2

STA 4

AUG 25 1994

ENGINEERING DATA TRANSMITTAL

1. EDT 157695

2. To: (Receiving Organization) Cesium Return Program	3. From: (Originating Organization) Cesium Return Program	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: Cesium Return Program	6. Cog. Engr.: P. T. Saueressig	7. Purchase Order No.: N/A

8. Originator Remarks:
Transmittal and release of the supporting document which compiles the documentation for initial testing and inspections of Benificial Uses Shipping System (BUSS) Cask.

9. Equip./Component No.: N/A

10. System/Bldg./Facility: N/A

11. Receiver Remarks:
Comments have been incorporated.

12. Major Assm. Dwg. No.: N/A

13. Permit/Permit Application No.: N/A

14. Required Response Date: 10 August, 1994

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Impact Level	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-WM-TI-654	-	0	Documentation for initial testing of Benificial Uses Shipping System (BUSS) Cask.	N/A	1,2	1	1

16. KEY

Impact Level (F)	Reason for Transmittal (G)	Disposition (H) & (I)
1, 2, 3, or 4 (see MRP 5.43)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION
(See Impact Level for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
1,2	1	Cog. Eng. (P.T. Saueressig)	Paul T Saueressig	8/10/94	S6-65	Central Files			L8-04	3	
1,2	1	Cog. Mgr. (E.D. Robbins)	[signature]	8/15/94	S6-65	O.S.T.I. (2)			R1-05	3	
		QA	N/A								
		Safety	N/A								
		Env.	N/A								
1,2	1	Packaging Safety Engineering (W.A. McCormick)	[signature]	8/16/94	G2-02						

18.	19.	20.	21. DOE APPROVAL (if required)
E Lundan 8-10-94 Signature of EDT Originator / Date	[signature] 8-15-94 Authorized Representative for Receiving Organization / Date	[signature] 8-15-94 Cognizant/Project Engineer's Manager / Date	Ltr. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (07/91) GEF097

BD-7400-172-1 (02/89)

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

RELEASE AUTHORIZATION

Document Number:	DOCUMENTATION FOR INITIAL TESTING AND INSPECTIONS OF BENIFICIAL USES SHIPPING SYSTEM (BUSS) CASK.
Document Title:	WHC-SD-WM-TI-654 REVISION 0
Release Date:	08-22-94

* * * * * * * * * * * * *

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

* * * * * * * * * * * * *

WHC Information Release Administration Specialist:

Kara Broz
Kara Broz 08-23-94
(Signature) **(Date)**

A-6001-400 (07/94) WEF256

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SUPPORTING DOCUMENT

1. Total Pages 258

2. Title Documentation for initial testing and inspections of Benificial Uses Shipping System (BUSS) Cask.	3. Number WHC-SD-WM-TI-654	4. Rev No. 0
5. Key Words Cesium chloride capsule, Waste Encapsulation and Storage Facility (WESF), Benificial Uses Shipping System (BUSS) Cask, Sandia National Laboratories (SNL). APPROVED FOR PUBLIC RELEASE KMB 8/22/94	6. Author Name: J. E. Lundeen James E. Lundeen 8-10-94 Signature Organization/Charge Code 16800/KB51B	

7. Abstract

The purpose of this report is to compile data generated during the initial tests and inspections of the Benificial Uses Shipping System (BUSS) Cask. In addition, this report will verify that the testing criteria identified in chapter 8 of the BUSS Cask Safety Anylis Report for Packaging (SARP) was met.

Chapter 8 of the BUSS Cask SARP requires several acceptance tests and inspections, each intended to evaluate the performance of different components of the BUSS Cask system, must be performed before its first use. Some of these tests have been done during fabrication of the packaging components. The remaining tests have been performed before the cask is first loaded for transport. The results of the following tests and inspections are included in this document:

- Inspection and testing during fabrication
- Visual inspection before first use
- Pressure testing
- Leak testing
- Test for shielding integrity
- Thermal testing
- Lid closure bolt torque test

The results from all initial inspections and testing of the BUSS Cask met the SARP criteria and the BUSS Cask was released for use.

9. Impact Level N/A

10. RELEASE STAMP

OFFICIAL RELEASE (13)
BY WHC
DATE ~~AUG 24 1994~~ JKE 8/25/94
AUG 25 1994
STA 4

A-6400-073 (11/91) (EF) WEF124

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

1.0 Introduction

The purpose of this report is to compile data generated during the initial tests and inspections of the Beneficial Uses Shipping System (BUSS) Cask. In addition, this report will verify that the testing criteria identified in section 8.1 of the BUSS Cask Safety Analysis Report for Packaging (SARP), Reference 4.1, was met.

The BUSS Cask Model R-1 is a type B shipping container used for shipment of radioactive cesium-137 and strontium-90 capsules to Waste Encapsulation and Storage Facility (WESF). The BUSS Cask body and lid are each one-piece forgings fabricated from ASTM A473, Type 304 stainless steel. The primary purpose of the BUSS Cask is to provide shielding and confinement as well as impact, puncture, and thermal protection for the capsules under both normal and accident conditions

Chapter 8 of the BUSS Cask SARP requires several acceptance tests and inspections, each intended to evaluate the performance of different components of the BUSS Cask system, to be performed before its first use. The results of the tests and inspections required in the following SARP sections are included in this document:

8.1.1 "Inspection and Testing during Fabrication"
8.1.2 "Visual Inspection before First Use"
8.1.3 "Pressure Testing"
8.1.4 "Leak Testing"
8.1.5 "Test for Shielding Integrity"
8.1.6 "Thermal Testing"
8.1.7 "Lid Closure Bolt Torque Test"

The tests and inspections required in the following SARP sections were performed by Sandia National Laboratories (SNL) or the BUSS Cask manufacturer:

8.1.1 "Inspection and Testing during Fabrication"
8.1.3 "Pressure Testing"
8.1.4 "Leak Testing"
8.1.6 "Thermal Testing"
8.1.7 "Lid Closure Bolt Torque Test"

The inspection required in section 8.1.2 "Visual Inspection before first Use" was performed by Westinghouse Hanford Company (WHC) upon reciept of the BUSS Cask. The testing required in section 8.1.5 "Test for Shielding Integrity" was performed by RUST Federal Services (RFS), subcontractor to WHC.

2.0 Discussion/Summary

Section 8.1.1 of the SARP "Inspection and Testing during Fabrication" requires that the following tests and inspections be performed:

1) Testing during fabrication verifying that the cask material has the minimum material properties described in Chapter 2 of the SARP.

2) Nondestructive evaluation tests given to the cask components after they were machined to within 0.25 in.(0.64 cm) of their final configuration, including dimensional and visual inspection, magnetic and liquid penetrant inspection, and radiographic or ultrasonic inspection.

3) Inspection of the components after their final machining to verify compliance to the dimensions specified in the SARP.

4) Evaluation of the impact limiter foam during fabrication for yield strength and density.

Test numbers 1, 2 and 3 listed above were performed by SNL. The results of these tests are not included in this report, but auditable records (quality assurance documentation) are maintained at SNL, which document the results of these tests and certify that the tests have been successfully completed and the SARP requirements met. This is confirmed by the SNL letter contained in Appendix A.

The impact limiters were structurally tested (test number 4 above) by the manufacturer, General Plastics Manufacturing Company. The results of this testing are included in General Plastics letter 8E202, which is also included in Appendix A.

Requirements: The yield strength of the foam must be 350 psi(2.4 MPa) (-0%, +15%) parallel to the foam rise and 300 psi(2.1 MPa) (-0%, +15%) perpendicular to the foam rise. The calculated foam density will be nominally from 10.5 to 11.3 lb/ft^3.

Results: The yield strength for limiter S/N S48929-001 was measured to be 373 psi parallel and 323 psi perpendicular to the rise. The yield strength for limiter S/N S48929-002 was measured to be 373 psi parallel and 324 psi perpendicular to the rise. For limiter S/N S48929-001 the tare weight was 1,846 lbs, the whole weight was 3,006 lbs, and the foam density calculated to be 10.64 lb/ft^3. For limiter S/N S48929-002 the tare weight was 1,845 lbs, the whole weight was 2,994 lbs, and the foam density was calculated to be 10.54 lb/ft^3. All measurements met the SARP requirements.

Section 8.1.2 "Visual Inspection before First Use" requires a visual inspection of the packaging. Appendix B includes the initial inventory list of all system components. Also included is a page of the Westinghouse Inspection Plan from the first shipment confirming that the impact limiters were inspected.

Requirements: All system components must be available, there must be no damage to the impact limiters during transport, and the packaging must be labeled with its model number, gross weight, and package identification number.

Results: All system components and spare parts were documented and available and there was no damage to the impact limiters. The following information is contained on the labels:

"BUSS Cask
Model No. R-1
ID No. USA/9511/B (U) DOE
Cask Assembly only: 23,900
w/ Limiters and Skid: 32,600"

The labels are located on the bevelled top edge of the cask near the lid and adjacent to the horizontal lift lugs. This labeling information closes out the SARP requirement for proper package labeling. The results of the initial inspections met SARP criteria.

Section 8.1.3 "Pressure Tests" requires a hydrostatic pressure test of the confinement system before the first use of the BUSS Cask. This testing was performed by SNL. The results are documented in SNL letter 8E176, which is included in Appendix C.

Requirements: The container must be leak-tested at an internal pressure of 75 psi(0.52 MPa) (50% higher than the maximum normal operating pressure), which must be held for at least 30 min with no pressure decrease greater than 1/2 psi.

Results: A pressure of 76 psi was held for 31 min with no detectable decrease. The results met the SARP criteria.

Section 8.1.4 "Leak Tests" requires a fabrication leak test performed on the BUSS Cask. The testing was performed by SNL. The corresponding data sheets and calibration reports which contain the results of this testing are included in Appendix D.

Requirements: A confinement leakage criterion of 1.0E-4 atm-cm^3/s must be met. Leak tests are required on the cask body, lid, and port plugs before use, each meeting the leakage criterion of 1.0E-4 atm-cm^3/s. The leak detector sensitivity must be a minimum of 5.0E-6 atm-cm^3/s.

Results: The leak rates were as follows: 1.3E-7 atm-cm^3/s helium for the assembled boundary, no detectable leakage for the lid seal, 3.6E-6 atm-cm^3/s helium for the lower port, and no detectable leakage for the upper port. The sensitivity of the leak detector was 1.0E-9. All results exceeded the minimum requirements.

Section 8.1.5 "Test for Shielding Integrity" requires that the BUSS Cask be tested before its first use to verify that it provides the required level of shielding. This testing was performed by RUST Federal Services (RFS). The results are documented in RFS memo 733027.022, included in Appendix E. The original data compiled from this testing is included in Reference 4.2.

Requirements: The cask is loaded with 12 cesium chloride capsules with a maximum activity of 70.8 kCi each or 16 capsules with a maximum activity of 53.1 kCi each. The measured dose rates on the surface of the cask and at 2 meters from the surface must be less than or equal to 200 mrem/hr and 10 mrem/hr, respectively.

Results: Initial testing consisted of loading sixteen capsules in the BUSS Cask. A prototype plug was installed in the upper port to meet the SARP requirements on the surface and at a 2 meter distance. Documentation from the testing was compiled in Reference 4.2.

The shielding evaluation was repeated at IOTECH with the cask loaded with 16 capsules, as documented in Reference 4.3. The maximum dose rate measured on the surface was 70 mrem/hr at the lower port (a permanent shielding plug was installed in the upper port) and the maximum dose rate measured at 1 meter from the surface was 1.4 mrem/hr at the lower port, as documented by Appendix E. The results were below the maximum dose rates allowed by the SARP.

Section 8.1.6 "Thermal Testing" requires that a thermal test be conducted on a prototype cask before its first use to ensure that the cask will meet the thermal design criteria. Also, the results of this test provide benchmarking data to validate two thermal model programs developed for the SARP. This testing was performed by SNL. The results are documented by Sandia Report SAND87-2715, which is included in Appendix F.

Requirements: Twelve cesium chloride capsules are loaded and, in order to conduct the test for the highest thermal loading (4.0 kW), each shall have a thermal power of 333 watts, or capsules with accurately-known thermal outputs shall be used.

Results: The capsule heat rates averaged 265 W/capsule. Therefore the capsules produced a total thermal heat load of 3.2 kW. The values predicted by the programs were higher than measured for the basket, but very comparable in the cask region. The BUSS cask met the design criteria and the thermal model programs were validated.

Section 8.1.7 "Lid Closure Bolt Torque Tests" requires that bolt torquing tests be performed on the lid closure to validate the relationship between torque and preload on the 1 1/2 in. diameter lid bolts. Instrumented lubricated and unlubricated bolts and a calibrated torque wrench must be used, and a sensitivity curve for torque vs. preload be developed. Testing was performed by SNL. The results are documented by SNL letter 8E377, which is included in Appendix G.

Requirements: The torque value must be determined that produces 45,000 lbs of tension for each bolt.

Results: It was determined that a torque value of 1,250 ft-lbs for each bolt with Neolube dry-lubricant produces the required amount of tension. Therefore this value shall be used for cask assembly operations.

In conclusion, the results from all the initial testing and inspections of the BUSS Cask met the SARP criteria and the BUSS Cask was released for use.

4.0 References

4.1 SAND83-0698 TTC-0430, Rev. 4, May 1993, Benificial Uses Shipping System (BUSS) Cask Safety Analysis Report for Packaging (SARP), D.R. Bronowski et. all, Sandia National Laboratories.

4.2 WHC-SD-WM-PTR-010, Rev. 1, March 1994, Test Report for Beneficial Uses Shipping System (BUSS) Cask Radiological and Thermal Performance, P.T. Saueressig, Westinghouse Hanford Co.

4.3 EHC-SD-WM-DP-083, Rev. 0, July 1994, Documentation for Shipment WRM-8982 of Cesium Capsules from IOTECH to WESF, J.E. Lundeen, Westinghouse Hanford Co.

Appendix A: Inspection and Testing During Fabrication

SPECIMEN MATERIAL MINIMUM MATERIAL PROPERTY TESTING

Attachment; SNL Letter Dated April 26, 1994

Attachment; WHC Letter Dated December 21,1993 # 9360768

Sandia National Laboratories

P. O. Box 5800
Albuquerque, New Mexico 87185-0718

Managed by Martin Marietta Corporation
for the U. S. Department of Energy

H. Richard Yoshimura
Transportation Systems Analysis

April 26, 1994

E. D. Robbins
Westinghouse Hanford Company
P. O. Box 1970
MS S6-65
Richland, WA 99352

Dear Mr. Robbins:

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The BUSS Cask SARP Chapter 8 (Section 8.1, Acceptance Tests) requires the completion of specific testing and inspection criteria prior to use. SNL completed the acceptance testing requirements for Sections 8.1.1 "Inspection and Testing during Fabrication," 8.1.3 "Pressure Tests," 8.1.4 "Leak Tests," 8.1.6 "Thermal Testing," and 8.1.7 "Lid Closure Bolt Torque Tests".

The records for inspection and testing performed during fabrication (quality assurance documentation) as defined in Section 8.1.1 are maintained at SNL. SNL has an auditable set of fabrication records which confirms completion of this requirement. In addition, the procurement and fabrication records have been independently audited, and all discrepancies of the audit were resolved.

The initial hydrostatic test requirements were performed according to Section 8.1.3 of the BUSS Cask SARP by SNL. SNL document #8E176 (Attachment 1) confirms completion of this requircment.

The initial leak test requirements were performed according to Section 8.1.4 of the BUSS cask SARP by SNL. SNL document #8E177 (Attachment 2) confirms completion of this requirement.

The thermal test requirements were performed according to Section 8.2.3 of the BUSS cask SARP by SNL. SNL document #8E384, SAND 87-2715 (Attachment 3) confirms completion of this requirement.

The lid closure bolt torque tests were performed according to Section 8.1.7 of the BUSS cask SARP by SNL. SNL document #8E381 (Attachment 4) confirms completion of this requirement.

SNL has previously provided two controlled copies (copy no. 30 and 33) of the BUSS cask SARP to WHC. In addition, SNL will provide one additional controlled copy as requested by WHC Waste Encapsulation and Storage Facility (WESF). These controlled copies will be augmented with SARP Revision #4 upon approval by DOE-HQ (EH-33.2) and the subsequent issuance of the Certificate of Compliance. If you have any questions or require any additional documentation for the BUSS cask, please contact me on (505) 845-8181.

Sincerely,

H. R. Yoshimura

H. R. Yoshimura, Acting Manager
Transportation Systems Analysis
Department 6641

HRY:6641:kas

Attachments

Copy to:(w/o attachments)
6631 C. Olsen (Quality Assurance)
6641 Day File
6643 D. R. Bronowski
BUSS Cask File

Westinghouse
Hanford Company

P.O. Box 1970 Richland, WA 99352

December 21, 1993 9360768

Mr. R. H. Yoshimura
Transportation System Technology
Department 6642
Sandia National Laboratories
Albuquerque, New Mexico 87185

Dear Mr. Yoshimura:

REQUEST FOR BENEFICIAL USES SHIPPING SYSTEM (BUSS) CASK SAFETY ANALYSIS REPORT FOR PACKAGING (SARP) DOCUMENTATION

The purpose of this letter is to request documentation from Sandia National Laboratories (SNL) stating completion of the compilation and audit of BUSS cask fabrication Quality Assurance (QA) records and completion of specific acceptance tests as required in Chapter 8 of the BUSS cask SARP.

Westinghouse Hanford Company (WHC) is aware that SNL is reviewing and compiling its BUSS cask QA fabrication records and that an independant audit has been conducted on the records by SNL to assure the documentation will standup to a Nuclear Regulatory Commission (NRC) audit if conducted.

