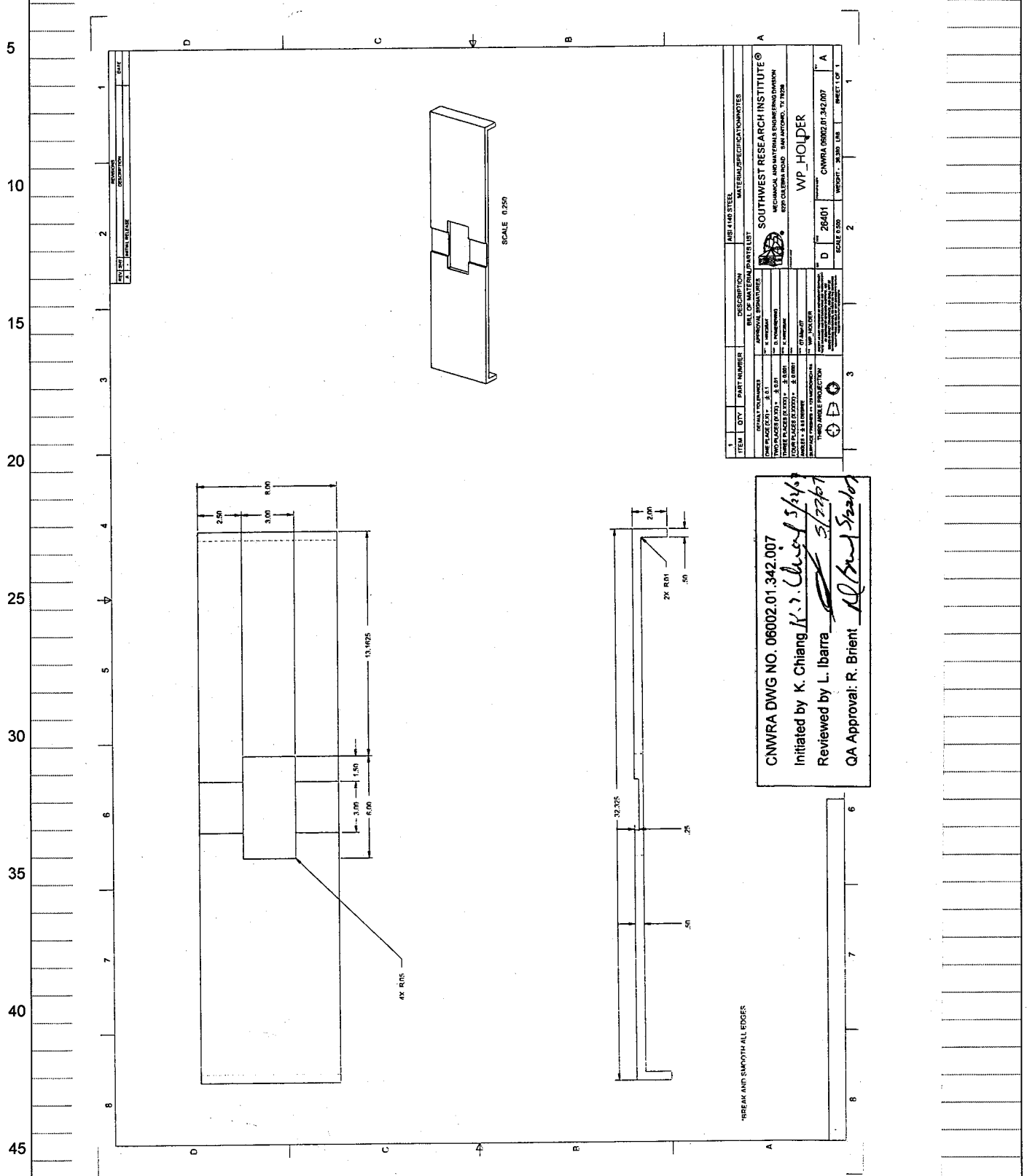

CNWRA DWG NO. 06002.01.342.007
Initiated by K. Chiang K.T. Chiang 5/22/07
Reviewed by L. Ibarra 5/22/07
QA Approval: R. Brient L. Bruce Brient

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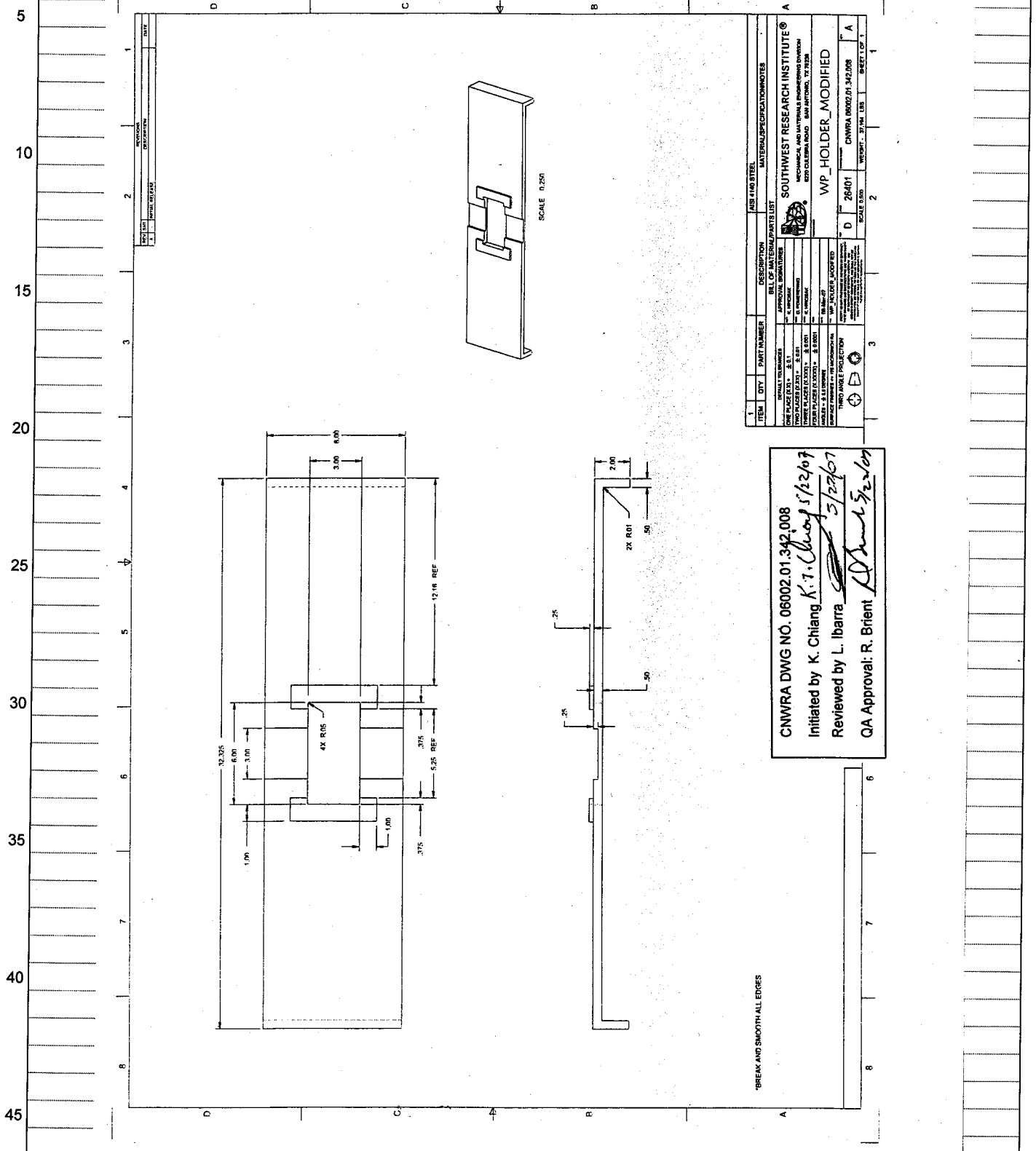