Please provide correspondence to WHC stating that all the appropriate QA fabricated records are assembled and maintained at SNL so that the BUSS cask can be used within the requirements of the SARP.

Chapter 8 of the BUSS cask SARP requires that a specific acceptance test be successfully conducted and documented prior to transporting radioactive materials with the cask. As per prior agreements with SNL, all tests are being conducted by WHC, except for those found in Sections 8.1.1 (as stated above), 8.1.4.1, 8.1.6 and 8.1.7.

Please provide to WHC documentation which states all testing required in the above sections are successfully completed by SNL, and address all documentation to myself.

If you have any questions or comments please contact me on (509) 372-0001.

Very truly yours,

E. D. Robbins

E. D. Robbins, Manager
Cesium Return Program
Facility Operations

slr

DOE-HQ - L. Blalock
R. B. Chitwood
J. J. Keenan

RL - L. D. Romine
R. O. Putoff (w/o attachment)

COMPONENT NonDESTRUCTIVE EXAMINATION (NDE) TESTING

Attachment; SNL Letter Dated April 26, 1994

Attachment; WHC Letter Dated December 21, 1993 # 9360768

Sandia National Laboratories

P. O. Box 5800
Albuquerque, New Mexico 87185-0718

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H. Richard Yoshimura
Transportation Systems Analysis

April 26, 1994

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MS S6-65
Richland, WA 99352

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The BUSS Cask SARP Chapter 8 (Section 8.1, Acceptance Tests) requires the completion of specific testing and inspection criteria prior to use. SNL completed the acceptance testing requirements for Sections 8.1.1 "Inspection and Testing during Fabrication," 8.1.3 "Pressure Tests," 8.1.4 "Leak Tests," 8.1.6 "Thermal Testing," and 8.1.7 "Lid Closure Bolt Torque Tests".

The records for inspection and testing performed during fabrication (quality assurance documentation) as defined in Section 8.1.1 are maintained at SNL. SNL has an auditable set of fabrication records which confirms completion of this requirement. In addition, the procurement and fabrication records have been independently audited, and all discrepancies of the audit were resolved.

The initial hydrostatic test requirements were performed according to Section 8.1.3 of the BUSS Cask SARP by SNL. SNL document #8E176 (Attachment 1) confirms completion of this requirement.

The initial leak test requirements were performed according to Section 8.1.4 of the BUSS cask SARP by SNL. SNL document #8E177 (Attachment 2) confirms completion of this requirement.

The thermal test requirements were performed according to Section 8.2.3 of the BUSS cask SARP by SNL. SNL document #8E384, SAND 87-2715 (Attachment 3) confirms completion of this requirement.

The lid closure bolt torque tests were performed according to Section 8.1.7 of the BUSS cask SARP by SNL. SNL document #8E381 (Attachment 4) confirms completion of this requirement.

SNL has previously provided two controlled copies (copy no. 30 and 33) of the BUSS cask SARP to WHC. In addition, SNL will provide one additional controlled copy as requested by WHC Waste Encapsulation and Storage Facility (WESF). These controlled copies will be augmented with SARP Revision #4 upon approval by DOE-HQ (EH-33.2) and the subsequent issuance of the Certificate of Compliance. If you have any questions or require any additional documentation for the BUSS cask, please contact me on (505) 845-8181.

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December 21, 1993

9360768

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J. J. Keenan

RL - L. D. Romine
R. O. Putoff (w/o attachment)

FINAL COMPONENT MACHINING INSPECTION

Attachment; SNL Letter Dated April 26, 1994

Attachment; WHC Letter Dated December 21, 1993 # 9360768

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Westinghouse Hanford Company (WHC) is aware that SNL is reviewing and compiling its BUSS cask QA fabrication records and that an independant audit has been conducted on the records by SNL to assure the documentation will standup to a Nuclear Regulatory Commission (NRC) audit if conducted.

Please provide correspondence to WHC stating that all the appropriate QA fabricated records are assembled and maintained at SNL so that the BUSS cask can be used within the requirements of the SARP.

Chapter 8 of the BUSS cask SARP requires that a specific acceptance test be successfully conducted and documented prior to transporting radioactive materials with the cask. As per prior agreements with SNL, all tests are being conducted by WHC, except for those found in Sections 8.1.1 (as stated above), 8.1.4.1, 8.1.6 and 8.1.7.

Please provide to WHC documentation which states all testing required in the above sections are successfully completed by SNL, and address all documentation to myself.

If you have any questions or comments please contact me on (509) 372-0001.

Very truly yours,

E. D. Robbins, Manager
Cesium Return Program
Facility Operations

slr

DOE-HQ - L. Blalock
R. B. Chitwood
J. J. Keenan

RL - L. D. Romine
R. O. Putoff (w/o attachment)

IMPACT LIMITER STRUCTURAL PROPERTIES

8E202 (1)

50 YEARS OF COMMITMENT TO QUALITY AND SERVICE

GENERAL PLASTICS MANUFACTURING COMPANY
4910 BURLINGTON WAY/P.O. BOX 9097
TACOMA, WASHINGTON 98409
(206) 473-5000

TELEX 989134
FAX (206) 473-5104
TOLL FREE FROM
Seattle-Renton Area
(206) 623-2795

September 9, 1992

REVIEWED AND ACCEPTED BY
[signature] Eakes 4/14/93

Sandia National Laboratories
1515 Eubank Boulevard S.E.
Albuquerque, New Mexico 87123

Attention: Richard Yoshimura, Division #6642

Subject: **Certificate of Conformance**

Reference: Purchase Order **#66-7466**

Gentlemen:

This is to certify that Part Number **S48929** has been manufactured, inspected and tested in accordance with purchase order requirements. Applicable specifications and drawings called for by the purchase order are:

Drawing: S48929 and
Specification: BUSS-001, Issue A.

Production control records and test reports covering subject material indicate conformance with applicable requirements and are on file, available for examination; copies of test reports and production control records are herein enclosed.

Material: General Plastics Mfg. Co.'s **LAST-A-FOAM® FR-3710.75**
Production Batches #1392 & #1393

Quantity: 2 each P/N S48929, S/Ns S48929-001 & S48929-002

Respectfully submitted,

GENERAL PLASTICS MANUFACTURING COMPANY

David B. Edmondson, Supervisor
Quality Assurance Materials Testing

DBE/de

Enclosures:
- 2 each Recap Sheet, Compressive Strength Data.
- 24 each Compressive Strength Graphs per BUSS-001, Issue A(Copies).
- 6 each Flammability Test Report, 14 CFR 25.853(a) (Copies).
- 2 each Production Control Records, P/N S48929 as serialized above (Copies).
- 1 each Certification Package, Subtier Suppliers (Copies).

E202(2)

GENERAL PLASTICS MA 'ACTURING COMPANY

BUSS Cask Impact Limiter

LIMITER S/N: S48929-001

SNLA P.O.#66-7466

Tested in accordance with:

BUSS-001, Issue A

POUR NUMBER	SAMPLE NUMBER	Density, p.c.f.	PARALLEL TO RISE PSI @ STRAIN% 10%	20%	30%	40%	50%	60%	65%	70%	75%
1	1	10.67	387	386	411	453	546	738	927	1,253	1,881
	2	11.00	396	399	422	470	568	766	960	1,293	1,917
	3	10.90	369	374	402	444	534	723	908	1,235	1,848
2	1	10.94	363	365	393	438	530	723	912	1,236	1,853
	2	10.95	336	369	396	440	516	729	922	1,260	1,899
	3	10.98	360	363	393	437	531	728	910	1,263	1,941
3	1	10.72	375	377	405	449	531	707	879	1,182	1,764
	2	10.97	385	384	411	458	549	740	910	1,221	1,799
	3	11.02	390	389	419	464	558	747	933	1,248	1,833
AVERAGES	(9 each)	10.91 pcf	373	378	406	450	540	733	918	1,243	1,859
Low Minimum		10.50 pcf	350			425				Report	
High Maximum		11.50 pcf	402			488					

POUR NUMBER	SAMPLE NUMBER	Density, p.c.f.	PERPENDICULAR TO RISE PSI @ STRAIN% 10%	20%	30%	40%	50%	60%	65%	70%	75%
1	4	10.77	326	341	366	414	510	729	953	1,331	2,034
2	4	10.52	305	320	341	384	474	678	900	1,281	2,010
3	4	10.83	338	351	378	420	515	717	930	1,293	1,980
AVERAGES	(3 each)	10.71 pcf	323	337	362	406	500	708	928	1,302	2,008
Low Minimum		10.50 pcf	300			Report				Report	
High Maximum		11.50 pcf									

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GENERAL STICS MANUFACTURING COMPANY APPROVED BY Production: GS Conrtacts: FPH QA: DBE Date: 8/1/92

E202(3)

Part Number: S48929 | Nomenclature: BUSS Impact Limiters, Operational Units | Qty Of Parts: 1 each

Purchase Order No: 66-7466 | Customer: Sandia National Labs | SJO: 2630

Specification: BUSS-001, | Issue: A | Drawing: S48929 | Issue: A

Serial Number: S48929-001 Start Date: AUG 12 1992 Due Date: Two weeks after Receipt

Op#	MANUFACTURING INSTRUCTIONS	SHOP / DATE	INSP / DATE
000	PREPARATION OF OPERATIONAL UNITS FOR FOAMING		QA 8 AUG 12 1992
010	Receive BUSS Impact Limiters. Inspect material and dimensions for correct fabrication.		QA 8 AUG 12 1992
020	Verify that interior surfaces are clean and dry. Inspect for damage.	GUY SHANKS 8-12-92	
030	Limiter Tare (empty) weight: 1,846 lbs. Stamp tare weight on placard.		QA 8 AUG 12 1992
040	Approve for foaming. PRODUCTION NOTES: Cask Interior cleaning & Exterior Coating per P.O.# Z846CR48d QA 8 Foam Batch # 1392 Approved for use 8/14/92 QA 10		
050	OK TO PROCEED WITH FOAMING INCREMENT #1		QA 8 AUG 12 1992
060	Verify limiter's wall temperature is between 55 and 85°F and record .(71 °F) Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note: Consistency of Unit and Box Sample rise height is very important.	GUY SHANKS 8-14-92 GUY SHANKS 8-15-92	QA 10 AUG 14 1992 QA 8 ~~SEP~~ AUG 15 1992
070	Record increment #1 pour date, crest height, and pour weight on page 3.		
090	From box sample: Cut four each specimens parallel and two each perpendicular to rise, 1.0 ±.01 X 2.0±.03 X 2.0±03 in for compressive strength testing. Cut two each 2.0 inch cube specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density, Compressive Strength and Intumescence per BUSS-001, Rev. A. (Rejection Tag ? N/A)		QA 10 AUG 15 1992

E202(4)

Op#	MA FACTURING INSTRUCTIONS S/N: S48 9-001	SHOP/DATE	INSP/DATE
100	OK TO PROCEED WITH FOAMING INCREMENT #2		8 ~~SEP~~ AUG 15 1992
110	Verify limiter's wall temperature is between 55 and 85°F and record .(69 °F) Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note: Consistency of Unit and Box Sample rise height is very important.	GUY SHANKS 8-15-92 GUY SHANKS 8-16-92	10 AUG 15 1992 8 AUG 16 1992
120	Record increment #2 crest height and pour weight on page 3.		
	From box sample: Cut four each specimens parallel and two each perpendicular to rise , 1.0±.01 X 2.0±.03 X 2.0±03 in for compressive strength testing. Cut two each 2.0 inch cube specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density ,Compressive Strength and Intumescence per BUSS-001, Rev. A. (Rejection Tag ? N/A)		10 AUG 16 1992
	OK TO PROCEED WITH FOAMING INCREMENT #3		8 AUG 16 1992
	Verify limiter's wall temperature is between 55 and 85°F and record .(73 °F) Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note: Consistency of Unit and Box Sample rise height is very important.	GUY SHANKS 8-17-92 GUY SHANKS 8-18-92	10 AUG 17 1992 8 AUG 18 1992
	Record increment #3 crest height and pour weight on page 3.		
170	From box sample: Cut four each specimens parallel and two each perpendicular to rise , 1.0±.01 X 2.0±.03 X 2.0±03 in for compressive strength testing. Cut two each 2.0 inch cube specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density ,Compressive Strength and Intumescence per BUSS-001, Rev. A. (Rejection Tag ? N/A)		10 AUG 18 1992
180	FINAL PREPARATION ON UNIT		
190	Trim foam flush to the surface of unit and clean all excess foam from unit.	GUY SHANKS 8-21-92	8 AUG 24 1992
200	Replace 4 each covers on foaming holes using supplied covers and screws.	GUY SHANKS 8-24-92	8 AUG 24 1992

2100 FINAL INSPECTION:

1.) Verify the unit configuration is essentially unchanged from "As Received".
2.) Inspect unit for cleanliness or any damage.
3.) Attach Inspection test records and graphs to copies of this PCR.
4.) Prepare applicable certifications.

QA 8 AUG 24 1992

220 TESTING RECORD

SN: -001	Date	Increment Weight Lbs.	Pour Rise Height	Flame Test No.	Insp.	Date
Increment No. 1	8-14-92	461 - 4	17"	920818-05	QA 10	AUG 18 1992
Increment No. 2	8-15-92	420 - 4	+12" = 29"	920818-06	QA 10	AUG 18 1992
Increment No. 3	8-17-92	290 - 3	Full	920820-01	QA 10	AUG 20 1992
Total Weight =		1160#				

NOTES:

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QA 8 AUG 24 1992

220 Final Whole Part Foam Weight: 3006

230 Final Whole Part Foam Density: 10.64

QA 8 AUG 24 1992

E202(5)

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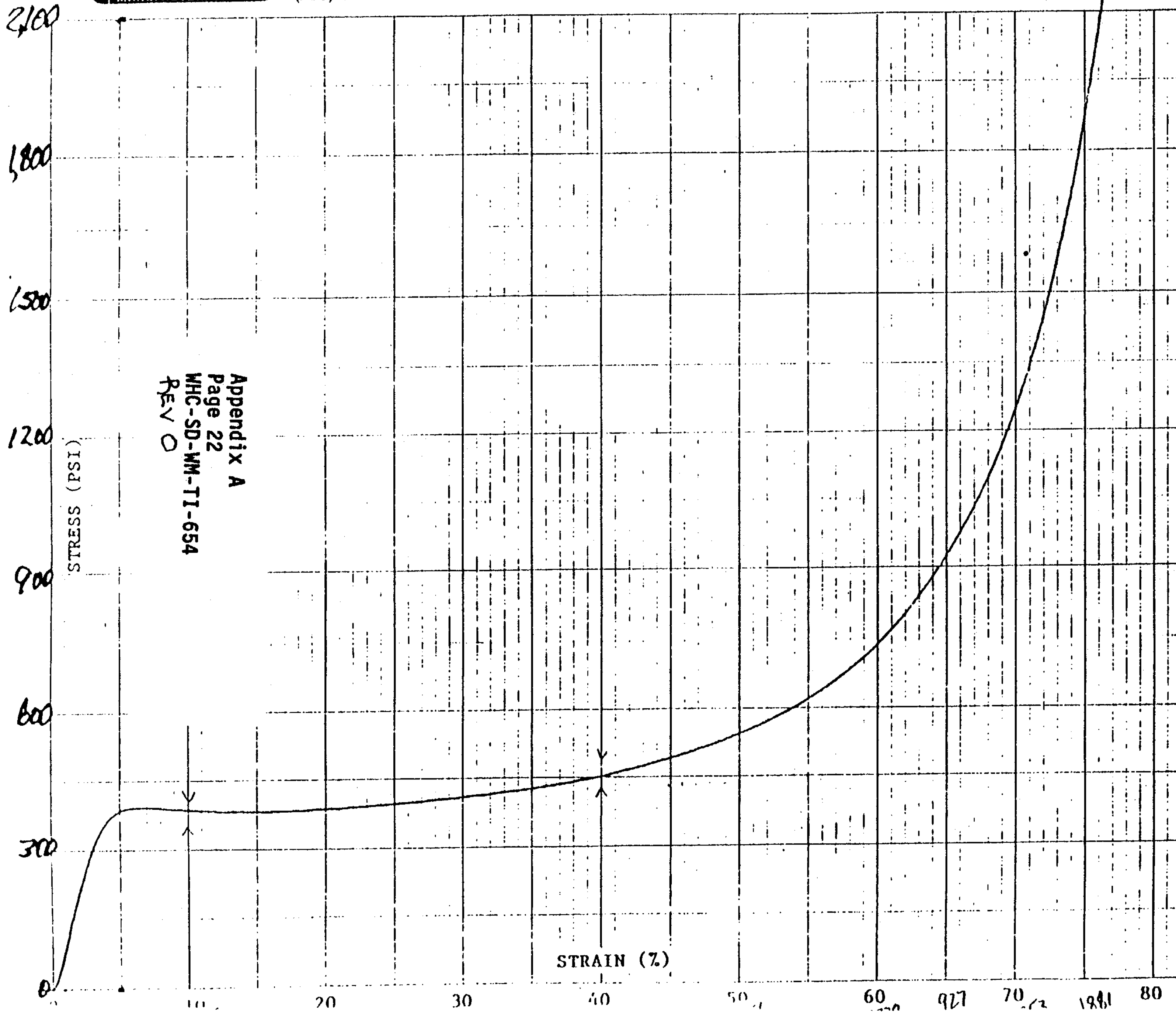

MATERIAL: LAST-A-FOAM FR-3710.75

PROPERTY TESTED: Compressive Strength At 75°F

TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:

Crosshead Speed	0.10 in/min
X-Axis	1.00 inches
Y-Axis	8400 lbs.
Load Cell	10K# @ 84%
Shunt Calibration	
Input Module	165.4
Recorder	84.0
Load	
Parallel to Rise	✓
Perpendicular	

SPECIMEN CONFIGURATION:
1.00" (T) x 2.00" x 2.00
Pour # 1 8/14/92
S/N: SA8929-001
Batch # 1392
Sample # 1

DENSITY: 10.67 lbs./cu.ft

MISC:
P.O. # 66-7466
SJO: 2630

F202 (c)

BY: DATE: AUG 1 7 1992

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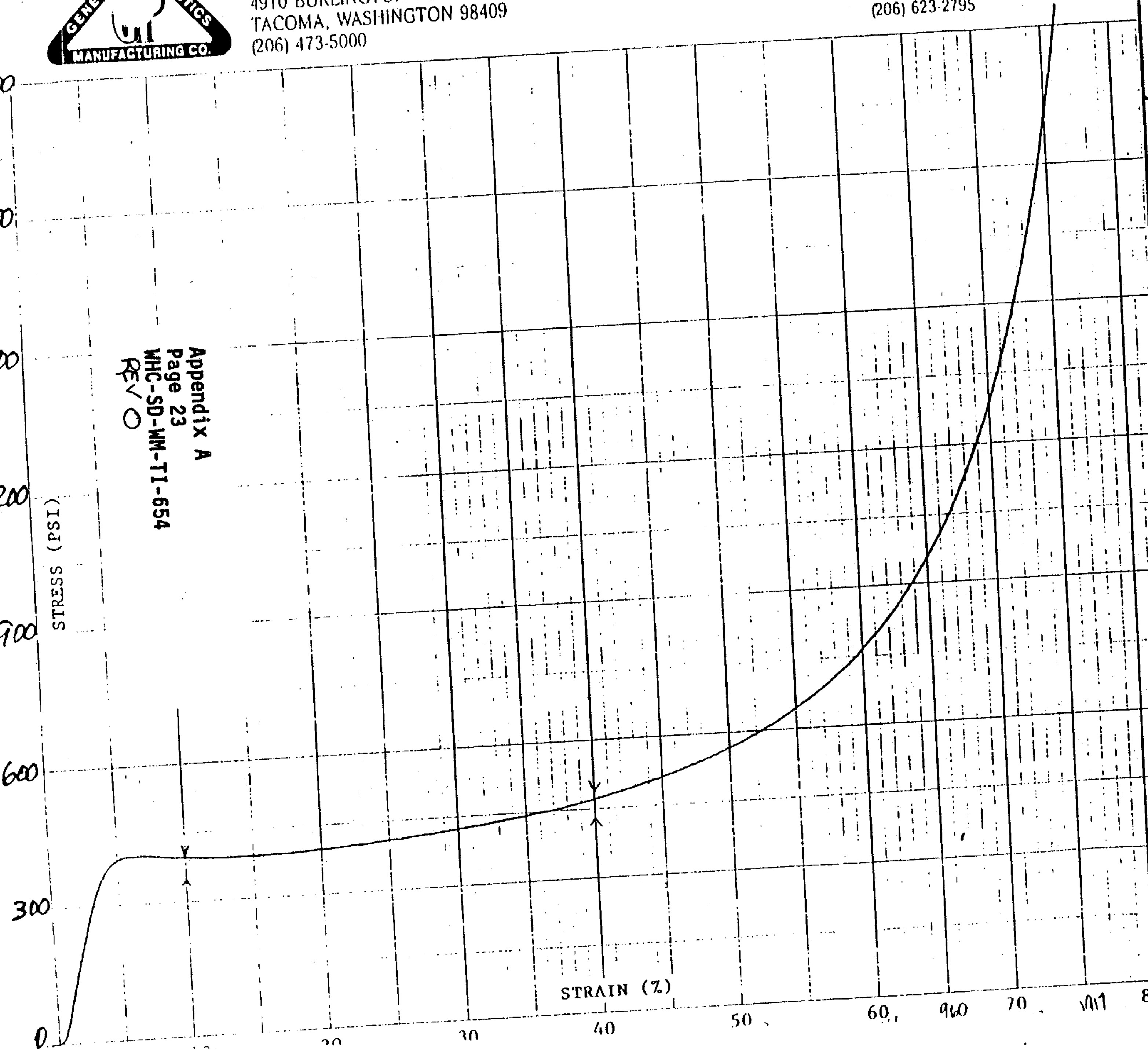

MATERIAL: LAST-A-FOAM P-3710.75

PROPERTY TESTED: Compressive Strength At 75°F

TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:

Crosshead Speed 0.10 in/min
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 842
Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (D) x 2.00" x 2.00"

Pour #1 8/14/92
S/N: S48929-001

Batch # 1392
Sample #2

DENSITY: 11.00 lbs./cu.ft

MISC:
P.O.# 66-7466
SJO: 2630

E202 (7)

BY: [QA stamp 8]
DATE: AUG 17 1992

GENERAL PLASTICS MANUFACTURING CO.

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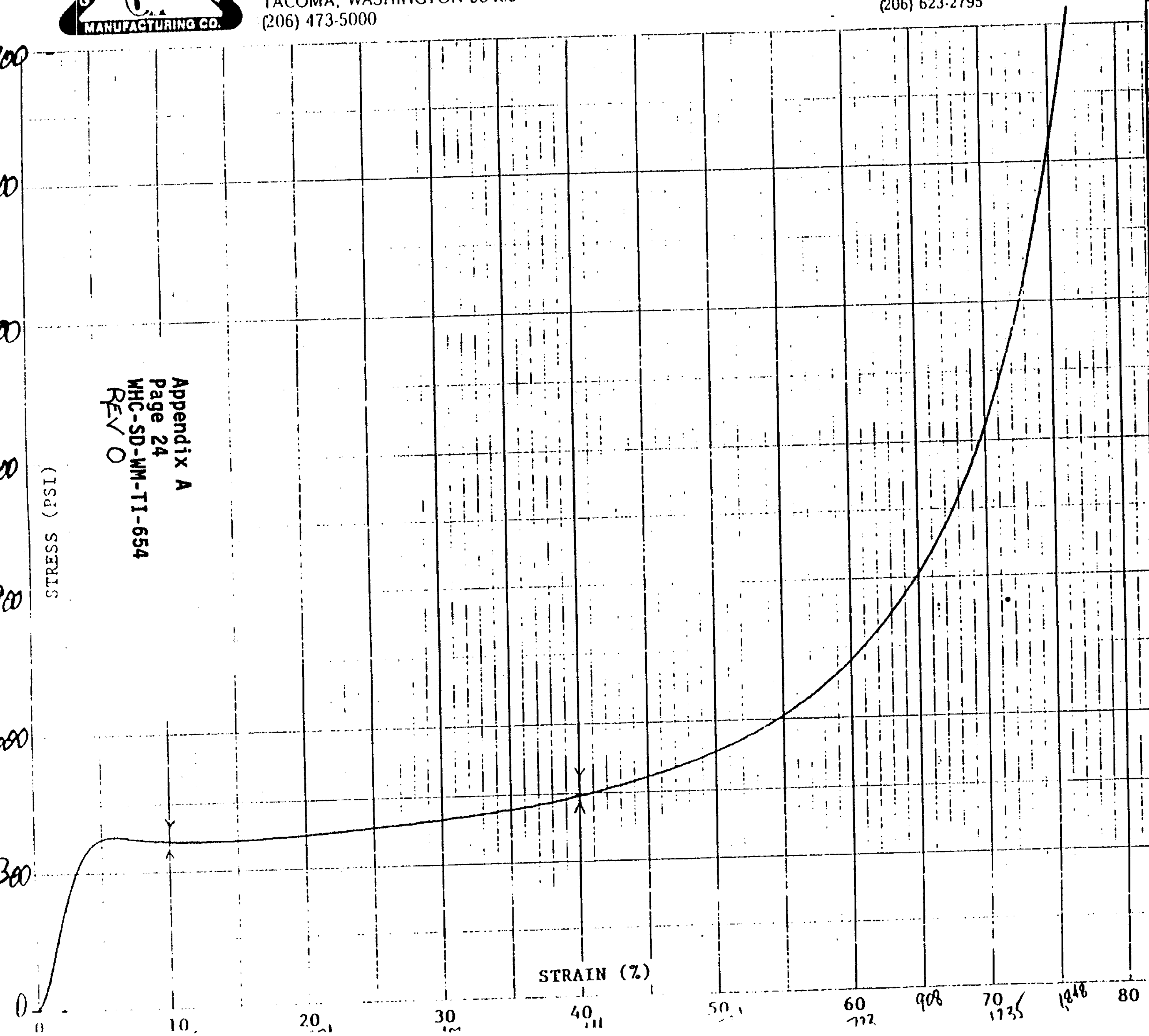

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MATERIAL:	FP-3710.75
LAST-A-FOAM	
PROPERTY TESTED:	**Compressive Strength At 75°F**
TEST METHOD:	BUSS-001, Issue A

TEST PARAMETERS:

Crosshead Speed	0.10	in/min
X-Axis	1.00	inches
Y-Axis	8400	lbs.
Load Cell	10K # @ 842	
Shunt Calibration		
Input Module	164.55	
Recorder	84.00	
Load		
Parallel to Rise	✓	
Perpendicular		

SPECIMEN CONFIGURATION

1.00" (T) x 2.00" x 2.00"

Pour # 1 8/14/92
S/N: S48929-001

Batch # 1392
Sample # 3

DENSITY: 10.90 lbs./cu.ft.

MISC:
P.O. # 667466
SJO: 2630

8E202(6)

BY: Q 8 P 94 DATE: AUG 1 7 1992

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SNLA BUSS

MATERIAL: LAST-A-FOAM® FR-3710.2
PROPERTY TESTED: Compressive Strength At 75°F
TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min.
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K # @ 84.00
Shunt Calibration
Input Module 164.45
Recorder 84.00
Load
Parallel to Rise
Perpendicular

SPECIMEN CONFIGURATION
1.00" (⊥) x 2.00" x 2.00"

Pour #1 8/14/92
S/N: S48929-001

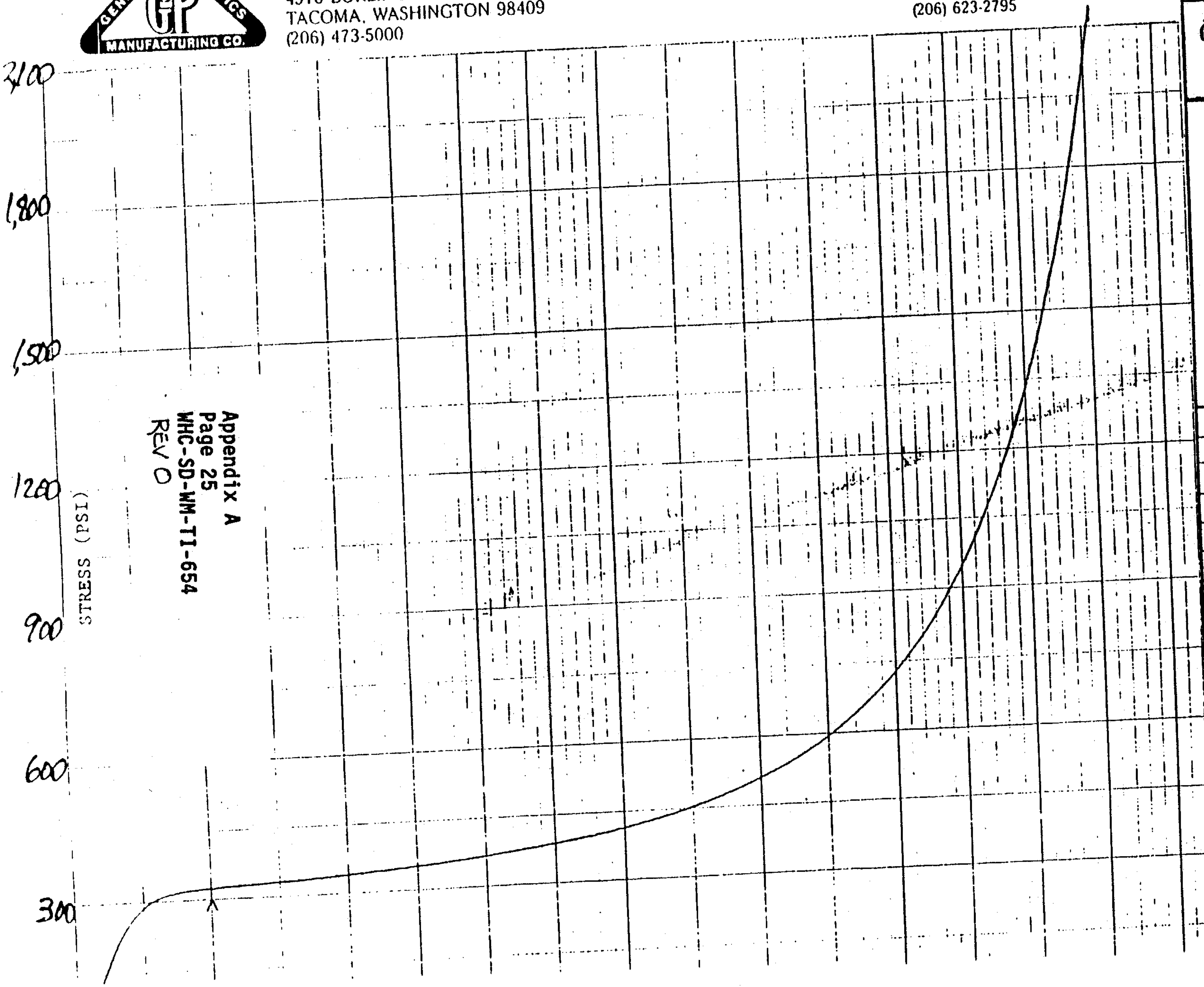
Batch # 1392
Sample # 4

DENSITY: 10.77 lbs./cu.ft

MISC:
PO. — 66-7466
SJD: 2630

BY: DATE: AUG 1 7 199

8E202(9)



8E202(10)

FLAMMABILITY TEST REPORT

GENERAL PLASTICS MANUFACTURING. COMPANY

Material Description * FRL 3710.75FB	.5 inch Thickness	Rigid Foam ✓ Flexible Foam	Bun No. 081492
Test Report Number 920818-05	Bun __ Bell Cup __ Box ✓ PCup	Batch "A"	Batch "B" 1392
Usage Sandia BUSS Cask, S/N 48929-001, Pour #1			
Manufacturer/Supplier GPMC	Model	Test Location: General Plastics Manufacturing Company, Tacoma, Washington 98409	
Tested By (GP QA 10)	Witness By **	Test Date 8-18-92	Flame Temperature 1550 °F

TEST METHOD / TEST REQUIREMENTS (MAXIMUM AVERAGE)

Pass/Fail	√		BSS 7230	F.A.R. Specification	Ignition time - Material position	Exting Time	Burn Length	Drip Exting	Burn Rate	Flame Penetrn	After Glow
		A	F1.	BSS 7230	60 Second - Vertical	15 Sec	6 In	3 Sec			
		B	F2.	BSS 7230	12 Second - Vertical	15 Sec	8 In	5 Sec			
Pass	✓	C	F1.	FAR 25.853 (a)	60 Second - Vertical	15 Sec	6 In	3 Sec			
		D	F2.	FAR 25.853 (b)	12 Second - Vertical	15 Sec	8 In	5 Sec			
		E	F1.	BMS 8-133	60 Second-Vertical	6 Sec	6 In	2 Sec			
		F	F3.	FAR 25.853 (b-2)	15 Second - Horizontal				2.5 In/Min		
		G	F4.	FAR 25.853 (b-3)	15 Second - Horizontal			4 In/Min			
		H	F5.	FAR 25.853 (a-1)	30 Second - 45°	15 Sec		None	10 Sec		
		I	F6.	FAR 1359 (d)	30 Second - 60° Electrical	30 Sec		3 Sec			
		J	F7.	FAR 25.853 (b)	12 Second - Vertical	No Limit	8 In.				
		K	F8.	MIL-P-26514F	60 Second - Horizontal	No Limit	<5 In.				

SJO 2630, PO# 66-7466

TEST VALUES

Sample No	Test Method	Exting. Time (Sec.s)	Burned Length (Inches)	Drips Exting. Time(Sec.s)	Burn Time (Sec.s)	Burn Rate (In/Min)	After Glow (Sec.s)
1	F1	Ø	4.4	D/N			
2	F1	Ø	4.2				
3	F1	Ø	4.6				
Average	--->	Ø	4.4				
4	F2	N/R					
5	F2						
6	F2						
Average	--->						

Sketch, comments (Penetration, etc.

Sample Conditioned Yes ✓ No

D/N= Does Not Apply

SELF EXTINGUISHING
BY THIS TEST

Density= 10.44 lbs/cu. ft. H2O= ____ %

Methane Gas ✓ Propane __ Type B __

* Include Material type, construction, specifications, thickness, color, etc.
** Required for qualification only by FAA DER of FAA Staff.