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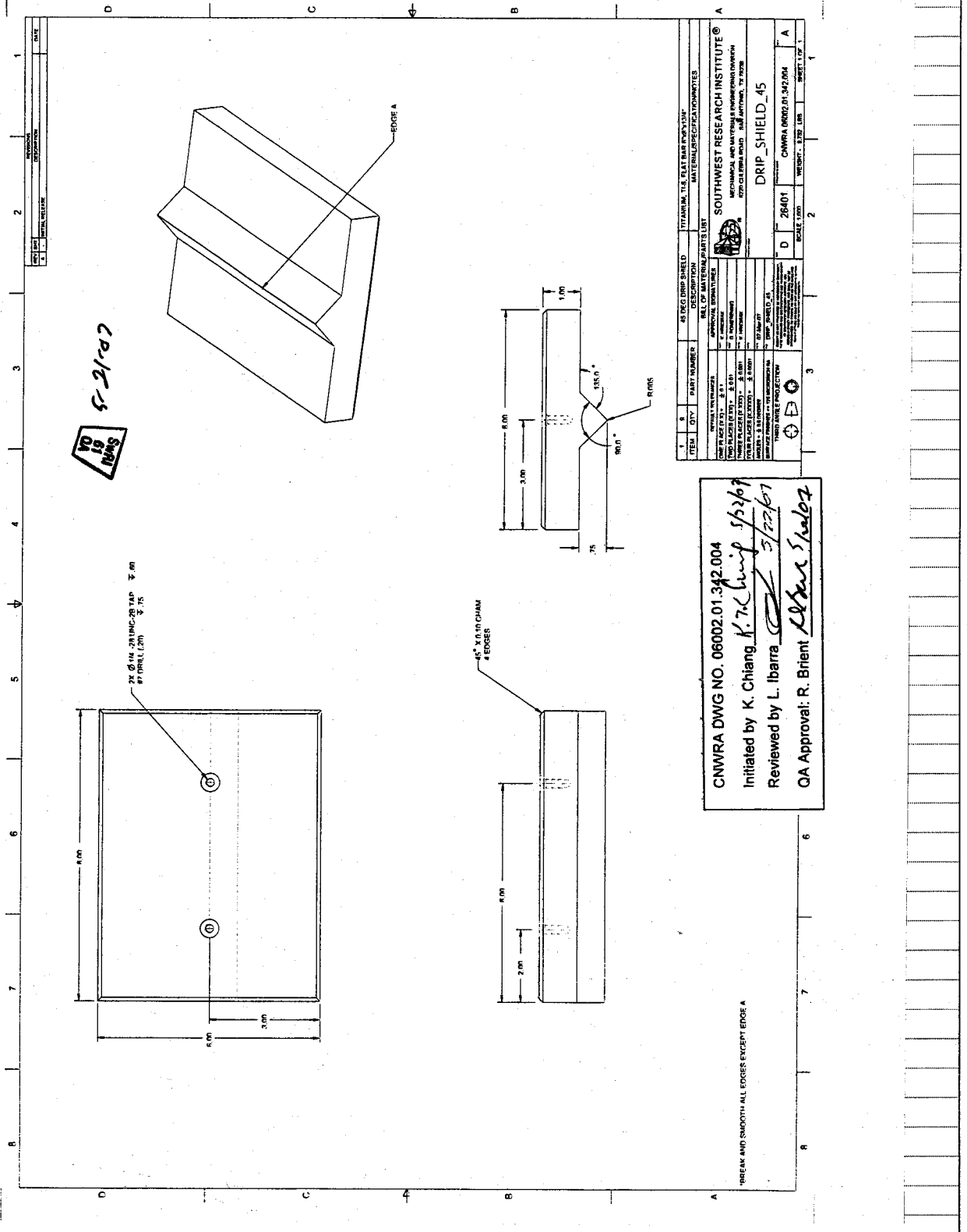
TITLE

PROJECT

Continued From Page Nine pieces completed and inspected.



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TITLE

PROJECT

Continued From Page Inspection Record

5-21-07

	#1	#2
1/4-28 unc-2B I.60	.750	.750
overall 8 x 6	8.003 x 6.002	8.003 / 6.000
ϕ Hole 2 x 6	2.001 x 6.001	2.004 / 6.002
45° EDGE	✓	✓
1.00	1.003	1.004
.75	.754	.753
90°	89.58°	89.53°
135°	134.87°	134.88°
3.00	3.004	3.001

#3 .750	#4 .754	#5 .750
7.999 / 6.000	7998 / 5.797	8.000 / 6.002
2.005 / 6.005	2.003 / 6.004	2.003 / 6.003
45° ✓	✓	✓
1.004	1.006	1.004
.754	.750	.754
89.56°	89.58	89.58
134.87°	134.87	134.89
3.005	3.004	3.004

#6 .735	#7 .755	#8 .755	#9 .755
8.002 / 6.002	7.999 / 6.000	8.002 / 6.002	7.998 / 6.001
2.004 / 6.004	2.002 / 6.003	2.003 / 6.005	2.002 / 6.003
45° ✓	✓	45° ✓	45° ✓
1.002	1.006	1.000	1.0005
.750	.755	.749	.749
89.57	89.58	89.58	89.58
134.88	134.90	134.88	134.88
3.006	3.005	3.003	3.003

ASSET # 002157
" # 006149
" # 006793

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TITLE

PROJECT

Continued From Page

Kuang-Tsan Ken Chiang

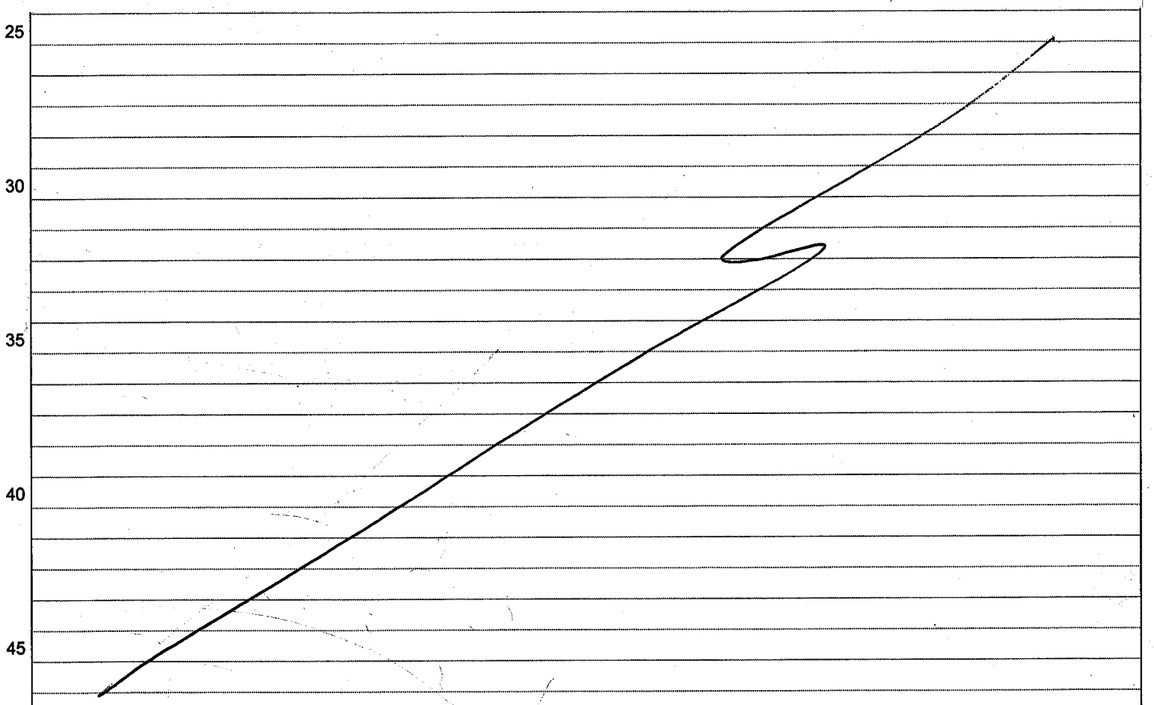
From: Mark Arnold [mark.arnold@swri.org]
Sent: Friday, May 18, 2007 1:13 PM
To: kuang-tsan.chiang@swri.org
Subject: Waste Package

Ken,

I have finished the inspection on the waste package plates. I have one part that is .002 u/s on the 3.0 +/- .010 dimension.
If this is with in expectable parameters let me know and the parts will be sitting in the window for pick up.

Thank You,

Mark D. Arnold
SR. QA Inspector, CMI, CQT
Institute Quality Systems
Mark.Arnold@SWRI.org
(210) 522-5477



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DATE 5/23/07

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TITLE

PROJECT

Continued From Page NOTES ON DS-43-01 TESTING

TESTING PERFORMED ON ONE SAMPLE EACH
ALLOY 22 WASTE PACKAGE (1)
TITATANIUM 45° PENETRATOR (1)

TEST PARAMETERS IDENTIFIED AS
LOAD APPLICATION RATE 0.01 in/min [0.234 mm/min]
MAX LOAD 400,000 lbs [1779 kN]
MAX DISP 0.325 inches [8.33 mm]
@26 DJP

TESTING AT AMBIENT CONDITION 76°F [24.4°C]

TESTING DONE ON 6/28/2007 - SEE PROCESS TRAVELER

TESTING STOPPED BASED ON REACHING MAXIMUM DISPLACEMENT.

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4/17/08 MS

TITLE

PROJECT

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MECHANICAL SCIENCES SECTION

PROCESS TRAVELER
Drip Shield – Waste package Mechanical Interaction Test

SECTION 1

Project Number: *06002.01.342*
Customer Name: NRC, Div 20, Luis Ibarra
Purchase or Work Order Number: NA
Product Name: Material Samples
Quantity of EUT: 1 each Waste Package Plate, 1 each 45° Drip Shield Penetrator
Unique ID(s): See Details Below
Require Services From Outside MSS: ☒ Yes ☐ No If yes information provided in steps below.
QA Participation Required: ☐ Yes ☒ No If yes generate a Quality Plan.
Project Manager Initial & Date: Daniel J Pomerening June 27, 2007

SECTION 2

Step	Task	Target Date	Initial & Date Completion
1	Receiving Inspection based on Fabrication and Inspection at SwRI Machine Shop ☑ Accept ☐ Reject		KH 6/28/07
	Identify Unique Sample ID(s) Waste Package Plate WP-01 45° Drip Shield Penetrator DS-45-01		KH 6/28/07
	Photographic Documentation of Samples with Scale in Picture(s)		KH 6/28/07
	Notes:		
2	Perform tests on EUT as described below:		
2.1	**Equipment Calibration** Identify calibration of equipment and load frame functional check. Load Cell ID CALIBRATION RECORDS Cal Due Date ON PDF File; Frame Displacement ID TO Calibration 2007.pdf Cal Due Date; Secondary Displacement ID Cal Due Date; Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step		6/28/07 KH
	Notes: CALIBRATION SHEET PROVIDED		

F-PT NEBS-ETSI, Rev 01

Page 1 of ~~34~~ DJP

3 Sept 2007

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DATE

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SECTION 2

Step	Task	Target Date	Initial & Date Completion
2.2	**Facility Configuration Checks** Configure the test facility with the designed apparatus and document with photographs. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*	X	6/28/07 KH
2.3	**Install Test Specimens** Verify that the appropriate specimens are available as identified in Step 1 and install them in the test facility. Document with photographs. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*	X	6/28/07 KH
2.4	**Test Parameters** Confirm the following test parameters. Load application rate (in/min) ~~0.005~~ 0.01 in/min Max Load 380,370 # 1774 Max Displacement after Contact 0.33 9.53 mm ~~0.25~~ 0.254 mm/min Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*	X	6/28/07 KH
2.5	**Hold Point** Test hold point based on configuration and test parameters. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*	X	6/28/07 KH
2.6	**Initial Loading of Specimen** Preload specimen to 1000 lbs. Transition the load frame for contact between the drip shield plate and the waste package penetrator. At initial contact record load and displacement values. First Contact Load 2e+050 / 8.353 E-04 # 4,45 KN First Contact Displacement 1.884 E-04 in Load specimen up to a value of 1000 lbs and use this as a secondary hold point 1000 lb Load Actual 1010.43 4.49 KN 1000 lb Displacement 0.00102 in 0.025 mm Record Ambient Temperature Nominal Test Facility Temperature 76° 24.4 Document Configuration with Photos Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*	X	6/28/07 KH

? How Load ?

3 Sept 2007

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SECTION 2

Step	Task	Target Date	Initial & Date Completion
2.7	**Constant Rate Loading** Test at the specified load until one of the two following conditions: Load Capacity of the Load Frame (400,000 lbs) is reached or Maximum displacement of 0.325 inches (8.26 mm) Document testing with Photos during and at end of testing. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*	X	6/28/07 KH
2.8	**Unload and Remove Specimen** Unload the specimen by backing of the load frame. Document configuration with photos while specimens are still in the load frame. Remove the specimens from the load frame. Document the configuration with photos. Anomalies? ☑ Yes If "Yes", notify PM to provide disposition ☐ No Proceed to next step *Notes:* SPECIMEN JAMMED INSIDE THE SPECIMEN HOLDER PLATE.	X	6/28/07 KH
2.9	**Post Test Load Deflection Data Reduction** Supply test engineer with electronic data of the load deflection data for reduction and presentation. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*	X	6/28/07 KH
2.10	**Post Test Geometric Measurement of Test Specimen** Document the as tested geometry of the waste package plate and drip shield penetrator over the area of deformation. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:* MEASUREMENT TAKEN USING DLS AND COORDINATE MEASURING MACHINE	X	8/1/07 KH
2.11	**Data Transfer to Report** Transfer data for inclusion in report. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*	X	8/24/07 KH

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Step	Task	Target Date	Initial & Date Completion
	SECTION 2		
2.12	**Fianal Inspection and Storage of Test Specimens** Final Inspection in accordance with instructions from project manager. ☑ Accept ☐ Reject Storage Location CURRENT STORAGE BLDG. 71 Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*	X	8/27/07 KH
	Reporting		
3	If requested or appropriate, prepare Draft Test Report in accordance with SwRI Procedures and deliver electronic copy to customer *(optional)*.	NA DJP	9/3/2007
4	Complete Test Report in accordance with SwRI Procedures and deliver as appropriate. _____ copies (with/without) CD-ROM PDF file to customer 1 copy, marked "Record Copy B" to Sara Domine, QA copies to all signers of report cover letter only to Tim Fey, Danny Deffenbaugh	NA DJP	9/3/2007
5	Transfer project file to Div 20 for document storage.	DJP	9/3/2007

Put information into Project Laboratory NOTEBOOK 873

DJP 3 Sept 2007

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PROJECT

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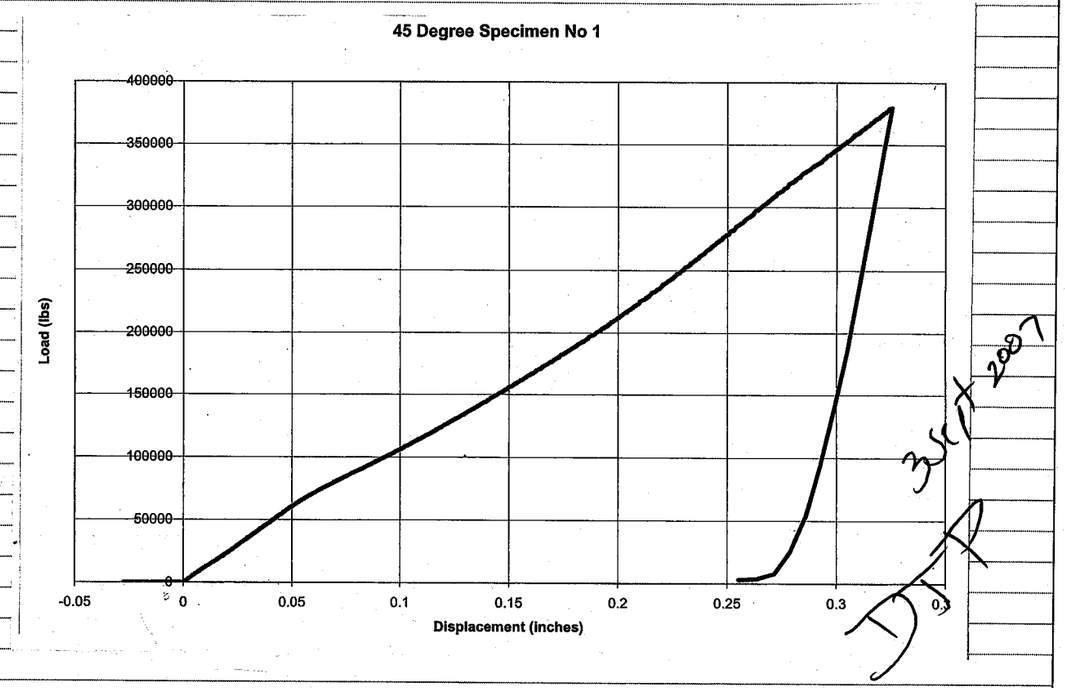
DATA REDUTION FOR DS-45-01

LOAD - DEFLECTION

The raw data is contained in DS-45-01.txt There are three columns of useful data load, displacement 1, and displacement 2. The data was imported into an EXCEL SPREADSHEET FOR processing and display. In the spreadsheet the data was converted to metric units from english. The data was plotted. Curve fits were done using function built into Excel to identify specific regions of the load-displacement time history.

DS-45-01 LOAD DEFLECTION.XLS



3 Sept 2007 DJP

DSL SCANS

The Alloy 22 and TITANIUM Penetrator were scanned using the DSL process by Div Personnel. SCANS of bare metal did not result in useful data because of reflectance of material. Scans were run with a light coat of powder. The resulting surface was rough. Additional scans were run with a light coat of white paint. Scan data was taken. Data was imported into Solid Work for display. Summary of results of DSL scans are give in Drip-Shield-Measurement Scan.ppt

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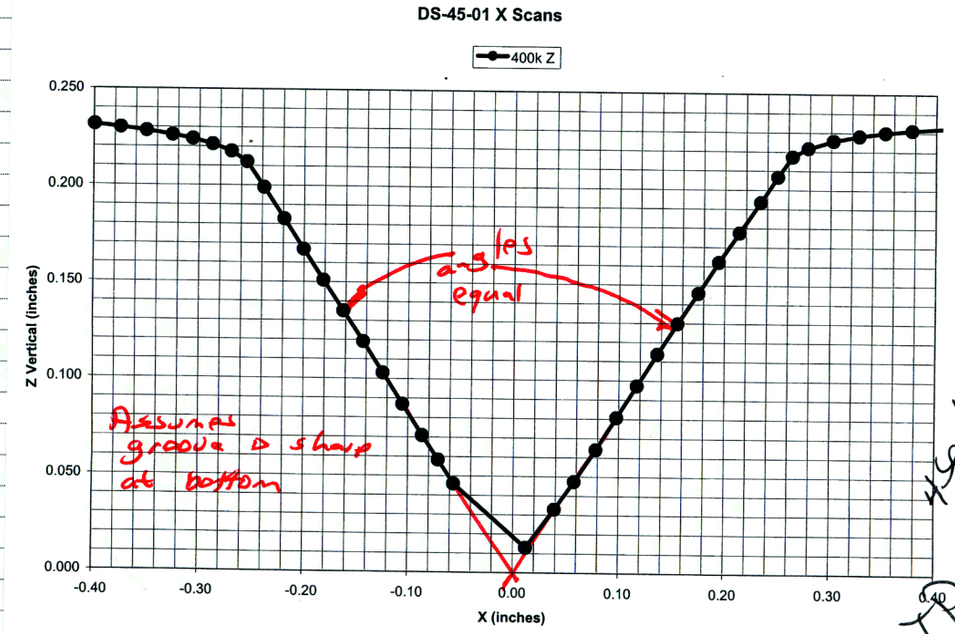
CMM SCANS

A single line scan perpendicular to the groove (X-Axis) was made for the Alloy 22 material ~~and DJP 4Sept2007~~ following loading. There was an obvious bow to the material. This made it difficult to clearly define the upper surface to get a depth of the groove. To orient the specimen the slopes of the side walls of the groove were matched and the scan data transformed to this coordinate system. The resulting data is shown below. The Excel spreadsheet used to do this is given.