GP-7700336W

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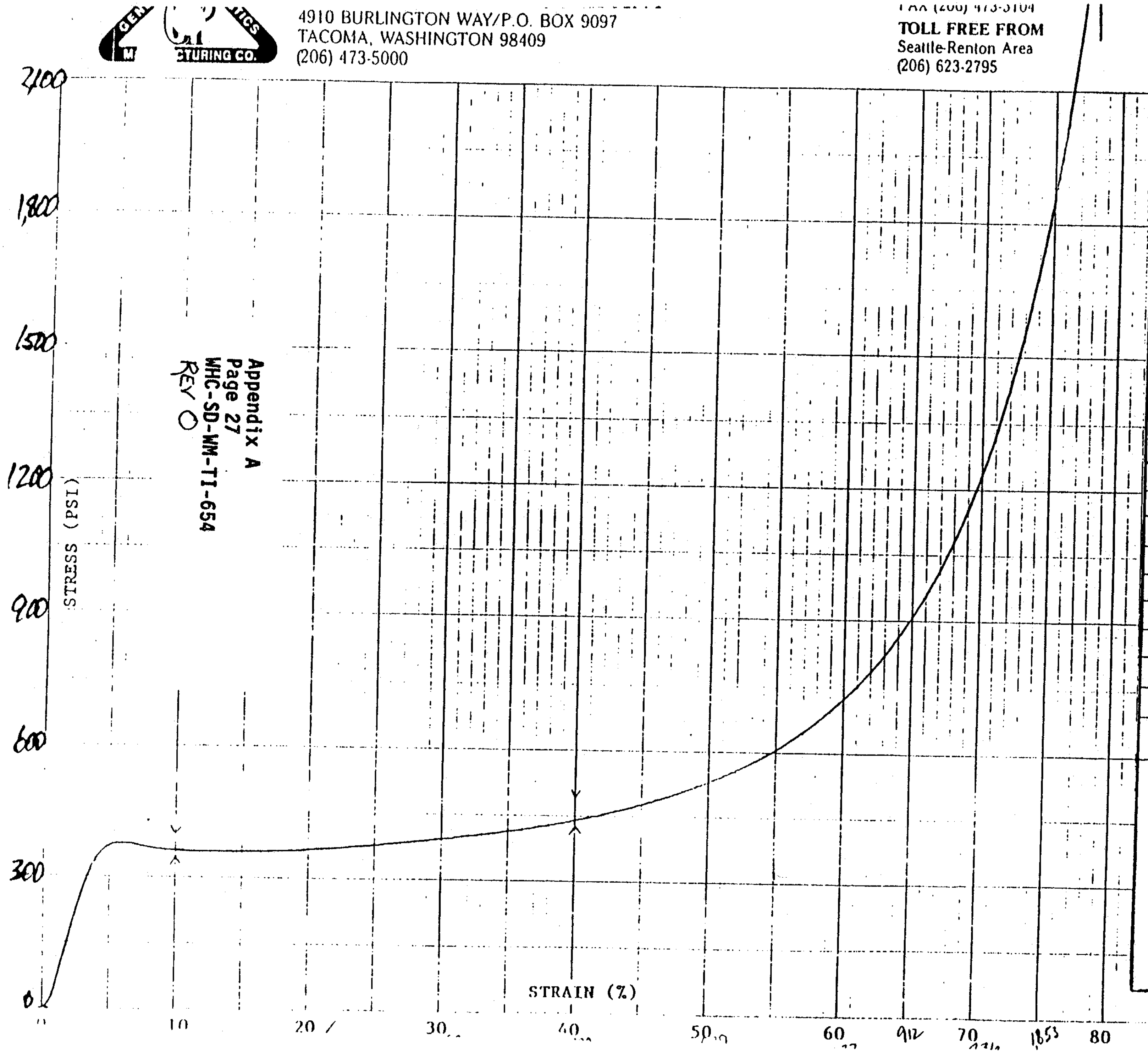

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MATERIAL: FR-3710.?
LAST-A-F(

PROPERTY TESTED:
Compressive Strength At 75°F

TEST METHOD:
BUSS-001, Issue A

TEST PARAMETERS:

Crosshead Speed	0.10 in/min
X-Axis	1.00 inches
Y-Axis	84.00 lbs.
Load Cell	10K# @ 84%
Shunt Calibration	
Input Module	164.55
Recorder	84.00
Load	
Parallel to Rise	✓
Perpendicular	

SPECIMEN CONFIGURATION
1.00" (II) x 2.00" x 2.00"

Pour #2 8/15/92
S/N: S48929-001

Batch #1392
Sample #1

DENSITY: 10.94 lbs./cu.ft

MISC:
P.O.# 66-7446
SJO: 2630

8E202(11)

BY: 9/8 P QA DATE: AUG 1 7 1992

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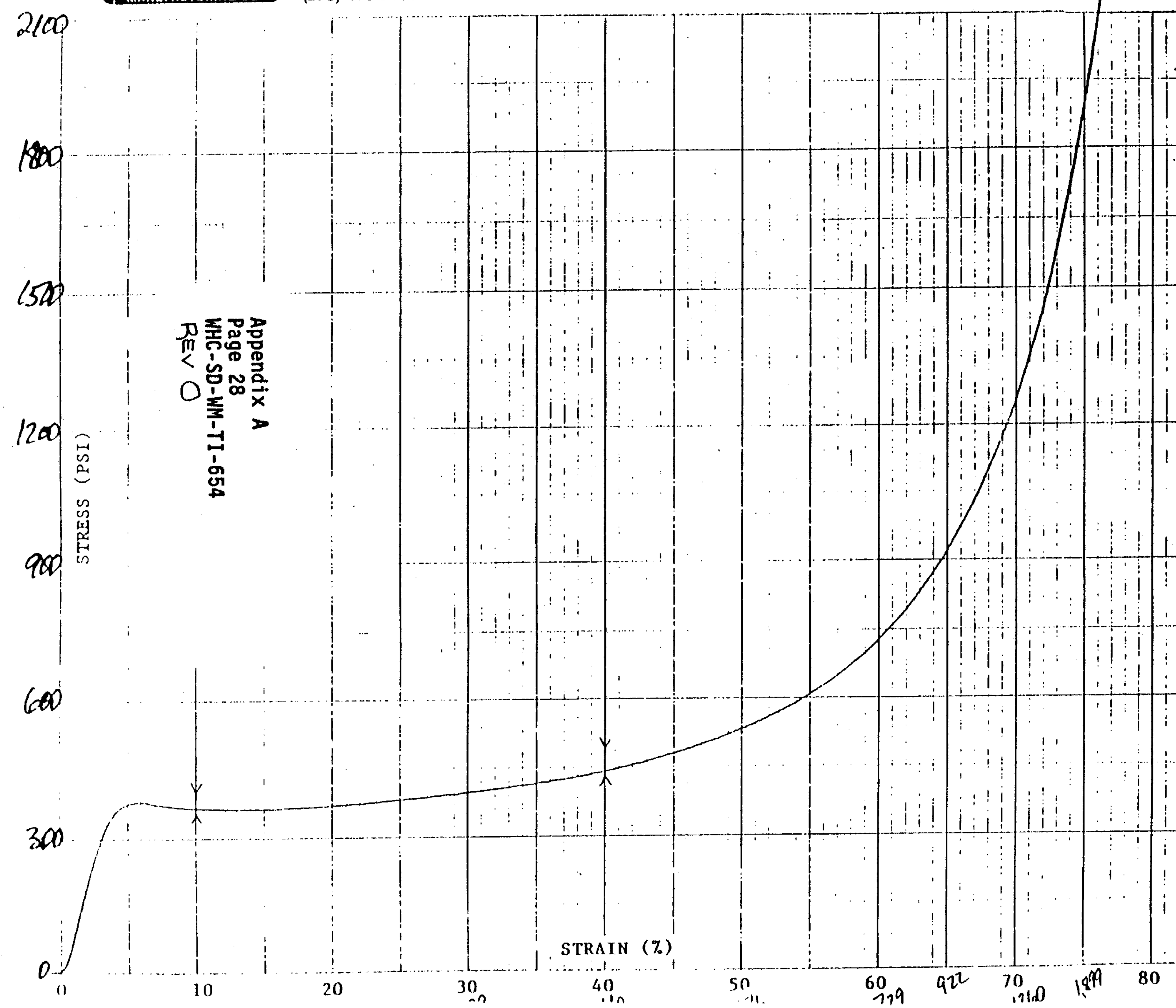

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MATERIAL: 9-3710.75
LAST-A-FOA

PROPERTY TESTED:
Compressive Strength At 75°F

TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 949
Shunt Calibration
Input Module 164.53
Recorder Load 84.00
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (T) x 2.00" x 2.00
Pour # 2 8/15/92
S/N: 48929-001
Batch # 1392
Sample # 2

DENSITY: 10.95 lbs./cu.ft

MISC:
P.O. # 66-7466
SJD: 2630

BY: 8 DATE: AUG 17 1992

8E202(12)(a)

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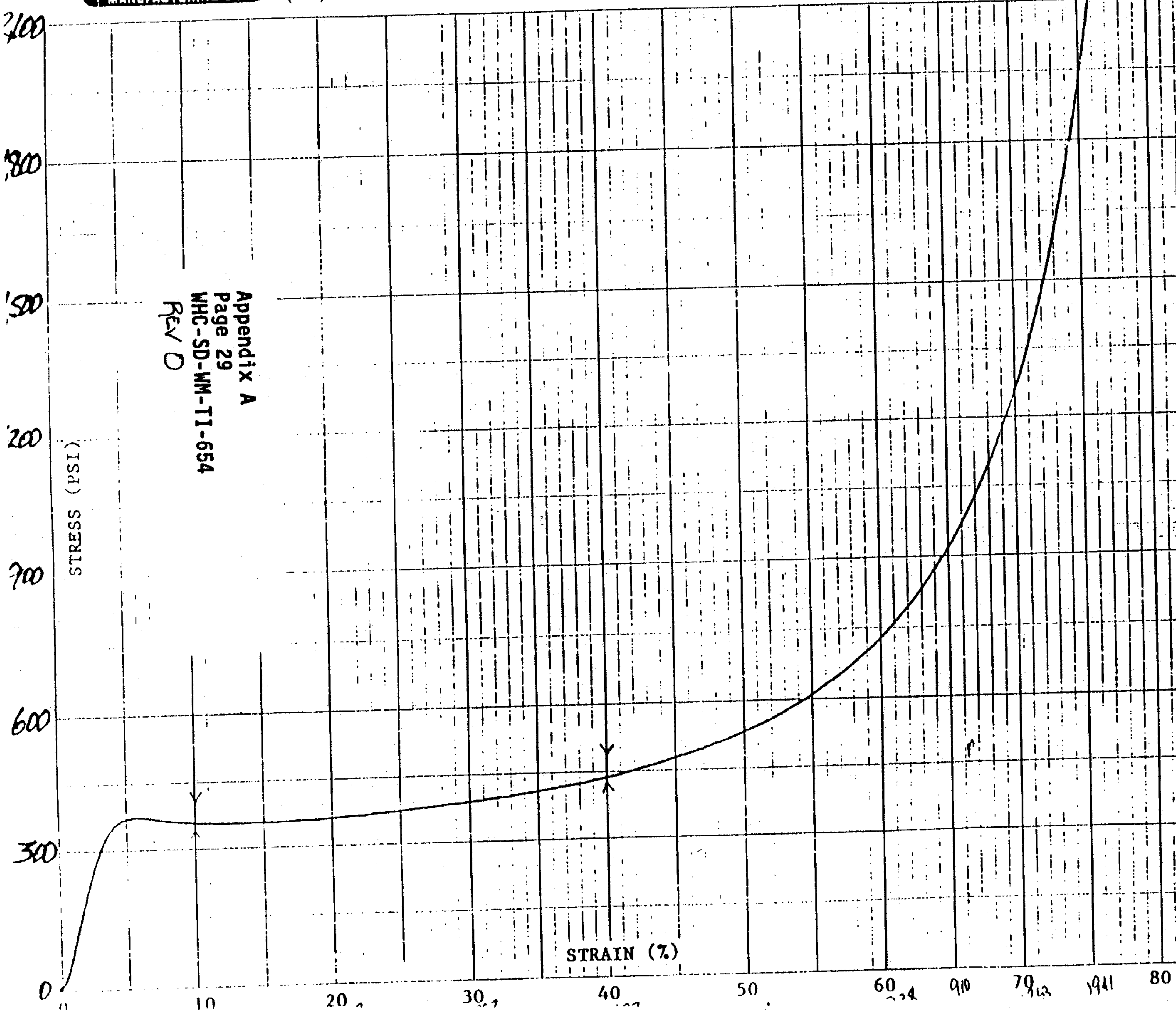

MATERIAL: LAST-A-FOAM 3710.75

PROPERTY TESTED: Compressive Strength At 75°F

TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 94%
Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (T) x 2.00" x 2.00"

Pour #2 8/15/92
S/W: 49929-001
Batch #1392
Sample #3

DENSITY: 10.98 lbs./cu.ft.

MISC:
P.O.# 66-7466
SJO: 2630

8E202(1/2)

BY: DATE: AUG 17 1992

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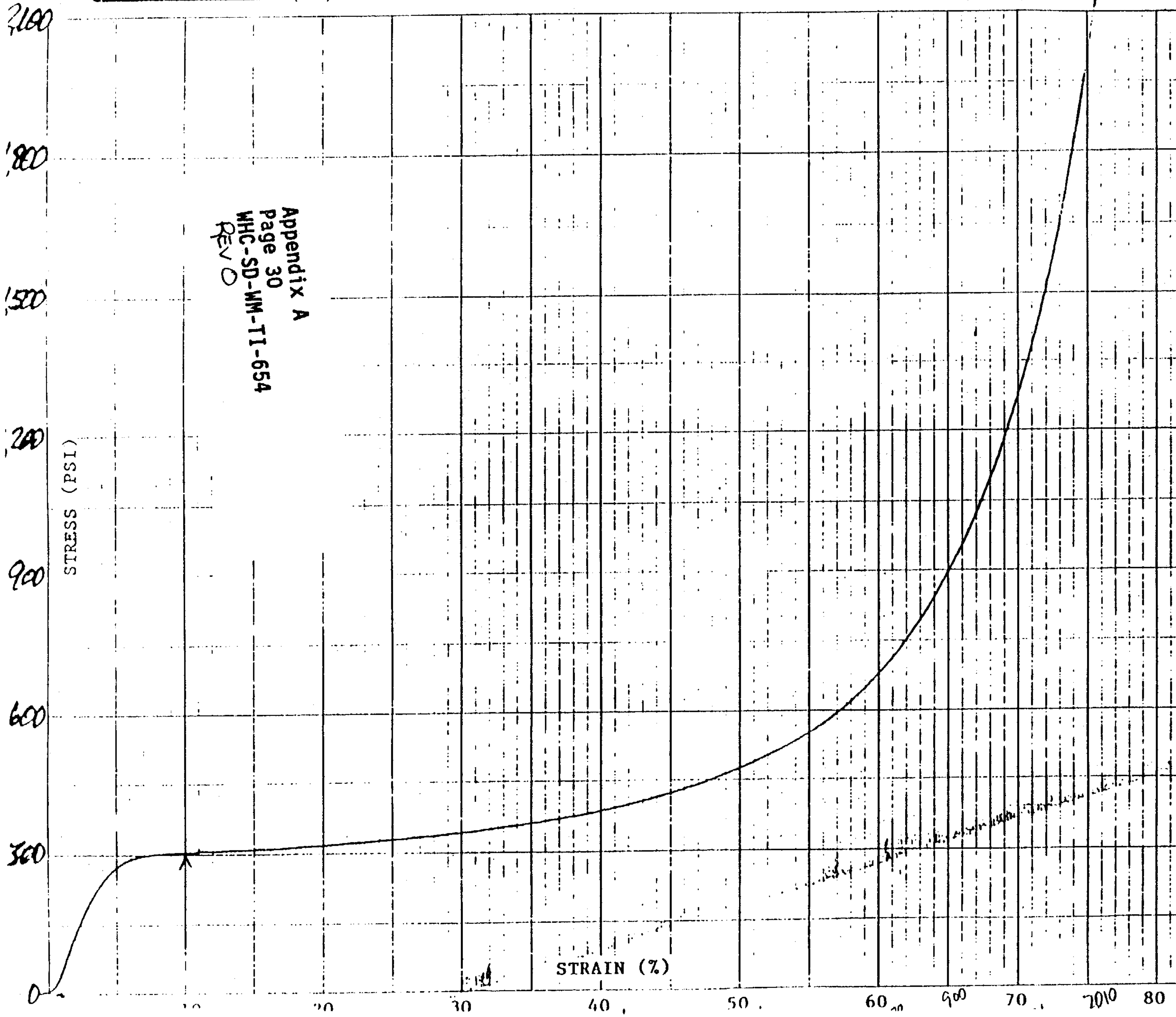
DNLH 10H.3

MATERIAL: LAST-A-FOAM	E-3710 75
PROPERTY TESTED:	Compressive Strength At 75°F
TEST METHOD:	BUSS-001, Issue A
TEST PARAMETERS:	
Crosshead Speed	0.10 in/min
X-Axis	1.00 inches
Y-Axis	8400 lbs.
Load Cell	10K# @ 84%
Shunt Calibration	
Input Module	164.55
Recorder Load	84.00
Parallel to Rise	
Perpendicular	✓
SPECIMEN CONFIGURATION	1.00" (⊥) x 2.00" x 2.00"
	Pour #2 8/15/92
	S/N: S48929-001
	Batch #1392
	Sample #4
DENSITY:	10.52 lbs./cu.ft
MISC:	P.O. #66-7466
	SJO: 2680
BY: 8	DATE: AUG 17 1992

8E202(1/2)