A single line scan perpendicular to the ~~right~~ DJP ridge of the titanium penetrator was made following loading. The raw data was again transformed to account for minor variations in the set up. In the first the slope of the side were set equal and the intersection of these two lines set at 0.765in. The tip of the titanium has been reduced and rounded over

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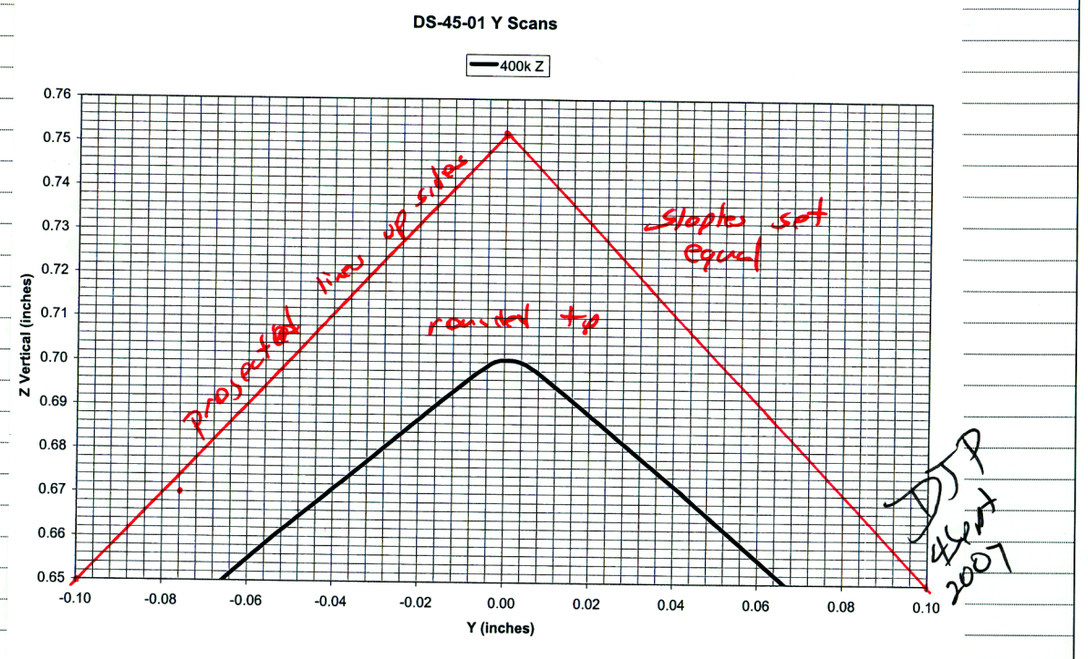
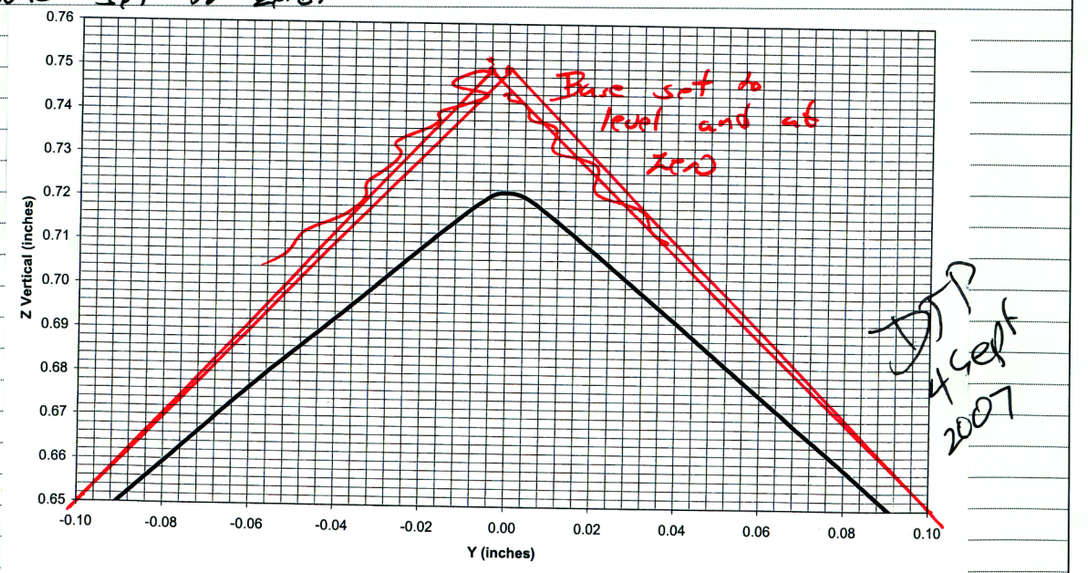


In the second process the base of the penetrator was assumed to have remained flat and the data was transformed to make it level. The vertical coordinates of the base, averaged, was set to zero.



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DATA FROM DS-45-01

DS-45-01 TESTING
DS-45-01 Load Deflection
DS-45-01 Load & Deflection . xls
DS-45-01 . txt
~~DS~~45-01 SCANS
txt files original data
xls processed files
DSH Scan data and plot
PICS_DS-45-01
Process traveler
Calibration record for load Frame (pdf)

DS 45-01 DATA
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TESTING CONTROLLED USING PROCESS TRAVELER

MECHANICAL SCIENCES SECTION

PROCESS TRAVELER
Drip Shield – Waste package Mechanical Interaction Test

SECTION 1

Project Number: *06002.01.342*
Customer Name: NRC, Div 20, Luis Ibarra
Purchase or Work Order Number: NA
Product Name: Material Samples
Quantity of EUT: 1 each Waste Package Plate, 1 each 45° Drip Shield Penetrator
Unique ID(s): See Details Below
Require Services From Outside MSS: ☒ Yes ☐ No If yes information provided in steps below.
QA Participation Required: ☐ Yes ☒ No If yes generate a Quality Plan.
Project Manager Initial & Date: Daniel J Pomerening August 3rd, 2007

SECTION 2

Step	Task	Target Date	Initial & Date Completion
1	Receiving Inspection based on Fabrication and Inspection at SwRI Machine Shop ☑ Accept ☐ Reject		8/7
	Identify Unique Sample ID(s) Waste Package Plate WP-02 45° Drip Shield Penetrator DS-45-02		VM
	Photographic Documentation of Samples with Scale in Picture(s)		
	Notes:		
2	Perform tests on EUT as described below:		
	Testing on EUT 1		
2.1	**Equipment Calibration** Identify calibration of equipment and load frame functional check. Load Cell ID ____ Cal Due Date ____ Frame Displacement ID ____ Cal Due Date ____ Secondary Displacement ID ____ Cal Due Date ____ Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:* SEE CALIBRATION DATA SHEET PROVIDED.		

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SECTION 2

Step	Task	Target Date	Initial & Date Completion
2.2	**Facility Configuration Checks** Configure the test facility with the designed apparatus. Document with photographs. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		
2.3	**Install Test Specimens** Verify that the appropriate specimens are available as identified in Step 1 and install them in the test facility. Document with photographs. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		
2.4	**Test Parameters** Confirm the following test parameters. Load application rate (in/min) 0.01 in/min Max Load Max Displacement after Contact Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		
2.5	**Hold Point** Test hold point based on configuration and test parameters. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:* 1000 lbf HOLD POINT ESTABLISHED FOR ALL INCREMENTS		
2.6	**Constant Rate Loading – 1st Increment (24,000 lbf)** Load specimen up to a value of 24,000 lbs and use this as a hold point. Record the actual load and displacement values: 24,000 lbs Load Actual 24,001 # 24,000 lbs Displacement Record Ambient Temperature Nominal Test Facility Temperature Document Configuration with Photos Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		

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SECTION 2

Step	Task	Target Date	Initial & Date Completion
2.7	**Unload and Remove Specimen and Penetrator** Unload the specimen by backing of the load frame. Document configuration with photos while specimens are still in the load frame. Remove the specimens from the load frame. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:* PENETRATOR – SHOWS NO INDENTATION ALLOY 22 – TRACED – 2 FILES (X,Y)		
2.8	**Geometric Measurement of Test Specimen and Penetrator** Document the tested geometry of the waste package plate and drip shield penetrator over the area of deformation. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		
2.9	**Install Test Specimens and Penetrator** Verify that the specimen and the drip shield penetrator are correctly aligned. Install them in the test facility. Document with photographs. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		
2.10	**Constant Rate Loading – 2nd Increment (50,000 lbf)** Load specimen up to a value of 50,000 lbs and use this as a hold point. Record the actual load and displacement values: 50,000 lbs Load Actual 50,002 # 50,000 lbs Displacement Record Ambient Temperature Nominal Test Facility Temperature Document Configuration with Photos Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		