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REV 0

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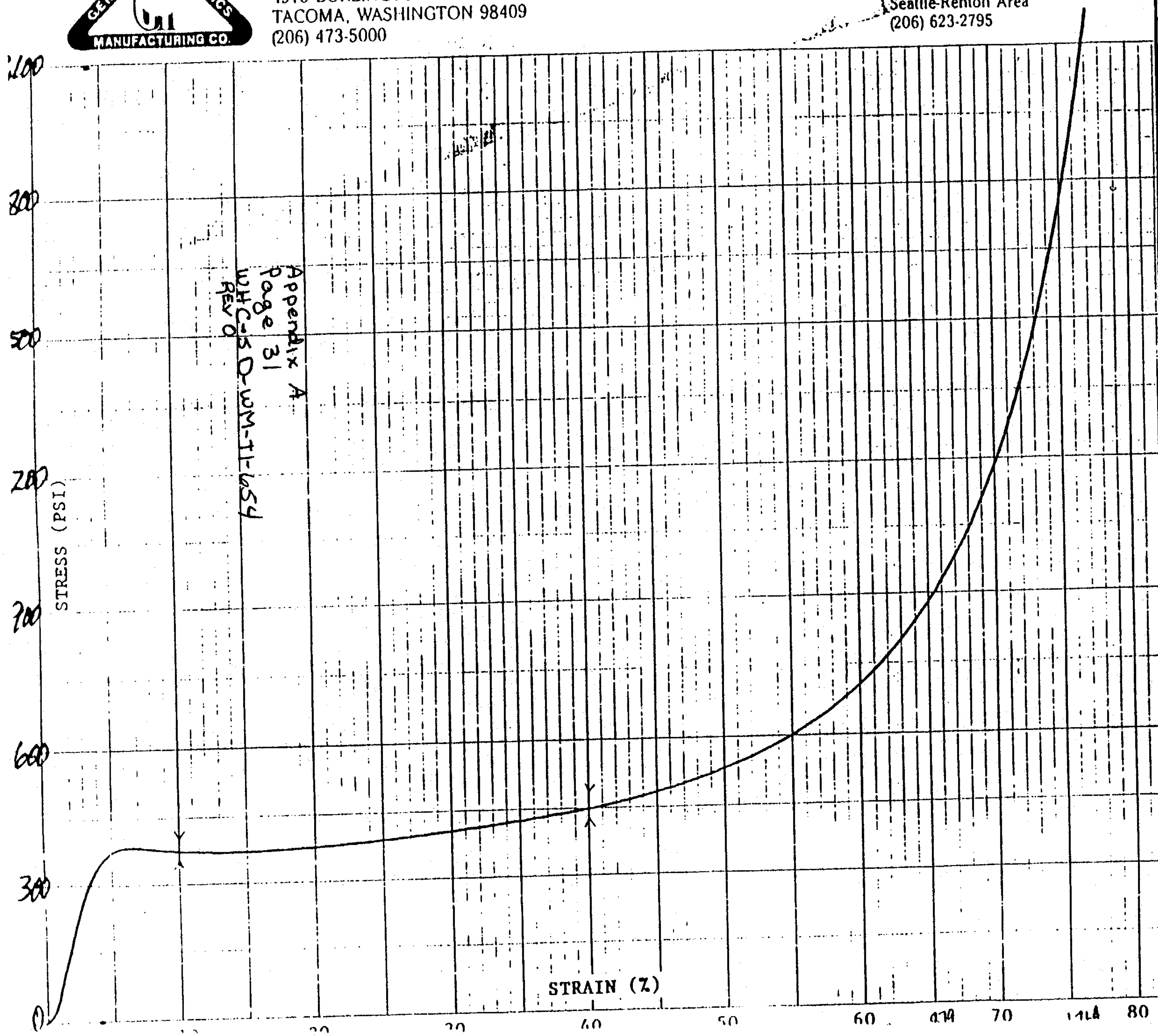


BMSS

MATERIAL:
LAST-A-FOAM®, 2-3710.75

PROPERTY TESTED:
Compressive Strength At 75°F

TEST METHOD:
BMSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min.
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 84% Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (11) x 2.00" x 2.00"

Pour # 3 8/17/92
S/N: S48929-001

Batch # 1392
Sample #1

DENSITY: 10.72 lbs./cu.ft.

MISC:
P.O.# 66-7466
SJO: 2630

BY: DATE: AUG 18 1992

8E202(14)

8E 202(13)

FLAMMABILITY TEST REPORT

GENERAL PLASTICS MANUFACTURING. COMPANY

Material Description * FRL 3710.75FB	.5 inch Thickness	Rigid Foam ✓ Flexible Foam	Bun No. 081592
Test Report Number 920818-06			
Usage Sandia BUSS Cask, S/N 48929-001, Part #2	Bun __ Bell Cup __ Box ✓ PCup __	Batch "A"	Batch "B" 1392
Manufacturer/ Supplier GPMC	Model	Test Location	General Plastics Manufacturing Company Tacoma, Washington 98409
Tested By (GP QA 10)	Witness By **	Test Date 8-18-92	Flame Temperature 1550 °F

TEST METHOD / TEST REQUIREMENTS (MAXIMUM AVERAGE)

Pass/ Fail	√		BSS 7230	F.A.R. Specification	Ignition time - Material position	Exting Time	Burn Length	Drip Exting	Burn Rate	Flame Penetrn	After Glow
		A	F1.	BSS 7230	60 Second - Vertical	15 Sec	6 In	3 Sec			
		B	F2.	BSS 7230	12 Second - Vertical	15 Sec	8 In	5 Sec			
pass	✓	C	F1.*	FAR 25.853 (a)	60 Second - Vertical	15 Sec	6 In	3 Sec			
		D	F2.*	FAR 25.853 (b)	12 Second - Vertical	15 Sec	8 In	5 Sec			
		E	F1.	BMS 8-133	60 Second-Vertical	6 Sec	6 In	2 Sec			
		F	F3.	FAR 25.853 (b-2)	15 Second - Horizontal				2.5 In/Min		
		G	F4.	FAR 25.853 (b-3)	15 Second - Horizontal			4 In/Min			
		H	F5.	FAR 25.853 (a-1)	30 Second - 45°	15 Sec		None	10 Sec		
		I	F6.	FAR 1359 (d)	30 Second - 60° Electrical	30 Sec		3 Sec			
		J	F7.	FAR 25.853 (b)	12 Second - Vertical	No Limit	8 In.				
		K	F8.	MIL-P-26514F	60 Second - Horizontal	No Limit	<5 In.				

SJO 2630, PO# 66-7466

TEST VALUES

Sample No	Test Method *	Exting. Time (Sec.s)	Burned Length (Inches)	Drips Exting. Time(Sec.s)	Burn Time (Sec.s)	Burn Rate (In/Min)	After Glow (Sec.s)
1	F1	Ø	4.6	D/N			
2	F1	Ø	4.6	✓			
3	F1	Ø	4.2				
Average	--->	Ø	4.5				
4	F2	N/R					
5	F2						
6	F2						
Average	--->						

Sketch, comments (Penetration, etc

Sample Conditioned Yes ✓ No __

D/N = Does Not Apply

SELF EXTINGUISHING BY THIS TEST

Density= 10.55 lbs/cu. ft. H2O= ____ %

Methane Gas ✓ Propane __ Type B __

* Include Material type, construction, specifications, thickness, color, etc.

** Required for qualification only by FAA DER of FAA Staff.

GP-7700336W

GENERAL PLASTICS
MANUFACTURING COMPANY
4910 BURLINGTON WAY/P.O. BOX 9097
TACOMA, WASHINGTON 98409
(206) 473-5000

TELEX 989134
FAX (206) 473-5104
TOLL FREE FROM
Seattle-Renton Area
(206) 623-2795

B1188

MATERIAL: LAST-A-FOAM® FR-3710.75
PROPERTY TESTED: **Compressive Strength At 75°F**
TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min.
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 84%
Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (ID) x 2.00" x 2.00"

Pour #3 8/17/92
S/N: 548929-001

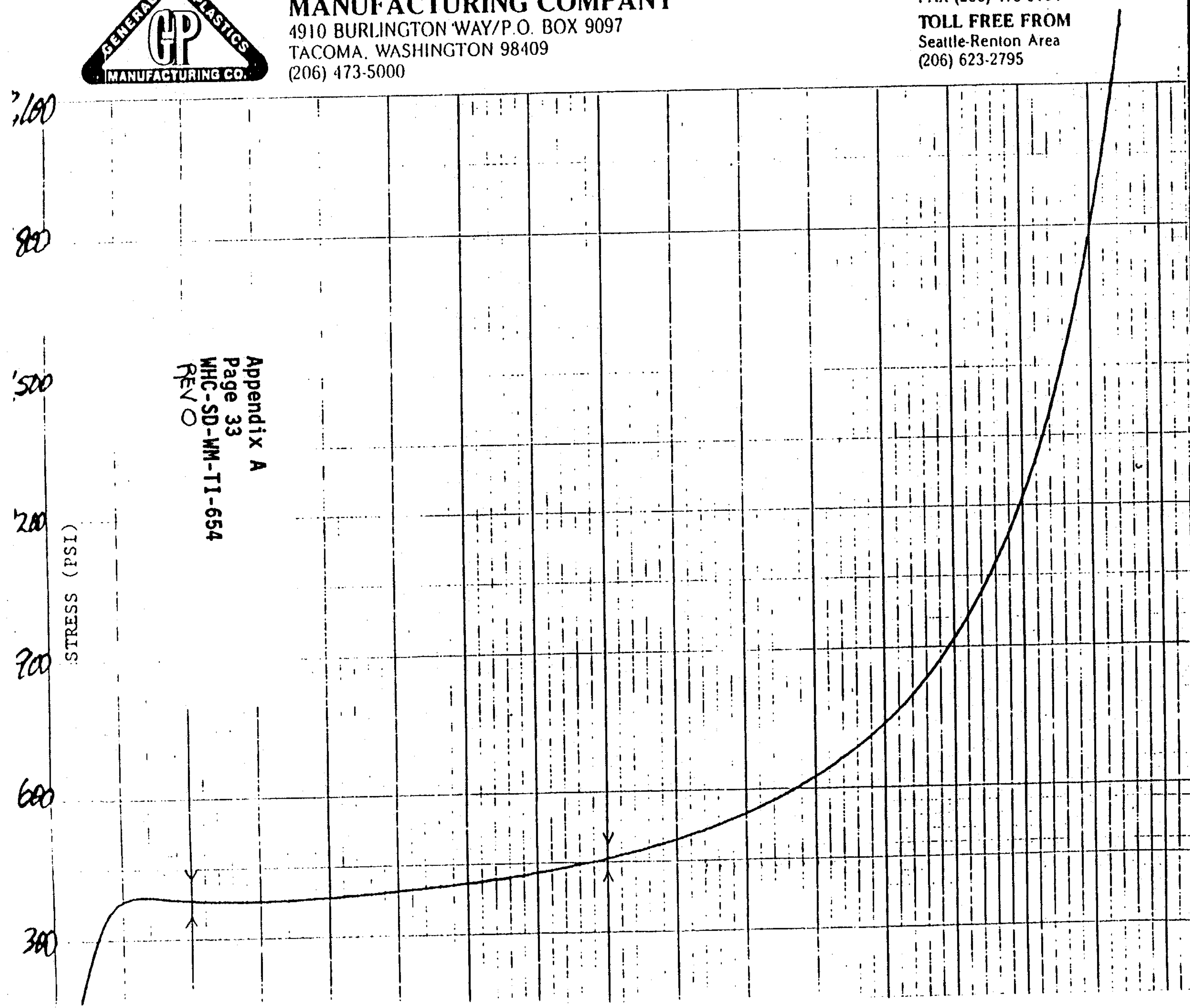
Batch # 1392
Sample #2

DENSITY: 10.97 lbs./cu.ft.

MISC:
P.O.# 66-7466
SJO: 2630

8E202 (15)

AUG 1 8 1992



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REV O

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MANUFACTURING COMPANY
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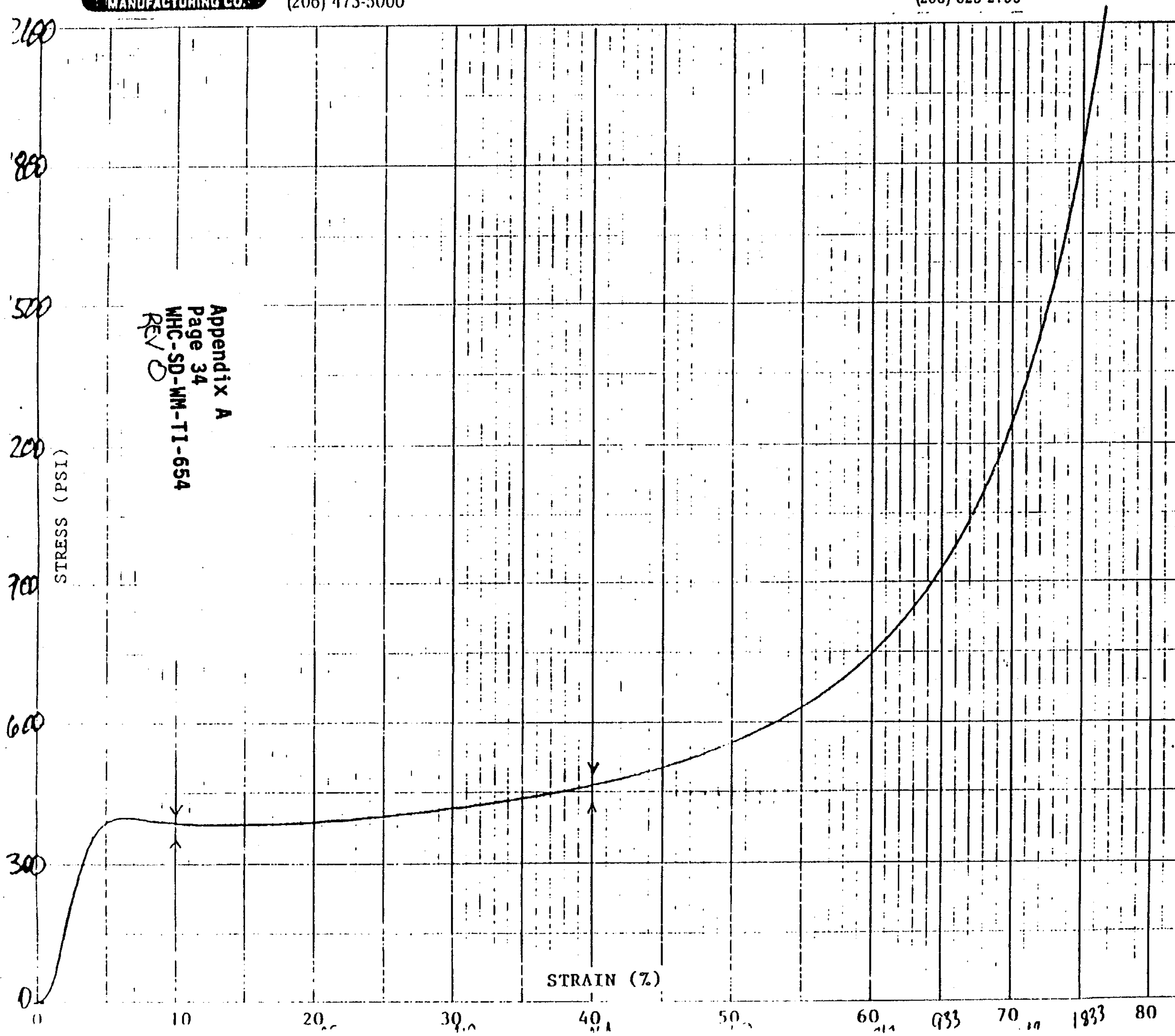

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REV 0

MATERIAL: LAST-A-FOAM®, R-3710.75

PROPERTY TESTED: Compressive Strength At 75°F

TEST METHOD: BHSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min.
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 84%
Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (T) x 2.00" x 2.00"

Pour #3 8/17/92
S/N: S48929-001

Batch #1392
Sample #3

DENSITY: 11.02 lbs./cu.ft.

MISC:
P.O. # 66-7466
SJO: 2630

BY: 9/8/P
DATE: AUG 18 1992

8E202 (1#)

GENERAL PLASTICS MANUFACTURING CO.

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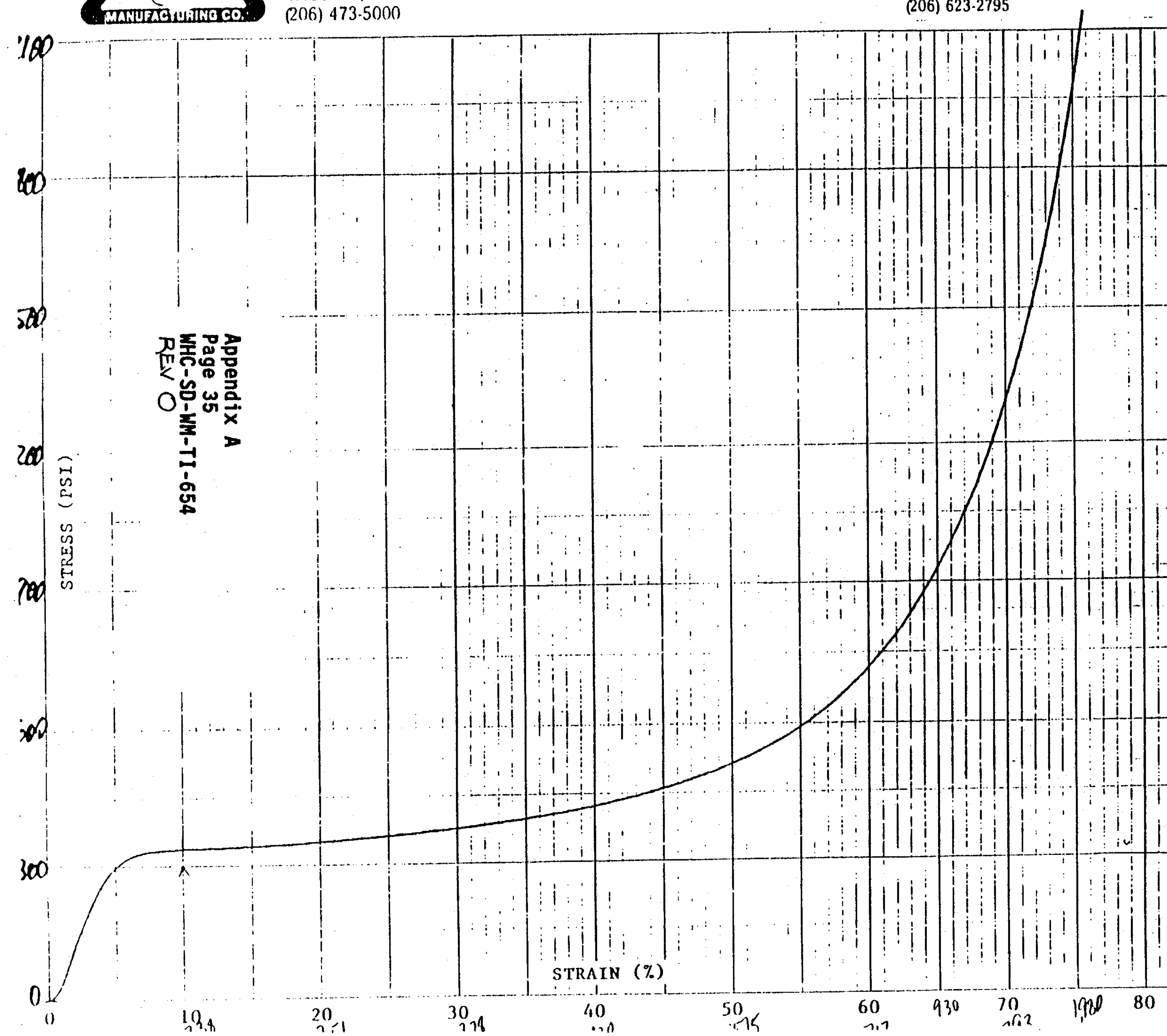

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REV 0

MATERIAL: LAST-A-FOAM '3710.75'

PROPERTY TESTED: Compressive Strength At 75°F

TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min.
X-Axis 1.00 Inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 84%
Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise
Perpendicular ✓

SPECIMEN CONFIGURATION
1.00" (⊥) x 2.00" x 2.00"

Pour # 3 8/17/92
S/N: 548129-001

Batch # 1392
Sample # 4

DENSITY: 10.83 lbs./cu.ft.

MISC:
P.O.# 66-7466
SJO: 2630

8E202(17)

BY: QA 8 DATE: AUG 1 8 1992

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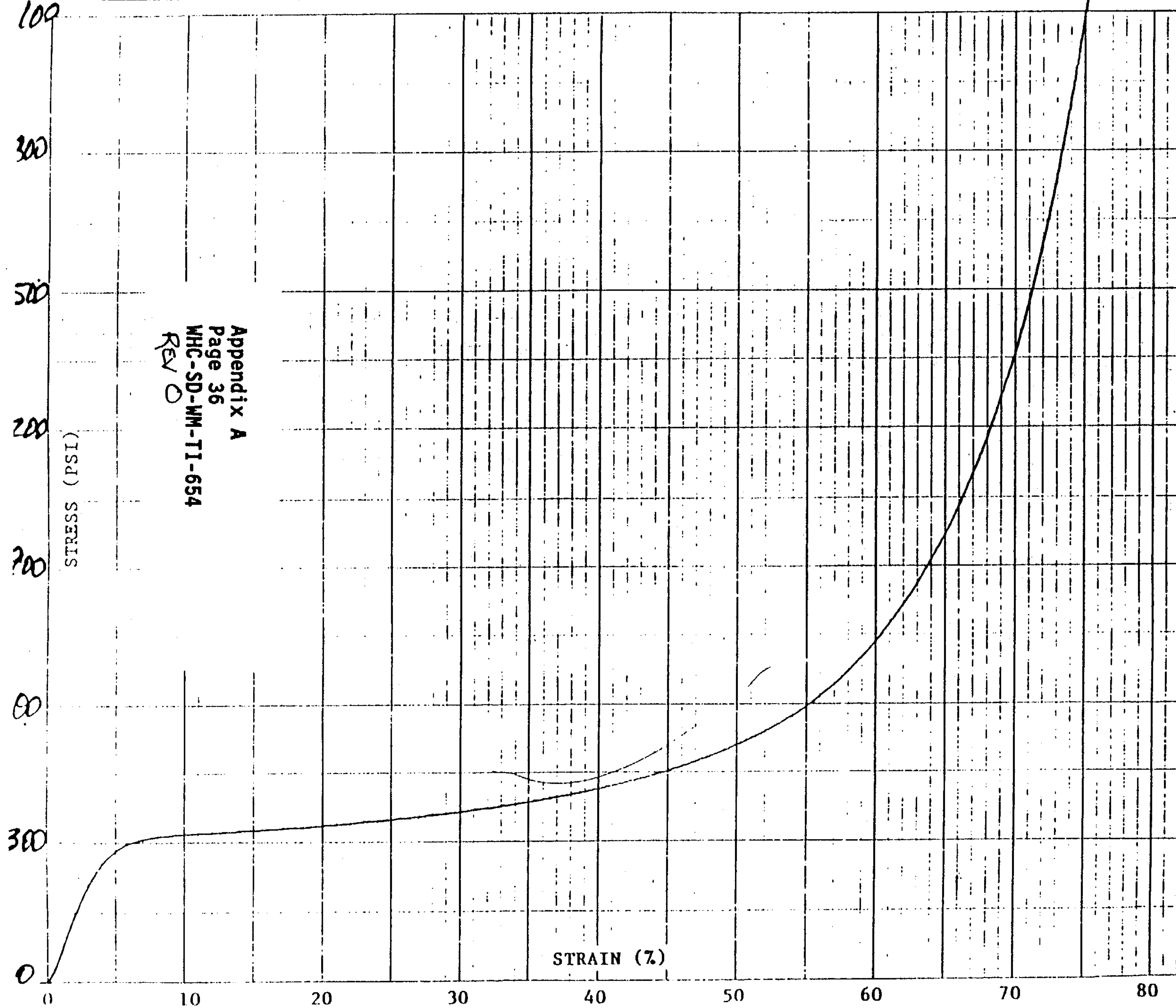

MATERIAL: FR-3710.75
LAST-A-FOAM

PROPERTY TESTED:
Compressive Strength At 75°F

TEST METHOD:
BUSS-001, Issue A

TEST PARAMETERS:
Crosshead
Speed 0.10 in/min
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 84%
Shunt Calibration:
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise
Perpendicular ✓

SPECIMEN CONFIGURATION
1.00" (1) x 2.00" x 2.00"

Pour #1 8/14/92
S/N: S48929-001

Batch #1392

DENSITY: 10.13 lbs./cu.ft.

MISC:
P.O. # 66-7466
SJD: 2690

8E202(18)

BY: DATE: AUG 17 1992

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Rev 0

FLAMMABILITY TEST REPORT **GENERAL PLASTICS MANUFACTURING. COMPANY**

Material Description * FRL 3710.75FB	.5 inch Thickness	Rigid Foam ✓ Flexible Foam	Bun No. 081792	Test Report Number 920820-01	
Usage Sandia BUSS, S48929-001, Pour #3			Bun __ Belt __ Box ✓ Cup PCup	Batch "A"	Batch "B" 1392
Manufacturer/ Supplier GPMC		Model	Test Location	General Plastics Manufacturing Company Tacoma, Washington 98409	
Tested By (QA stamp 10)	Witness By ** :		Test Date 8-20-92	Flame Temperature 1560 °F	

TEST METHOD / TEST REQUIREMENTS (MAXIMUM AVERAGE)

Pass/ Fail	✓		BSS 7230	F.A.R. Specification	Ignition time - Material position	Exting Time	Burn Length	Drip Exting	Burn Rate	Flame Penetrn	After Glow
		A	F1.	BSS 7230	60 Second - Vertical	15 Sec	6 In	3 Sec			
		B	F2.	BSS 7230	12 Second - Vertical	15 Sec	8 In	5 Sec			
Pass	✓	C	F1.	FAR 25.853 (a)	60 Second - Vertical	15 Sec	6 In	3 Sec			
		D	F2.	FAR 25.853 (b)	12 Second - Vertical	15 Sec	8 In	5 Sec			
		E	F1.	BMS 8-133	60 Second-Vertical	6 Sec	6 In	2 Sec	2.5 In/Min		
		F	F3.	FAR 25.853 (b-2)	15 Second - Horizontal			4 In/Min			
		G	F4.	FAR 25.853 (b-3)	15 Second - Horizontal						
		H	F5.	FAR 25.853 (a-1)	30 Second - 45°	15 Sec		None	10 Sec		
		I	F6.	FAR 1359 (d)	30 Second - 60° Electrical	30 Sec		3 Sec			
		J	F7.	FAR 25.853 (b)	12 Second - Vertical	No Limit	8 In.				
		K	F8	MIL-P-26514F	60 Second - Horizontal	No Limit	<5 In.				

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REV 0

SJO:2630, PO: 66-7466

TEST VALUES

Sample No	Test Method	Exting. Time (Sec.s)	Burned Length (Inches)	Drips Exting. Time(Sec.s)	Burn Time (Sec.s)	Burn Rate (In/Min)	After Glow (Sec.s)
1	F1	Ø	4.8	D/N			
2	F1	Ø	5.1	✓			
3	F1	Ø	4.5				
Average	--->	Ø	4.8				
4	F2	N/R					
5	F2						
6	F2						
Average	--->						

Sketch, comments (Penetration, et

Sample Conditioned Yes ✓ No __
D/N= Does Not Apply

Dimensional Stability

Before Thick.	After Thick.	% Change
0.4847"	0.4838	-0.19%

Density= 10.67 lbs/cu. ft. H2O=____ %
Methane Gas ✓ Propane __ Type B __

* Include Material type, construction, specifications, thickness, color, etc.
** Required for qualification only by FAA DER of FAA Staff.

Intumescence

Density	Growth	% Growth
[illegible]	2.5"	125%

GP-7700336W

8E202(19)

(08) Sandia BUSS Cask Testing

8E202(20)

SJO: 2630
PO # 66-7466
S/N: S 48929-001
FRL 3710.75 FB
— Batch 1392 —

Intumescence Testing

Pour #	Pour Date	Sample Density	Growth inch	Growth %
1	8-14-92	10.37 pcf	2.6	130
2	8-15-92	10.38 pcf	2.6	130
3	8-17-92	10.73 pcf	2.7	135

Dimensional Stability

Pour #	Pour Date	Before Thick.	After Thick.	% Change
1	8-14-92	0.5042"	0.4992"	~~= 0.01~~ 1.00
2	8-15-92	0.5080"	0.5040"	= 0.79
3	8-17-92	0.5036"	0.4980"	= 1.11

$\bar{X}$ = 0.97 %

8-18-92

8E202(21)

GENERAL PLASTICS MA' ACTURING COMPANY

BUSS Cask Impact Limiter

LIMITER S/N: S48929-002

SNLA P.O.#66-7466

Tested in accordance with:

BUSS-001, Issue A

POUR NUMBER	SAMPLE NUMBER	Density, p.c.f.	PARALLEL TO RISE PSI @ STRAIN% 10%	20%	30%	40%	50%	60%	65%	70%	75%
1	1	10.92	378	393	423	475	570	774	981	1,332	2,022
	2	10.99	384	390	417	463	561	753	945	1,287	1,931
	3	10.99	372	378	408	451	540	722	896	1,190	1,785
2	1	10.70	363	369	395	438	528	714	899	1,232	1,910
	2	10.96	386	390	420	471	572	780	983	1,332	2,028
	3	11.02	381	387	417	468	563	776	990	1,371	2,138
3	1	10.73	363	372	400	449	540	747	951	1,320	2,099
	2	10.82	366	377	398	450	537	728	918	1,232	1,839
	3	10.89	366	372	402	452	546	750	966	1,350	2,196
AVERAGES	(9 each)	10.89 pcf	373	381	409	457	551	749	948	1,294	1,994
Low Minimum		10.50 pcf	350			425				Report	
High Maximum		11.50 pcf	402			488					

POUR NUMBER	SAMPLE NUMBER	Density, p.c.f.	PERPENDICULAR TO RISE PSI @ STRAIN% 10%	20%	30%	40%	50%	60%	65%	70%	75%
1	4	10.92	330	345	372	420	512	724	948	1,323	2,023
2	4	10.86	323	335	365	411	503	717	939	1,311	1,992
3	4	10.93	318	335	363	408	498	716	936	1,301	1,998
AVERAGES	(3 each)	10.90 pcf	324	338	367	413	504	719	941	1,312	2,004
Low Minimum		10.50 pcf	300			Report				Report	
High Maximum		11.50 pcf									

8/31/92

GENERAL I STICS MANUFACTURING COMPANY APPROVED BY ?roduction: GS Conrtacts: FPH QA: DBE Date: 8/1/92

Part Number: S48929 Nomenclature: BUSS Impact Limiters, Operational Units Qty Of Parts: 1 each

Purchase Order No: 66-7466 Customer: Sandia National Labs SJO: 2630

Specification: BUSS-001, Issue: A Drawing: S48929 Issue: A

Serial Number: S48929-002 Start Date: AUG 12 1992 Due Date: Two weeks after Receipt

Op#	MANUFACTURING INSTRUCTIONS	SHOP / DATE	INSP / DATE
000	PREPARATION OF OPERATIONAL UNITS FOR FOAMING		8 QA AUG 12 1992
010	Receive BUSS Impact Limiters. Inspect material and dimensions for correct fabrication.		8 QA AUG 12 1992
020	Verify that interior surfaces are clean and dry. Inspect for damage.	GUY SHANKS	
030	Limiter Tare (empty) weight: 1845 lbs. Stamp tare weight on placard.	8-12-92	8 QA AUG 12 1992
040	Approve for foaming. PRODUCTION NOTES: Cask Interior & Exterior prep. per P.O.# 2846CR486 8 QA Foam Batch #1393 Approval for use 8/16/92 10 QA		
050	OK TO PROCEED WITH FOAMING INCREMENT #1		8 QA AUG 18 1992
060	Verify limiter's wall temperature is between 55 and 85°F and record (69 °F). Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note: Consistency of Unit and Box Sample rise height is very important.	GUY SHANKS 8-18-9	10 QA AUG 18 1992
070	Record increment #1 pour date, crest height, and pour weight on page 3.	GUY SHANKS 8-19-92	8 QA AUG 19 1992
090	From box sample: Cut four each specimens parallel and two each perpendicular to rise; 1.0 ±.01 X 2.0±.03 X 2.0±03 in for compressive strength testing. Cut two each 2.0 inch cube specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density, Compressive Strength and Intumescence per BUSS 001 Rev A (Rejection Tag ? N/A)		10 QA AUG 19 1992

8E202(22)

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REV 0

Op#	MA ACTURING INSTRUCTIONS S/N: S48 002	SHOP/DATE	INSP/DATE
100	OK TO PROCEED WITH FOAMING INCREMENT #2		AUG 19 1992
110	Verify limiter's wall temperature is between 55 and 85°F and record (71 °F) Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note: Consistency of Unit and Box Sample rise height is very important.	GUY SHANKS 8-19-9	AUG 19 1992
120	Record increment #2 crest height and pour weight on page 3.	GUY SHANKS 8-20-9	AUG 20 1992
130	From box sample: Cut four each specimens parallel and two each perpendicular to rise, 1.0 ±.01 X 2.0±.03 X 2.0±03 in for compressive strength testing. Cut two each 2.0 inch cube specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density, Compressive Strength and Intumescence per BUSS-001, Rev. A. (Rejection Tag ? N/A)		AUG 20 1992
140	OK TO PROCEED WITH FOAMING INCREMENT #3		AUG 20 1992
150	Verify limiter's wall temperature is between 55 and 85°F and record (71 °F) Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note: Consistency of Unit and Box Sample rise height is very important.	GUY SHANKS 8-20-92	AUG 20 1992
160	Record increment #3 crest height and pour weight on page 3.	GUY SHANKS 8-21-92	AUG 21 1992
170	From box sample: Cut four each specimens parallel and two each perpendicular to rise, 1.0 ±.01 X 2.0±.03 X 2.0±03 in for compressive strength testing. Cut two each 2.0 inch cube specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density, Compressive Strength and Intumescence per BUSS-001, Rev. A. (Rejection Tag ? N/A)		AUG 21 1992
180	FINAL PREPARATION ON UNIT		
190	Trim foam flush to the surface of unit and clean all excess foam from unit.	GUY SHANKS 8-21-92	AUG 24 1992
200	Replace 4 each covers on foaming holes using supplied covers and screws.	GUY SHANKS 8-24-92	AUG 24 1992

8E 202 (23)

210 FINAL INSPECTION:
1.) Verify the unit configuration is essentially unchanged from "As Received".
2.) Inspect unit for cleanliness or any damage.
3.) Attach Inspection test records and graphs to copies of this PCR.
4.) Prepare applicable certifications.