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Step	Task	Target Date	Initial & Date Completion
2.11	**Unload and Remove Specimen and Penetrator** Unload the specimen by backing of the load frame. Document configuration with photos while specimens are still in the load frame. Remove the specimens from the load frame. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		
2.12	**Geometric Measurement of Test Specimen and Penetrator** Document the tested geometry of the waste package plate and drip shield penetrator over the area of deformation. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:* PENET – 2 FILES AUG 22 – 2 FILES		
2.13	**Install Test Specimens and Penetrator** Verify that the specimen and the drip shield penetrator are correctly aligned. Install them in the test facility. Document with photographs. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		
2.14	**Constant Rate Loading – 3rd Increment (100,000 lbf)** Load specimen up to a value of 100,000 lbs and use this as a hold point. Record the actual load and displacement values: 100,000 lbs Load Actual 100,001 # 100,000 lbs Displacement _____ Record Ambient Temperature Nominal Test Facility Temperature _____ Document Configuration with Photos Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		

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Step	Task	Target Date	Initial & Date Completion
2.15	**Unload and Remove Specimen and Penetrator** Unload the specimen by backing of the load frame. Document configuration with photos while specimens are still in the load frame. Remove the specimens from the load frame. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		
2.16	**Geometric Measurement of Test Specimen and Penetrator** Document the tested geometry of the waste package plate and drip shield penetrator over the area of deformation. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		8.3
2.17	**Install Test Specimens and Penetrator** Verify that the specimen and the drip shield penetrator are correctly aligned. Install them in the test facility. Document with photographs. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		8.6.07
2.18	**Constant Rate Loading – 4th Increment (200,000 lbf)** Load specimen up to a value of 200,000 lbs and use this as a hold point. Record the actual load and displacement values: 200,000 lbs Load Actual 200,006 lbf 200,000 lbs Displacement _____ Record Ambient Temperature Nominal Test Facility Temperature _____ Document Configuration with Photos Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		8.6.07

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Step	Task	Target Date	Initial & Date Completion
2.19	**Unload and Remove Specimen and Penetrator** Unload the specimen by backing of the load frame. Document configuration with photos while specimens are still in the load frame. Remove the specimens from the load frame. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		
2.20	**Geometric Measurement of Test Specimen and Penetrator** Document the tested geometry of the waste package plate and drip shield penetrator over the area of deformation. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		
2.21	**Install Test Specimens and Penetrator** Verify that the specimen and the drip shield penetrator are correctly aligned. Install them in the test facility. Document with photographs. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		
2.22	**Constant Rate Loading – 5th Increment (300,000 lbf)** Load specimen up to a value of 300,000 lbs and use this as a hold point. Record the actual load and displacement values: 300,000 lbs Load Actual 300,000 lbf 300,000 lbs Displacement Record Ambient Temperature Nominal Test Facility Temperature Document Configuration with Photos Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		

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Step	Task	Target Date	Initial & Date Completion
2.23	**Unload and Remove Specimen and Penetrator** Unload the specimen by backing of the load frame. Document configuration with photos while specimens are still in the load frame. Remove the specimens from the load frame. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:* BOW IS EVIDENT IN THE SPECIMEN.		KJ 8/6/07
2.24	**Geometric Measurement of Test Specimen and Penetrator** Document the tested geometry of the waste package plate and drip shield penetrator over the area of deformation. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:* 4 PEGS ARE USED TO SUPPORT THE SPECIMEN.		KJ 8/6/07
2.25	**Install Test Specimens and Penetrator** Verify that the specimen and the drip shield penetrator are correctly aligned. Install them in the test facility. Document with photographs. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		KJ 8/6/07
2.26	**Constant Rate Loading – 6th Increment (max lbf)** Test at the specified load until one of the two following conditions: Load Capacity of the Load Frame (400,000 lbs) is reached or Maximum displacement of 0.325 inches (8.26 mm) Record Ambient Temperature Nominal Test Facility Temperature 400,000 # Document Configuration with Photos Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		KJ 8/6/07
2.27	**Unload and Remove Specimen and Penetrator** Unload the specimen by backing of the load frame. Document configuration with photos while specimens are still in the load frame. Remove the specimens from the load frame. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		KJ 8/6/07

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SECTION 2

Step	Task	Target Date	Initial & Date Completion
2.28	**Geometric Measurement of Test Specimen and Penetrator** Document the tested geometry of the waste package plate and drip shield penetrator over the area of deformation. Document the configuration with photos. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		KG 8/6/07
2.29	**Post Test Load Deflection Data Reduction** Supply test engineer with electronic data of the load deflection data for reduction and presentation. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		KG 8/6/07
2.30	**Data Transfer to Report** Transfer data for inclusion in report. Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		8/25/07 KG
2.31	**Final Inspection and Storage of Test Specimens** Final Inspection in accordance with instructions from project manager. ☑ Accept ☐ Reject Storage Location CURRENT LOCATION - BLD6.71 Anomalies? ☐ Yes If "Yes", notify PM to provide disposition ☑ No Proceed to next step *Notes:*		8/27/07 KG
	Reporting		
3	If requested or appropriate, prepare Draft Test Report in accordance with SwRI Procedures and deliver electronic copy to customer *(optional)*.		
4	Complete Test Report in accordance with SwRI Procedures and deliver as appropriate. _____ copies (with/without) CD-ROM PDF file to customer 1 copy, marked "Record Copy B" to Sara Domine, QA copies to all signers of report cover letter only to Tim Fey, Danny Deffenbaugh		
5	Transfer project file to Div 20 for document storage.		

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I WILL ADD TO THIS SCIENTIFIC NOTEBOOK THE ASSOCIATED FINITE ELEMENT ANALYSES USED FOR COMPARISON TO THE EXPERIMENTAL RESULTS PRESENTED PREVIOUSLY.

THOMAS WILT

Thomas E Wilt 9/4/2007 TEW

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Conti

TITANIUM TRUE STRESSES AND STRAINS

For the Titanium Aero Plate 6AL-4V Grade 5 per ASTM B265 material, the true stress calculations are based on the average of the values reported by the vendor:

$\sigma_{y,eng} = 135.6$ ksi

$\sigma_{UTS,eng} = 144.4$ ksi

$\varepsilon_{failure,eng} = 0.177$

Conversion at Yielding

The Young's modulus for titanium is:

$E = 15{,}500$ ksi

Thus, the strain at yielding is:

$\varepsilon_{y,eng} = \sigma_{y,eng} / E = 0.0087$

Then, the true strain at yielding is:

$\varepsilon_{UTS,true} = \ln(1 + \varepsilon_{UTS,eng}) = 0.0087$

The true stress at yielding is:

$\sigma_{y,true} = \sigma_{y,eng}(1 + \varepsilon_{y,eng}) = 136.8$ ksi = 943 MPa

Conversion at UTS

To obtain the true stresses and strains at the UTS, it is assumed that the strain at UTS is 90% of the strain at failure. Then,

$\varepsilon_{UTS,eng} = 0.159$

Then, the true strain at UTS is:

$\varepsilon_{UTS,true} = \ln(1 + \varepsilon_{UTS,eng}) = 0.148$

The true stress at UTS is:

$\sigma_{UTS,true} = \sigma_{UTS,eng}(1 + \varepsilon_{UTS,eng}) = 167.4$ ksi = 1,153 MPa

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ALLOY 22 TRUE STRESSES AND STRAINS

For Hastelloy C-22 Alloys, the following data is provided by the fabricant,

$\sigma_{y,eng} = 49.0$ ksi

$\sigma_{UTS,eng} = 108$ ksi

$\varepsilon_{failure,eng} = 0.70$

Conversion at Yielding

The Young's modulus for Alloy 22 is taken from Ibarra, et al. (2007) as:

$E = 26{,}100$ ksi

Thus, the engineering strain at yielding is:

$\varepsilon_{y,eng} = \sigma_{y,eng} / E = 0.00188$

Then, the true strain at yielding is:

$\varepsilon_{UTS,true} = \ln(1 + \varepsilon_{UTS,eng}) = 0.00188$

The true stress at yielding is:

$\sigma_{y,true} = \sigma_{y,eng}(1 + \varepsilon_{y,eng}) = 49.1$ ksi = 338 MPa

Conversion at UTS

To obtain the true stresses and strains at the UTS, it is assumed that the strain at UTS is 90% of the strain at failure. Then,

$\varepsilon_{UTS,eng} = 0.63$

Then, the true strain at UTS is:

$\varepsilon_{UTS,true} = \ln(1 + \varepsilon_{UTS,eng}) = 0.490$

The true stress at UTS is:

$\sigma_{UTS,true} = \sigma_{UTS,eng}(1 + \varepsilon_{UTS,eng}) = 176.0$ ksi = 1,213 MPa

Ibarra, L., T. Wilt, G. Ofoegbu, R. Kazban, F. Ferrante, and A. Chowdhury. "Drip Shield-Waste Package Mechanical Interaction." San Antonio, Texas: Center for Nuclear Waste Regulatory Analyses. 2007.

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SAMPLE ABAQUS INPUT FILE FOR Ti-24 ALLOY 22 INTERACTIO ANALYSIS

```
*Heading
** Job name: optmesh50rnd2body Model name: Model-1
***Preprint, echo=NO, model=NO, history=NO, contact=NO
**
** PARTS
**
*Part, name=Part-2
*End Part
**
*Part, name=Part-5
*End Part
**
**
** ASSEMBLY
**
*Assembly, name=Assembly
**
*Instance, name=Part-2-6, part=Part-2   ALLOY 22 MODEL
*Node
      1,  0.061999999, -0.00100000005
      2,  0.061999999, -0.0109999999
      3, 0.0379999988, -0.0109999999
      4, 0.0379999988, -0.00100000005
  12477, 0.0381249972, -0.00135714281
  12478, 0.0381250009, -0.00117857149
```

TYPICAL NODAL DATA

```
*Element, type=CPE4   PLANE STRAIN ELEMENT
   1, 1000,   22,   23, 1001
   2,  424,  425,  670,  624
   3,  986, 1364, 1337, 1629
   4,  902, 1019, 1190, 1255
12316, 12477, 12478,   309,   308
12317, 12478,   623,     4,   309
**********
*Nset, nset=_PickedSet9, internal, generate
     1,  12478,      1
*Elset, elset=_PickedSet9, internal, generate
     1,  12317,      1
** Region: (wp:Picked)
*Elset, elset=_PickedSet9, internal, generate
     1,  12317,      1
** Section: wp
*Solid Section, elset=_PickedSet9, material=alloy22   ASSIGNMENT TO
1.,                                                   ALLOY 22 MATERIAL
*End Instance
**
*Instance, name=Part-5-6, part=Part-5   Ti-24 MODEL
0.0165516844118473, 0.0378406204335659,          0.
0.0165516844118473, 0.0378406204335659,          0.,
0.0165516844118473, 0.0378406204335659,         -1., 44.9999993411413
*Node
      1, 0.0500456654, 0.0200001318
      2, 0.0300456639, 0.0200001318
      3, 0.0300456639,  1.31087035e-07
      4, 0.0460456647,  1.31087035e-07
   9652, 0.0183867291, 0.0109851938
   9653, 0.0184678994, 0.00887299702
*Element, type=CPE4   PLANE STRAIN ELEMENT
   1,  903,  251,  252,  913
   2,  733,   37,   38,  734
   3, 1006, 1005, 1425, 1330
```

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```
   4,  730,   91,   92,  776
 9444, 9445, 9446, 9447, 9448, 9449, 9450, 9451, 9452, 9453, 9454, 9455,
9456, 9457, 9458, 9459
 9460, 9461, 9462, 9463, 9464, 9465, 9466, 9467, 9468, 9469, 9470, 9471,
9472
** Section: stiffrigid
*Solid Section, elset=_PickedSet7, material=rigid
1.,
** Region: (stiffrigid:Picked)
*Elset, elset=_PickedSet6, internal, generate
 7427,  8286,     1
** Section: stiffrigid
*Solid Section, elset=_PickedSet6, material=rigid
1.,
*Elset, elset=_PickedSet8, internal, generate
    1,  6807,     1
** Region: (stiff2:Picked)
*Elset, elset=_PickedSet8, internal, generate
    1,  6807,     1
** Section: stiff2
*Solid Section, elset=_PickedSet8, material=ti24   ASSIGNMENT TO
1.,                                                Ti-24 MATERIAL
*ELEMENT, TYPE=SPRING1, ELSET=YGRND
 20004, 14
 20005, 19
*SPRING, ELSET=YGRND
 2,
 1.0E+02,
*End Instance
**
*Nset, nset=_PickedSet636, internal, instance=Part-2-6
   6,   7, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366,
367, 368
 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382,
383, 384
 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398,
399, 400
 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413
*Elset, elset=_PickedSet636, internal, instance=Part-2-6
   5,  42, 136, 165, 204, 206, 208, 210, 211, 213, 214, 272, 273, 276,
279, 281
 283, 284, 286, 287, 289, 290, 292, 293, 295, 296, 298, 300, 304, 305,
307, 310
 311, 313, 314, 316, 318, 319, 322, 325, 326, 330, 338, 346, 350, 353,
371, 386
 414, 423, 429, 484, 573, 646, 662, 682, 685, 688, 691, 706
*Nset, nset=_PickedSet694, internal, instance=Part-2-6
   5,   6, 350, 351, 352, 353, 354
*Elset, elset=_PickedSet694, internal, instance=Part-2-6
 301, 302, 305, 674, 677, 679
*Nset, nset=_PickedSet844, internal, instance=Part-5-6
 14, 16, 17
*Nset, nset=n432, instance=Part-5-6
  432
*Nset, nset=n14, instance=Part-5-6
   14
*Nset, nset=n4479, instance=Part-5-6
  4479
*Nset, nset=n4895, instance=Part-5-6
  4895
*Nset, nset=n5363, instance=Part-5-6
```

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```
*Density
** 8691.5,
 1.0E-33
***Elastic
** 1.97e+11, 0.31
***Plastic
** 2.547e+08,     0.
** 9.541e+08, 0.335
** 11.545e+08, 0.525
*Elastic
 1.799e+11, 0.31
*Plastic
 338.0e+06,     0.
 1213.0e+06, 0.490
 5000.0e+06, 2.690
*Material, name=rigid
*Density
4429.,
*Elastic
 1.072e+11, 0.31
*Plastic
 1e+21,0.
*Material, name=ti24
*Density
4429.,
*Elastic
 1.072e+11, 0.31
*Plastic
 943.0e+06,     0.
 1153.0e+06, 0.148
 5000.0e+06, 2.86
**
** INTERACTION PROPERTIES
**
*Surface Interaction, name=IntProp-1
1.,
*Friction, slip tolerance=0.005
 0.4,
*Surface Behavior, no separation, pressure-overclosure=HARD
**
** BOUNDARY CONDITIONS
**
** Name: BC-3 Type: Displacement/Rotation
*Boundary
_PickedSet694, 1, 1
** Name: BC-4 Type: Displacement/Rotation
*Boundary
_PickedSet844, 1, 1
** Name: BC-6 Type: Displacement/Rotation
*Boundary
_PickedSet636, 2, 2
**
** INTERACTIONS
**
** Interaction: Int-1
*Contact Pair, interaction=IntProp-1
_PickedSurf835, _PickedSurf834
** ----------------------------------------------------------------
**
** STEP: Step-1
**
```