G P 8 QA AUG 24 1992

220 POURING AND TESTING RECORD

SN: -002	Date	Increment Weight Lbs.	Pour Rise Height	Flame Test No.	Insp.	Date
Increment No. 1	8-18-92	430 - 3	15.75"	920820-02	G P 10 QA	AUG 20 1992
Increment No. 2	8-19-92	436 - 2	+13.5" = 29.25"	920825-01	G P 10 QA	AUG 25 1992
Increment No. 3	8-20-92	290 - 2	FULL	920825-02	G P 10 QA	AUG 25 1992
Total Weight =		1149 #				

NOTES:

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REV 0

230 Final Whole Part Foam Weight: 2994 #

240 Final Whole Part Foam Density: 10.54

G P 8 QA AUG 24 1992

G P 8 QA AUG 24 1992

8E202(24)

GENERAL PLASTICS
MANUFACTURING COMPANY
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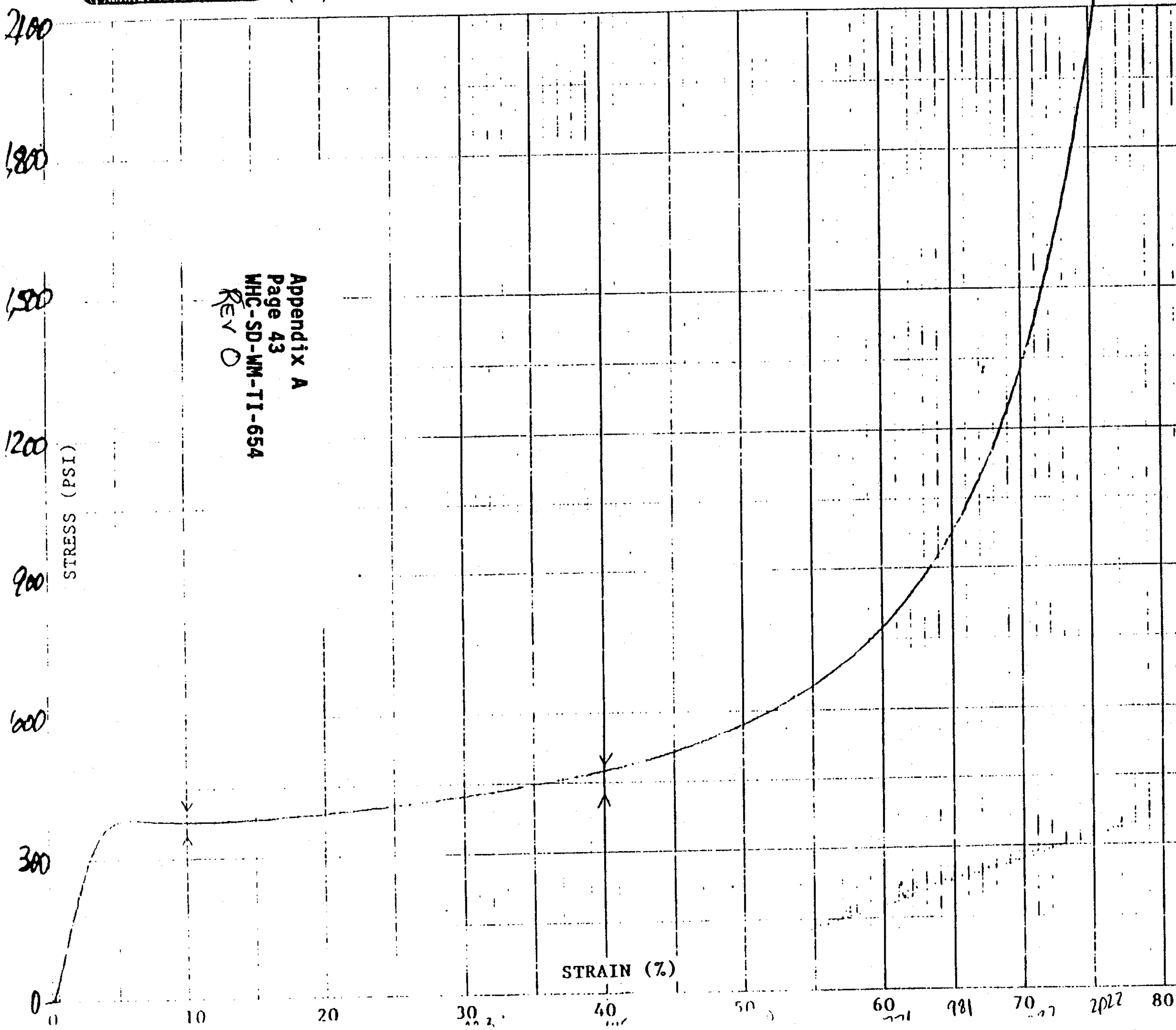
BUSS



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REV O

MATERIAL: LAST-A-FOAM 2-3710.75

PROPERTY TESTED: Compressive Strength At 75°F

TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min.
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 84%
Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (T) x 2.00" x 2.00"

Pour #1 8/18/92
S/N: S48929-002

Batch # 1393
Sample # 1

DENSITY: 10.92 lbs./cu.ft.

MISC:
P.O.# 66-7466
SJO: 2630

8E202(25)

BY: GP 8 DATE: AUG 19 1992

GENERAL PLASTICS MANUFACTURING CO.

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4910 BURLINGTON WAY/P.O. BOX 9097
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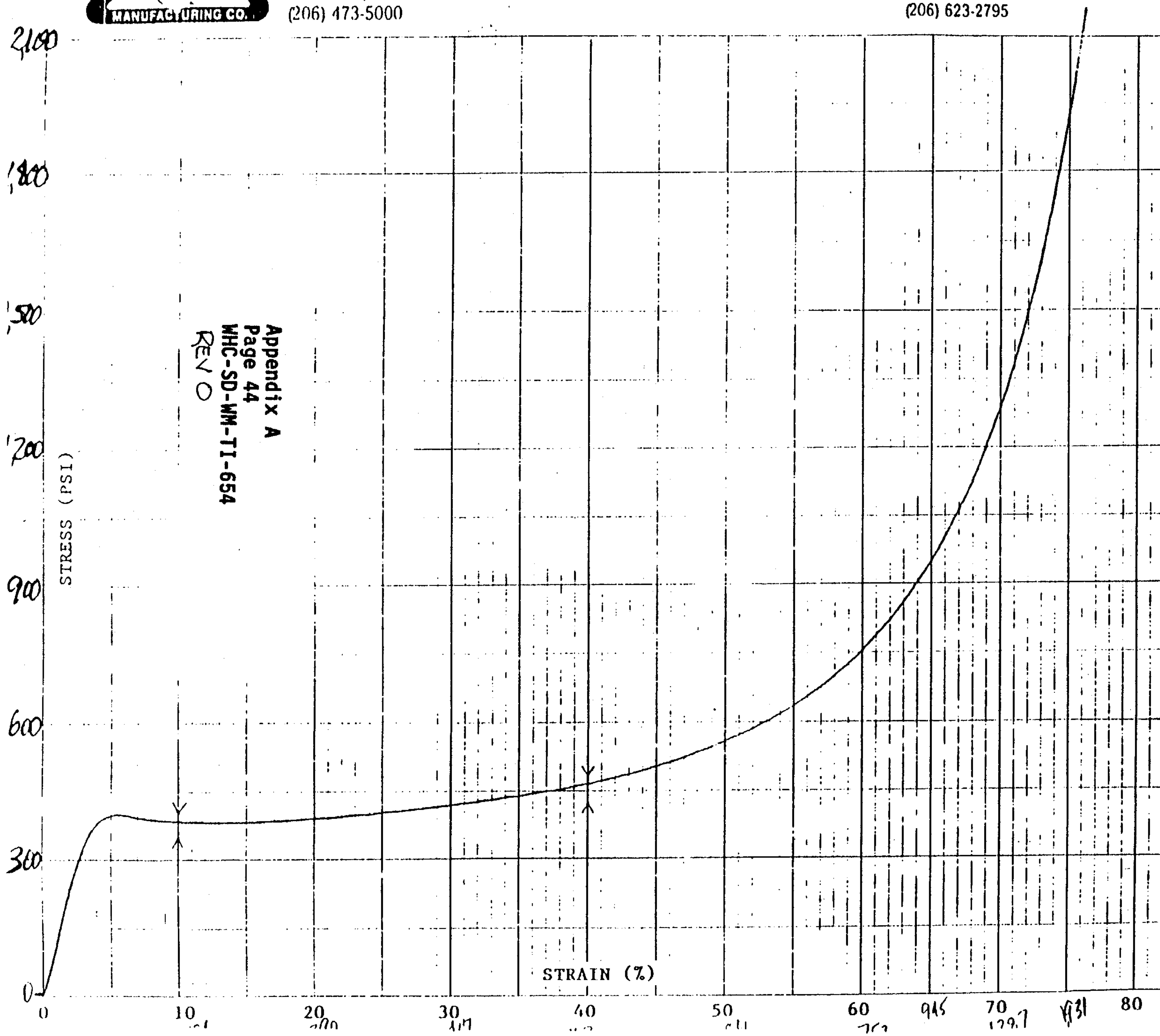

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REV O

MATERIAL: LAST-A-FOAM FR-3710.75

PROPERTY TESTED: Compressive Strength At 75°F

TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# 84%
Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (1D) x 2.00" x 2.00"

Pour #1 8/18/92
S/N: S48929-002

Batch # 1393
Sample # 2

DENSITY: 10.99 lbs./cu.ft.

MISC:
P.O. # 66-7466
SJD: 2630

8E202(26)

BY: DATE: AUG 1 9 1992

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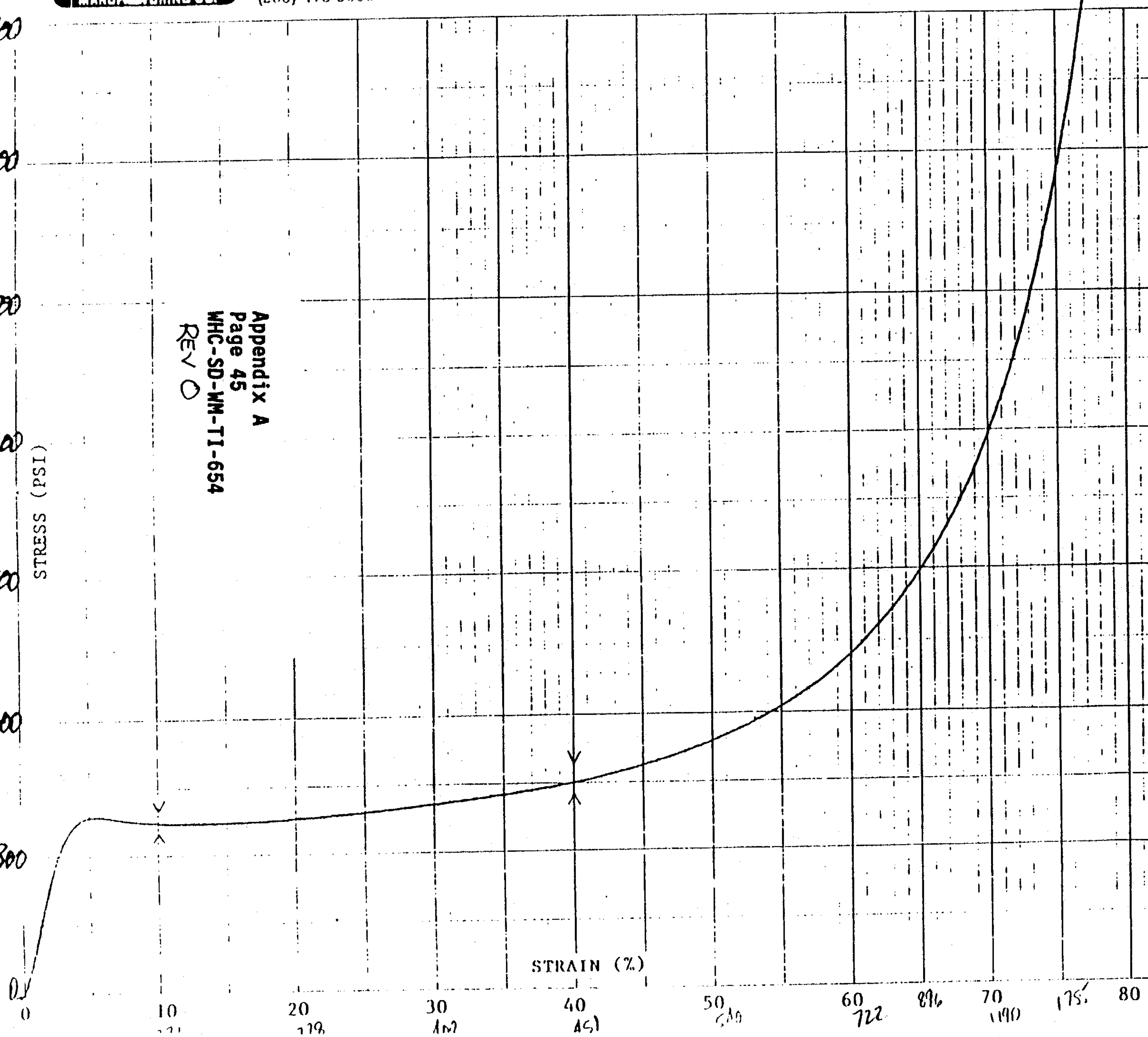

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REV 0

MATERIAL: LAST-A-FOA R-3700.75
PROPERTY TESTED: Compressive Strength At 75°F
TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 84%
Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (T) x 2.00" x 2.00"

Pour #1 8/18/92
S/N: S48929-002

Batch #1393
Sample #5

DENSITY: 10.99 lbs./cu.ft.

MISC:
P.O. # 66-7466
SJD: 2630

8E202(27)

BY: DATE: AUG 19 1992

GENERAL PLASTICS MANUFACTURING CO.

MANUFACTURING COMPANY
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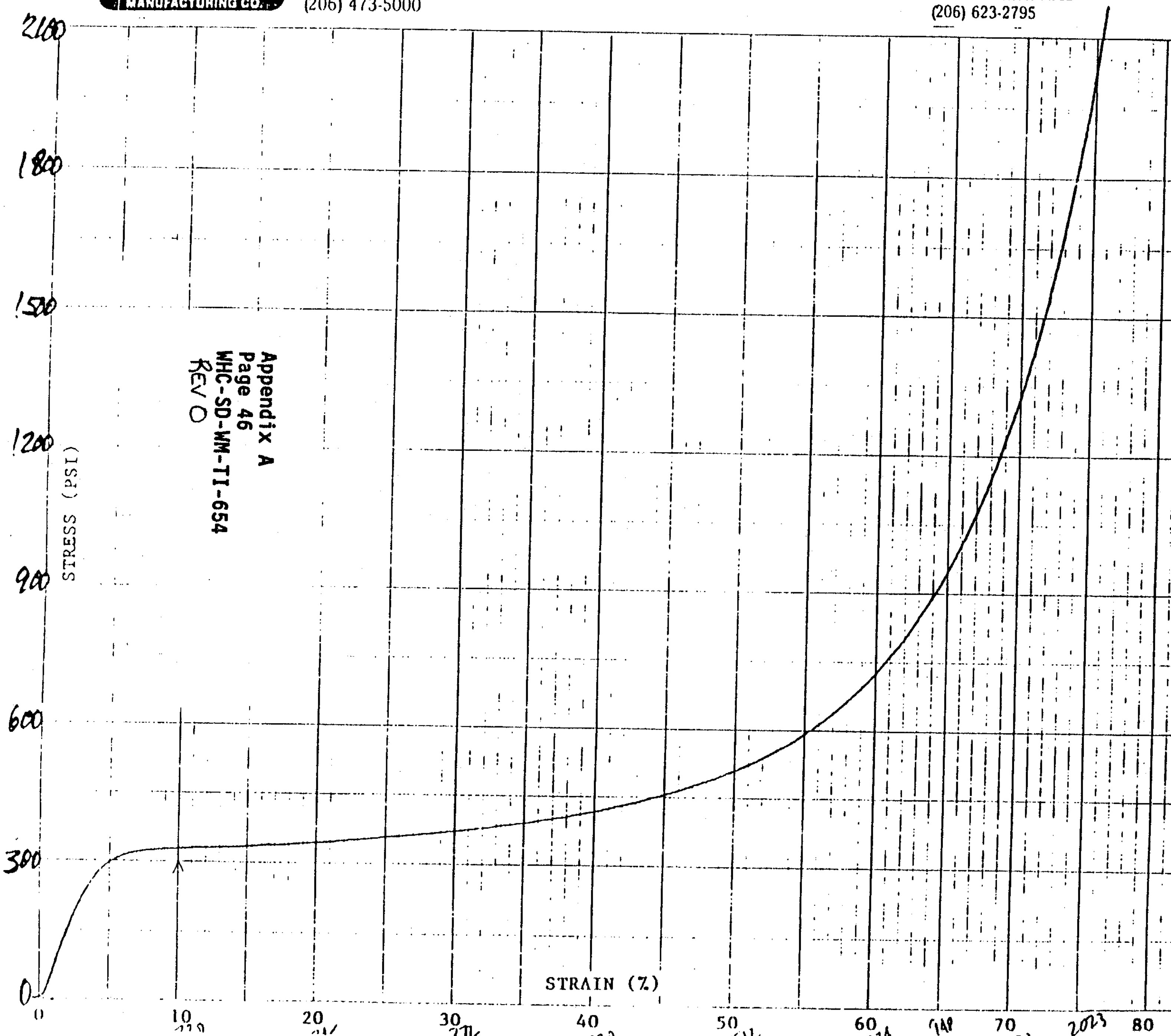

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REV O

MATERIAL:
LAST-A-FOAM FR-3710.75

PROPERTY TESTED:
Compressive Strength At 75°F

TEST METHOD:
BUSS-001, Issue A

TEST PARAMETERS:

Crosshead Speed	0.10 in/min
X-Axis	1.00 inches
Y-Axis	8400 lbs.
Load Cell	10K# @ 84%
Shunt Calibration	
Input Module	164.55
Recorder	84.00
Load	
Parallel to Rise	
Perpendicular	✓

SPECIMEN CONFIGURATION
1.00" (⊥) x 2.00" x 2.00"

Run #1 8/18/92
S/N: 48929-002

Batch # 1393
Sample #4

DENSITY: 10.92 lbs./cu.ft.