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CONTACT DATA

BOUNDARY CONDITIONS

CONTACT DATA

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```
*Step, name=Step-1, nlgeom=YES, inc=10000
*Static
0.0001, 1., 1e-10, 1.0
**
** LOADS
**
** Name: Load-1   Type: Pressure
*dload, op=mod
   stiff, grav, 9.81, 0.0, -1.0
***Dsload
**_PickedSurf650, P, 1.
**
** OUTPUT REQUESTS
**
***Restart, write, frequency=0
**
** FIELD OUTPUT: F-Output-1
**
*Output, field, variable=PRESELECT
**
** HISTORY OUTPUT: H-Output-1
**
*Output, history, variable=PRESELECT
***node output, nset=n432
**u1,u2
***node print, nset=n432
**u1,u2
*contact output
carea
*contact print, frequency=1
carea
*End Step
** ----------------------------------------------------------------
**
** STEP: Step-2
**
*Step, name=Step-2, nlgeom=YES, inc=1000
*Static
0.01, 1., 1e-05, 0.1
**
** LOADS
**
** Name: Load-1   Type: Pressure
*dload, op=mod
**   stiff, grav, 544210.0, 0.0, -1.0
   stiff, grav, 1088420.0, 0.0, -1.0
***Dsload
**_PickedSurf650, P, 56.58E+07
**
** OUTPUT REQUESTS
**
***Restart, write, frequency=1
**
** FIELD OUTPUT: F-Output-1
**
*Output, field, variable=PRESELECT
**
** HISTORY OUTPUT: H-Output-1
**
*Output, history, variable=PRESELECT, frequency=1
***Output, history
```

LOAD STEP DATA

LOAD STEP DATA

APPLY LOADS

ASSIGN OUTPUT VARIABLES

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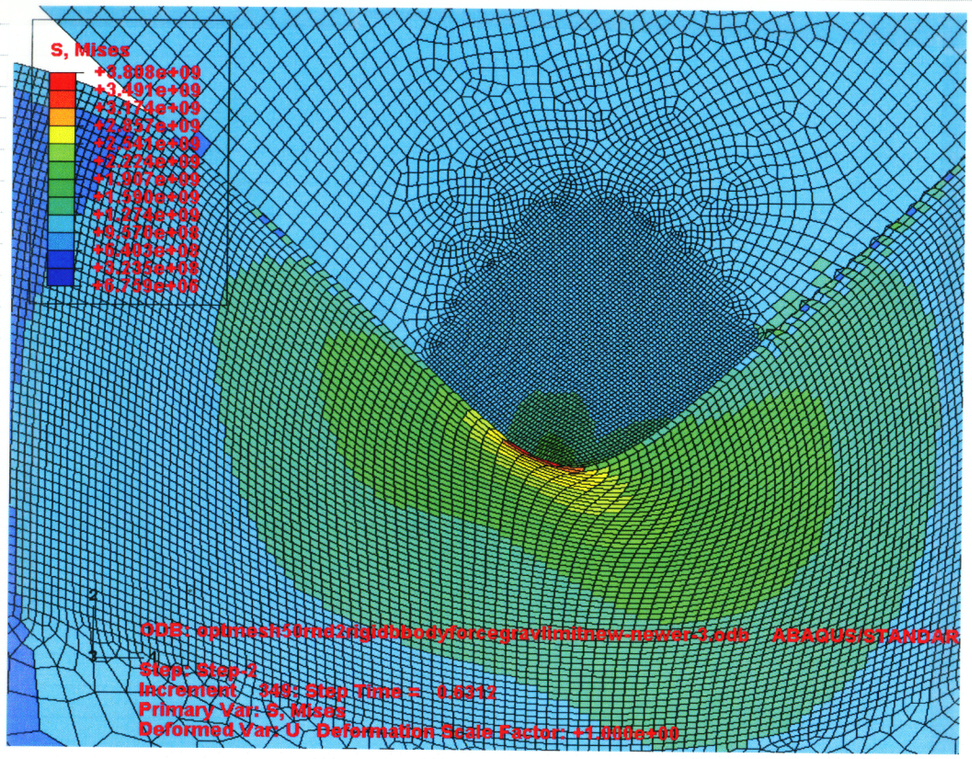

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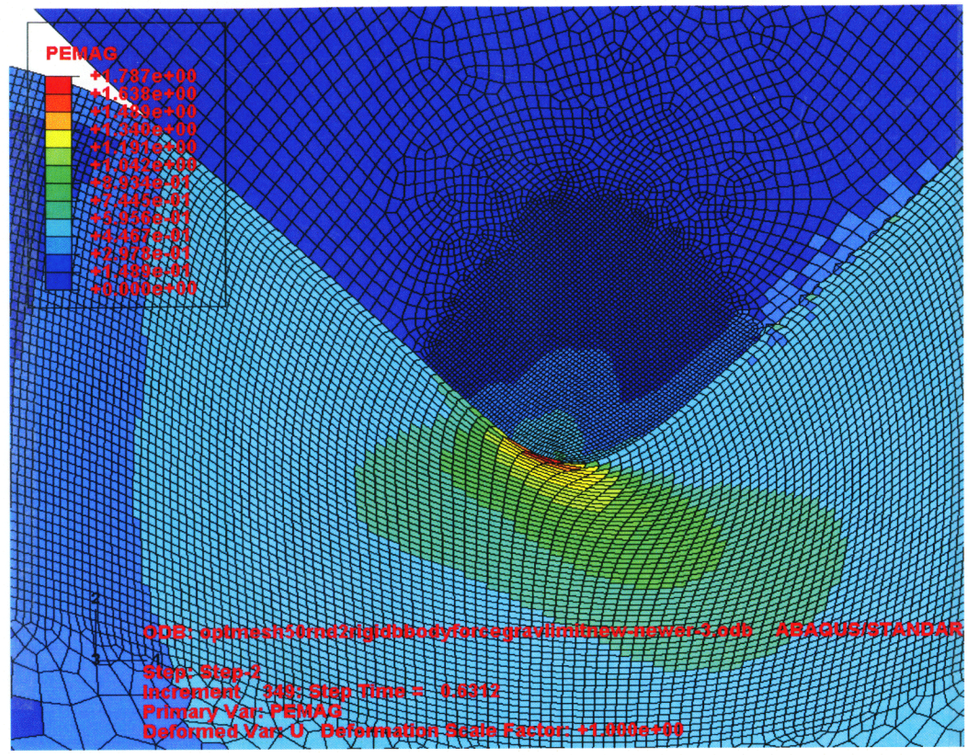

MAGNITUDE OF PLASTIC STRAIN

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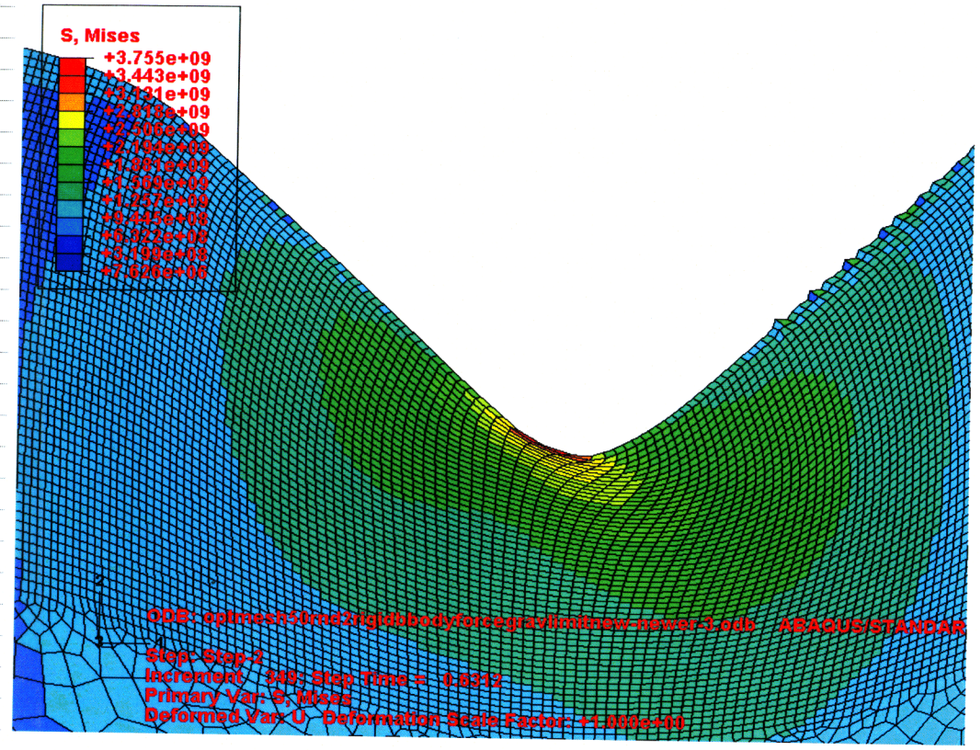

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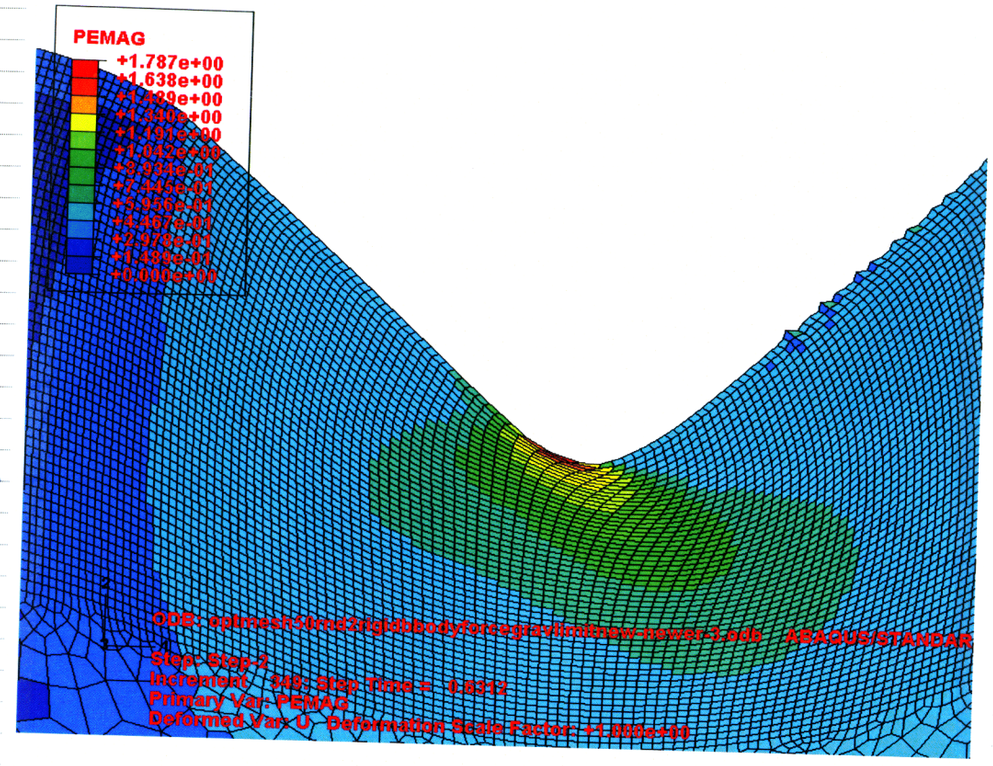

MAGNITUDE OF PLASTIC STRAIN

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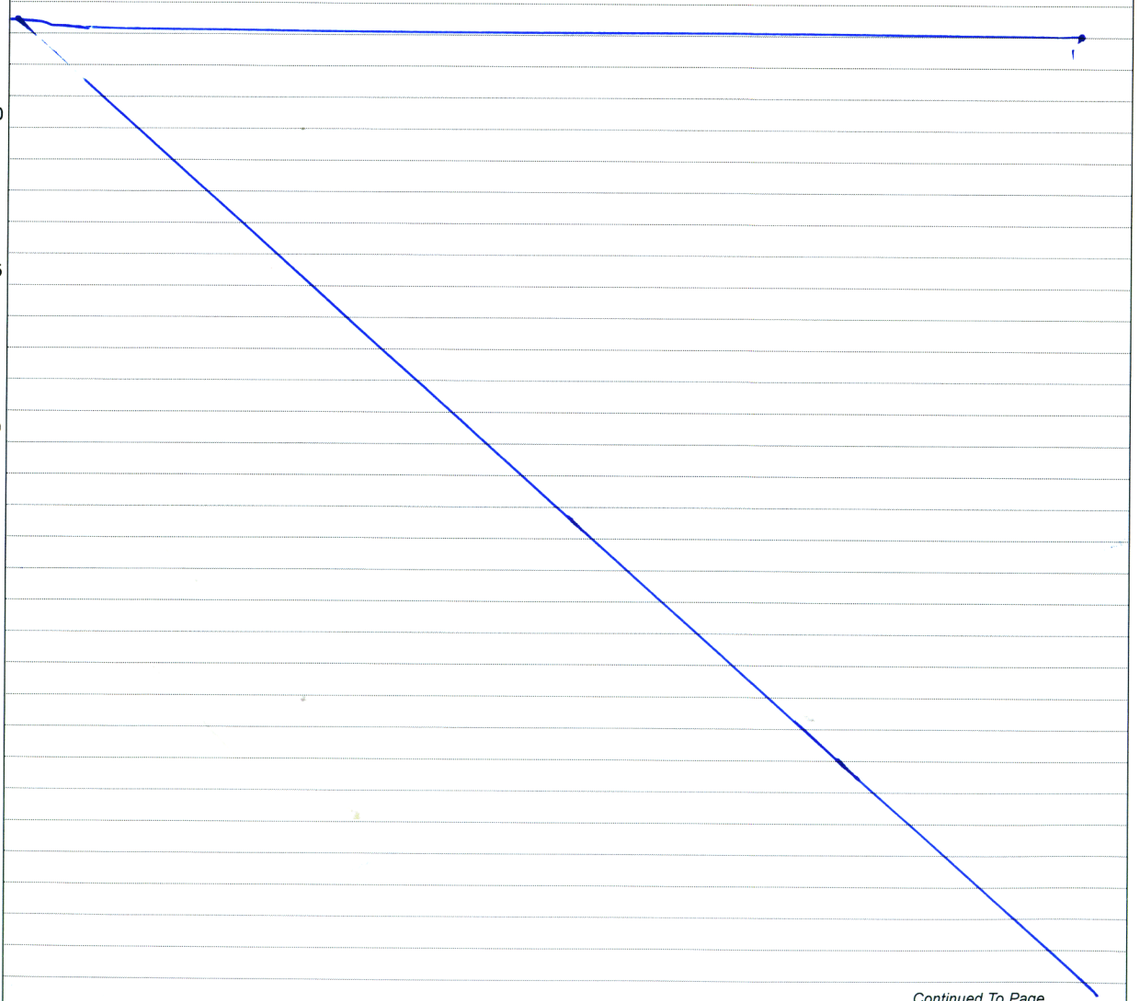
PLEASE NOTE THAT ON PAGES 52 - 55
THE LOAD LEVEL IS APPROXIMATELY 1690039 N
WHICH CORRESPONDS TO THE PEAK LOAD ~~FOR~~ FROM
THE ACTUAL TEST.
(THE PLOTS ON PAGES 57 AND 58 ALSO ARE AT THIS
LOAD LEVEL)



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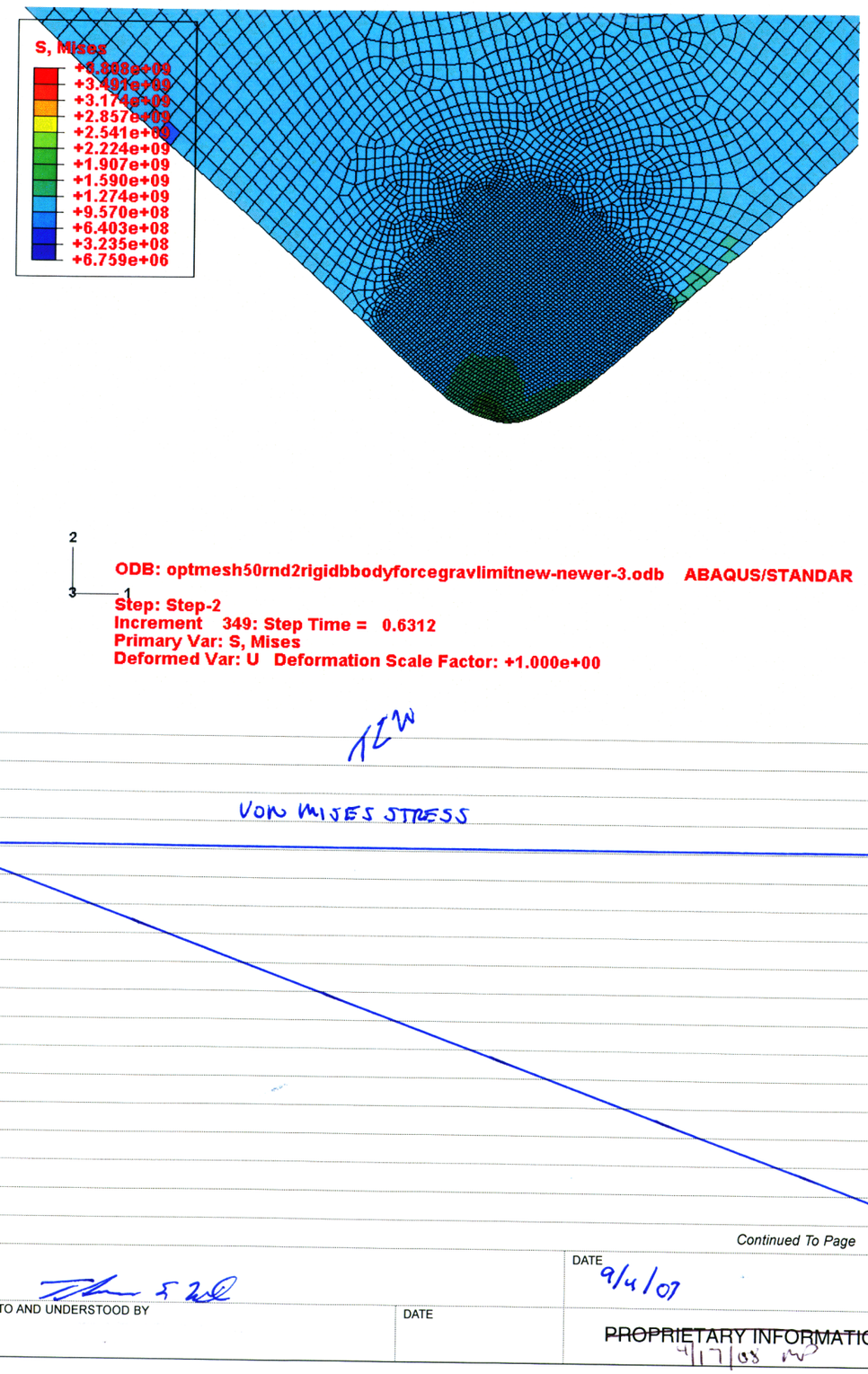

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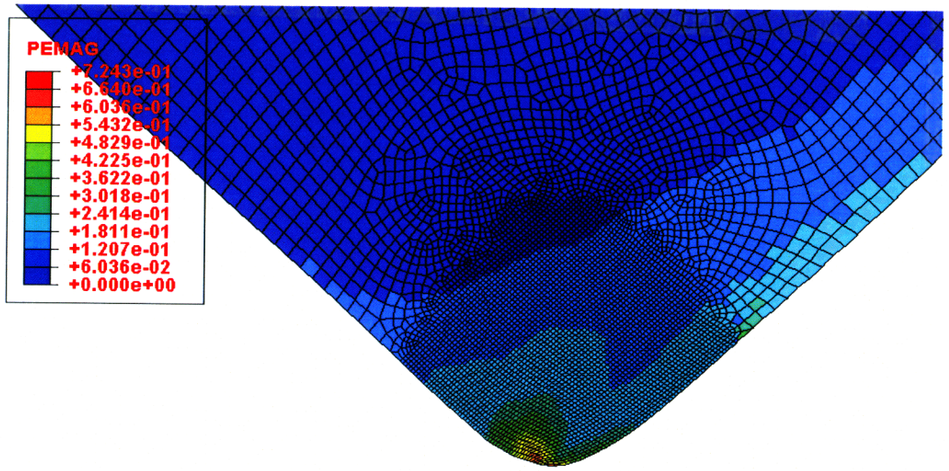

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MAGNITUDE OF PLASTIC STRAINS

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ATTACHED IS A CD CONTAINING THE ABAQUS INPUT FILE AND TEXT OF OUTPUT FILE.

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File Types: (.exe, .bat, .zip, etc.)	Pdf., doc, xls, ppt, jpg, dat, inp
Remarks: (computer runs, etc.)	Media contains: Software change forms, tables, development plan, run-time