MISC:
P.O. # 66-7466
SJO: 2630

8E202 (28)

BY: DATE: AUG 1 9 1992

FLAMMABILITY TEST REPORT

GENERAL PLASTICS MANUFACTURING COMPANY

Material Description * FRL 3710.75FB	.5 inch Thickness	Rigid Foam ✓ Flexible Foam	Bun No. 081892	Test Report Number 920820-02	
Usage Sandia BUSS, S48929-002, Pour #1		Bun __ Belt __ Box ✓ Cup __ PCup __		Batch "A" 1215	Batch "B" 1393
Manufacturer/ Supplier GPMC	Model	Test Location	General Plastics Manufacturing Company Tacoma, Washington 98409		
Tested By (G/P 10 QA)	Witness By **	Test Date 8-20-92	Flame Temperature °F		

TEST METHOD / TEST REQUIREMENTS (MAXIMUM AVERAGE)

Pass/ Fail	✓		BSS 7230	F.A.R. Specification	Ignition time - Material position	Exting Time	Burn Length	Drip Exting	Burn Rate	Flame Penetrn	After Glow
		A	F1.	BSS 7230	60 Second - Vertical	15 Sec	6 In	3 Sec			
		B	F2.	BSS 7230	12 Second - Vertical	15 Sec	8 In	5 Sec			
Pass	✓	C	F1.	FAR 25.853 (a)	60 Second - Vertical	15 Sec	6 In	3 Sec			
		D	F2.	FAR 25.853 (b)	12 Second - Vertical	15 Sec	8 In	5 Sec			
		E	F1.	BMS 8-133	60 Second-Vertical	6 Sec	6 In	2 Sec			
		F	F3.	FAR 25.853 (b-2)	15 Second - Horizontal				2.5 In/Min		
		G	F4.	FAR 25.853 (b-3)	15 Second - Horizontal			4 In/Min			
		H	F5.	FAR 25.853 (a-1)	30 Second - 45°	15 Sec		None	10 Sec		
		I	F6.	FAR 1359 (d)	30 Second - 60° Electrical	30 Sec		3 Sec			
		J	F7.	FAR 25.853 (b)	12 Second - Vertical	No Limit	8 In.				
		K	F8.	MIL-P-26514F	60 Second - Horizontal	No Limit	<5 In.				

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REV O

SJO: 2630 PO: 66-7466

TEST VALUES

Sample No.	Test Method	Exting. Time (Sec.s)	Burned Length (Inches)	Drips Exting. Time(Sec.s)	Burn Time (Sec.s)	Burn Rate (In/Min)	After Glow (Sec.s)
1	F1	∅	4.6	D/N			
2	F1	∅	5.6				
3	F1	∅	5.0				
Average	--->	∅	5.1				
4	F2	N/R					
5	F2						
6	F2						
Average	--->						

Sketch, comments (Penetration, et

Sample Conditioned Yes ✓ No __
D/N= Does Not Apply

Dimensional Stability

Before Thick.	After Thick.	% Change
0.4858"	0.4845"	-0.27%

Density= 16.51 lbs/cu. ft. H2O= ____ %
Methane Gas ✓ Propane __ Type B __

8E202 (29)

* Include Material type, construction, specifications, thickness, color, etc.
** Required for qualification only by FAA DER of FAA Staff.

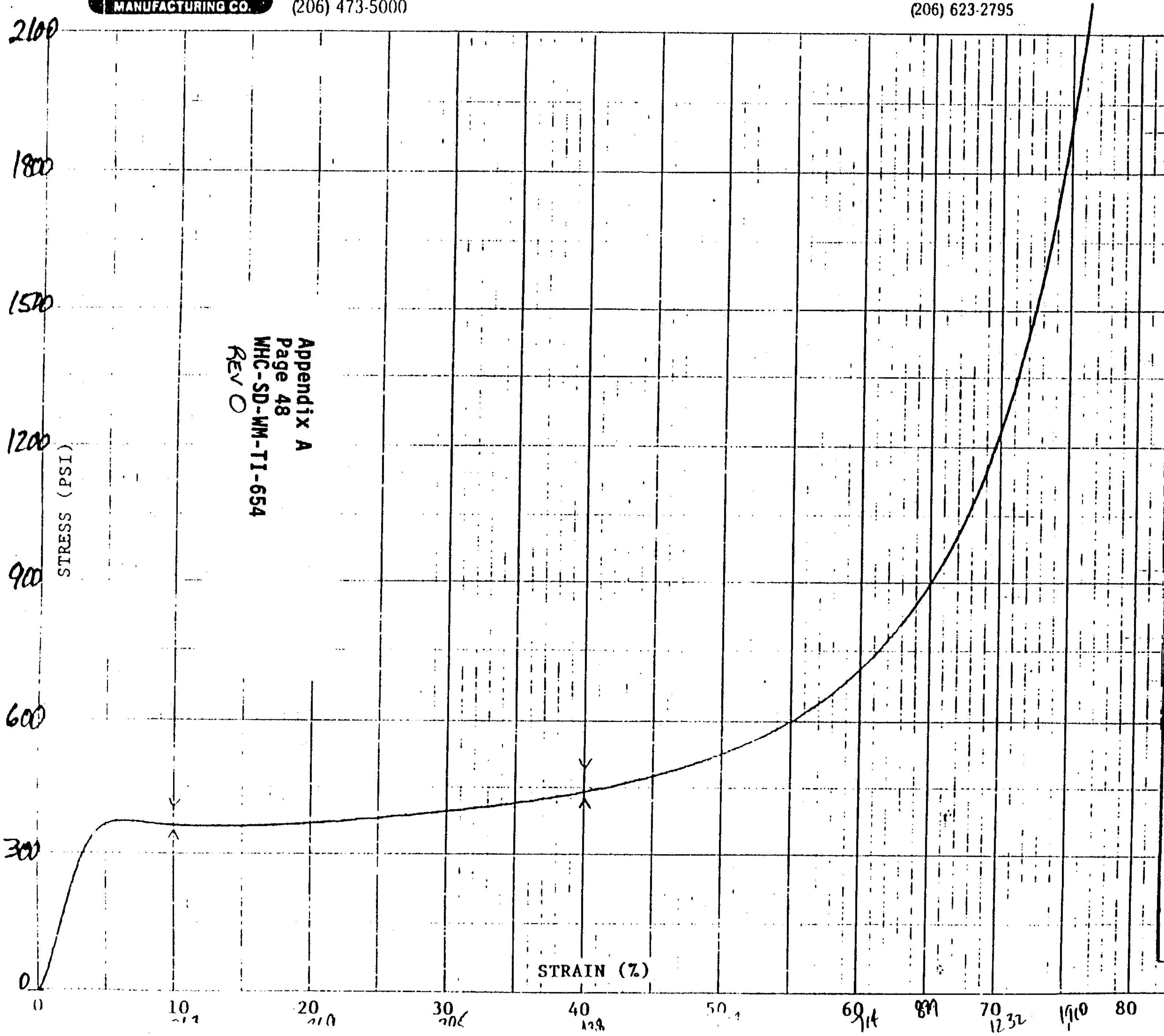
Intumescence

Density	Growth	% Growth
1[illegible]	2.8"	140%

GP-7700336W

GENERAL PLASTICS MANUFACTURING CO.
MANUFACTURING COMPANY
4910 BURLINGTON WAY/P.O. BOX 9097
TACOMA, WASHINGTON 98409
(206) 473-5000

FAX (206) 473-5104
TOLL FREE FROM
Seattle-Renton Area
(206) 623-2795



MATERIAL: LAST-A-FOA FR-3710.75

PROPERTY TESTED: Compressive Strength At 75°F

TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 84%
Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (T) x 2.00" x 2.00"

Pour # 2 8/19/92
S/N: SA8929-002

Batch # 1393
Sample # 1

DENSITY: 10.70 lbs./cu.ft

MISC:
P.O # 66-7466
SJO: 2630

8E202(30)

BY: DATE: AUG 21 1992

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GENERAL PLASTICS MANUFACTURING CO.

MANUFACTURING COMPANY
4910 BURLINGTON WAY/P.O. BOX 9097
TACOMA, WASHINGTON 98409
(206) 473-5000

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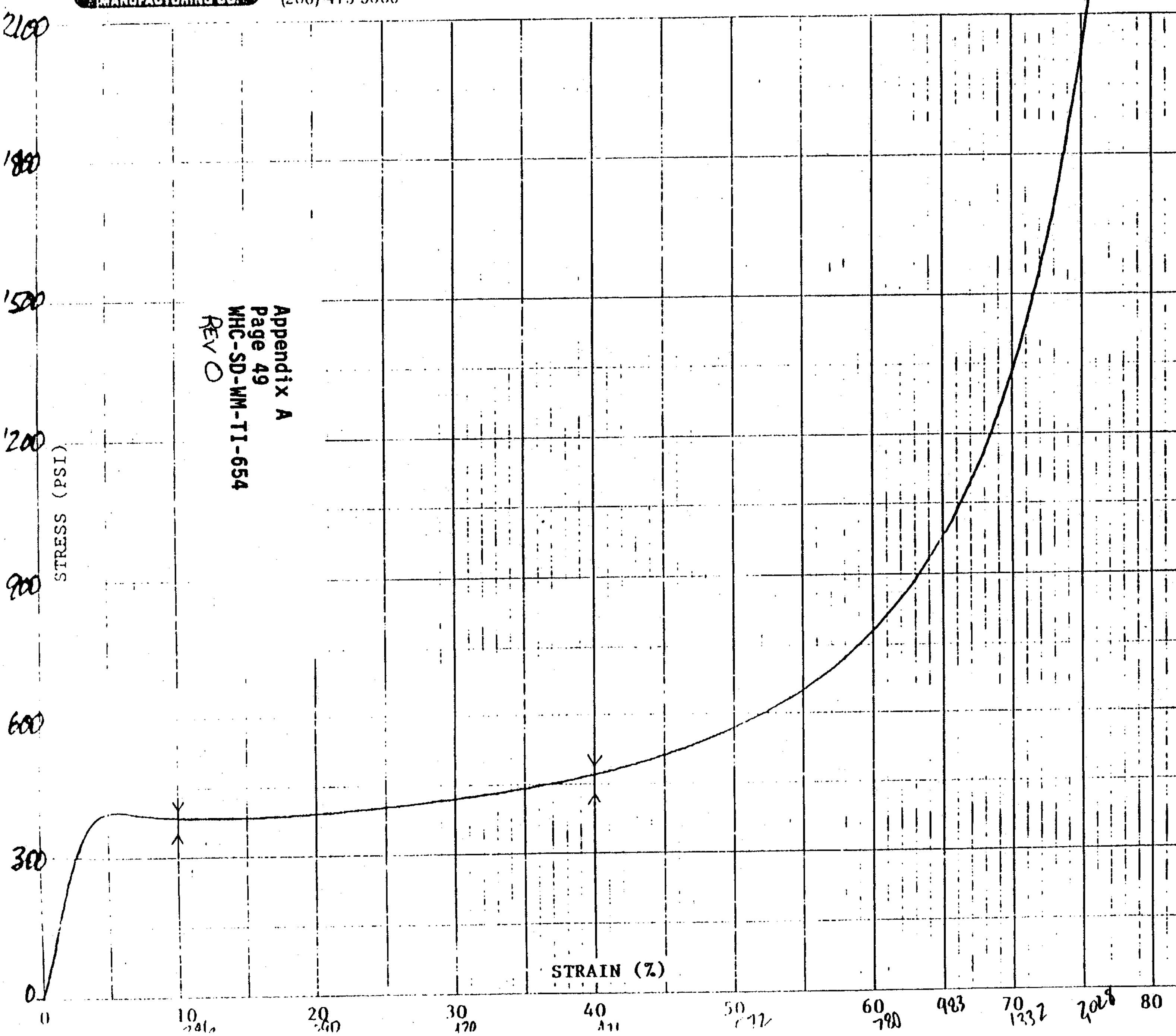
TOLL FREE FROM
Seattle-Renton Area
(206) 623-2795



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MATERIAL: LAST-A-FOAM e-3710.75

PROPERTY TESTED: **Compressive Strength At 75°F**

TEST METHOD: B155-001, Issue A

TEST PARAMETERS:
Crosshead
Speed 0.10 in/min.
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 8412
Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (T) x 2.00" x 2.00"

Pour #2 8/19/92
S/N: S48929-002

Batch #1393
Sample #2

DENSITY: 10.96 lbs./cu.ft.

MISC:
P.O. #66-7466
SJO: 2630

8E202(31)

BY: QA 8 P DATE: AUG 21 1992

GENERAL PLASTICS MANUFACTURING CO.
MANUFACTURING COMPANY
4910 BURLINGTON WAY/P.O. BOX 9097
TACOMA, WASHINGTON 98409
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TOLL FREE FROM
Seattle-Renton Area
(206) 623-2795

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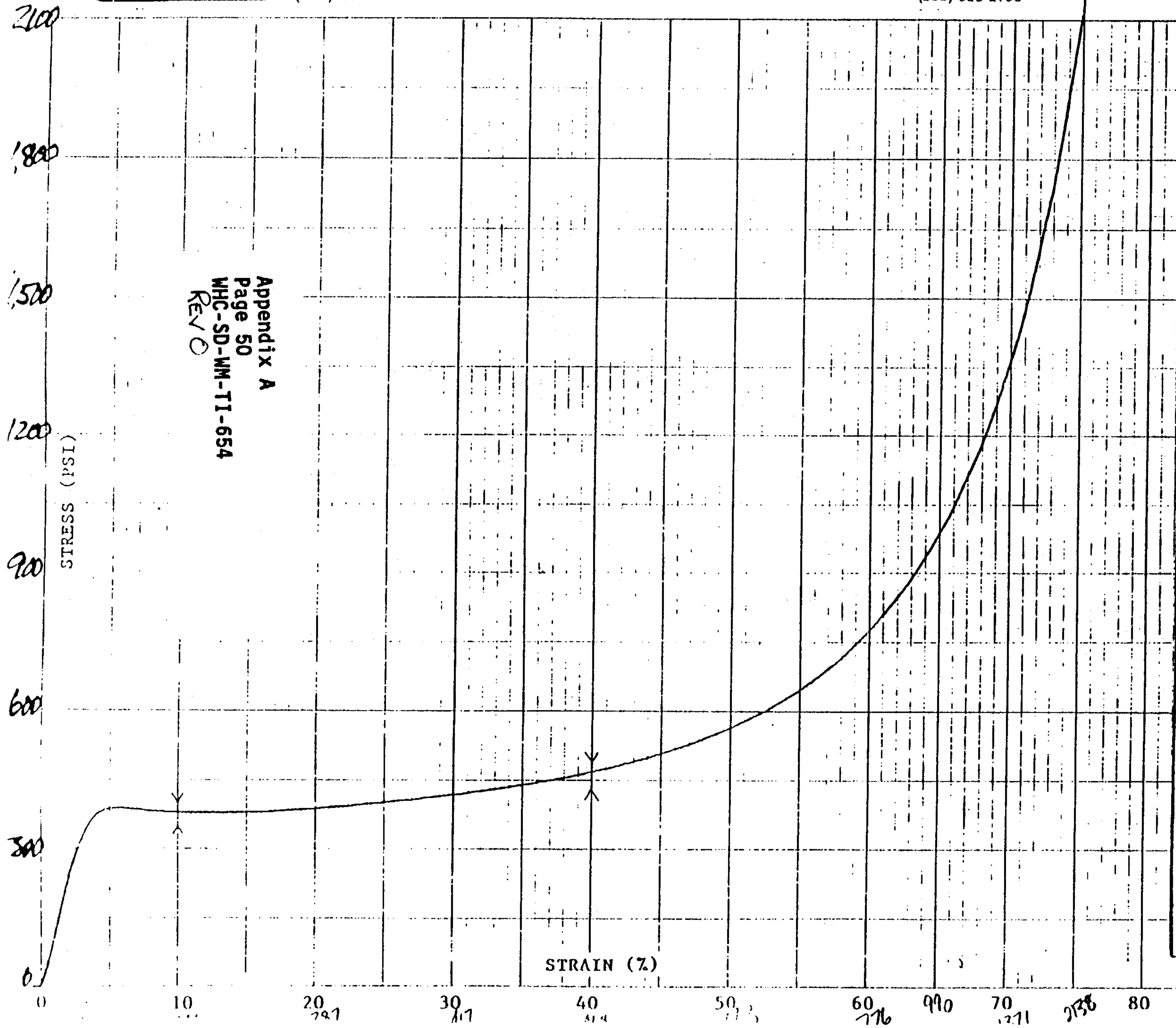


MATERIAL: LAST-A-FOAM FR-3710.75

PROPERTY TESTED:

TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:

Crosshead Speed 0.10 in/min.

X-Axis 1.00 inches

Y-Axis 8400 lbs.

Load Cell 10K# @ 84%

Shunt Calibration

Input Module 164.55

Recorder 84.00

Load

Parallel to Rise ✓

Perpendicular

SPECIMEN CONFIGURATION

1.00" (T) x 2.00" x 2.00"

Pour #2 8/19/92

S/N S48929

Batch # 1393

Sample #3

DENSITY: 11.02 lbs./cu.ft.

MISC:

P.O.# 66-7466

SJO: 2630

8E202(32)

BY: DATE: AUG 21 1992

GENERAL PLASTICS MANUFACTURING CO.

MANUFACTURING COMPANY
4910 BURLINGTON WAY/P.O. BOX 9097
TACOMA, WASHINGTON 98409
(206) 473-5000

FAX (206) 473-5104
TOLL FREE FROM
Seattle-Renton Area
(206) 623-2795

MATERIAL: LAST-A-FOAM 2-3700.75
PROPERTY TESTED: Compressive Strength At 75°F
TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min.
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @84%
Shunt Calibration
Input Module 164.55
Recorder 84.00
Load
Parallel to Rise
Perpendicular ✓

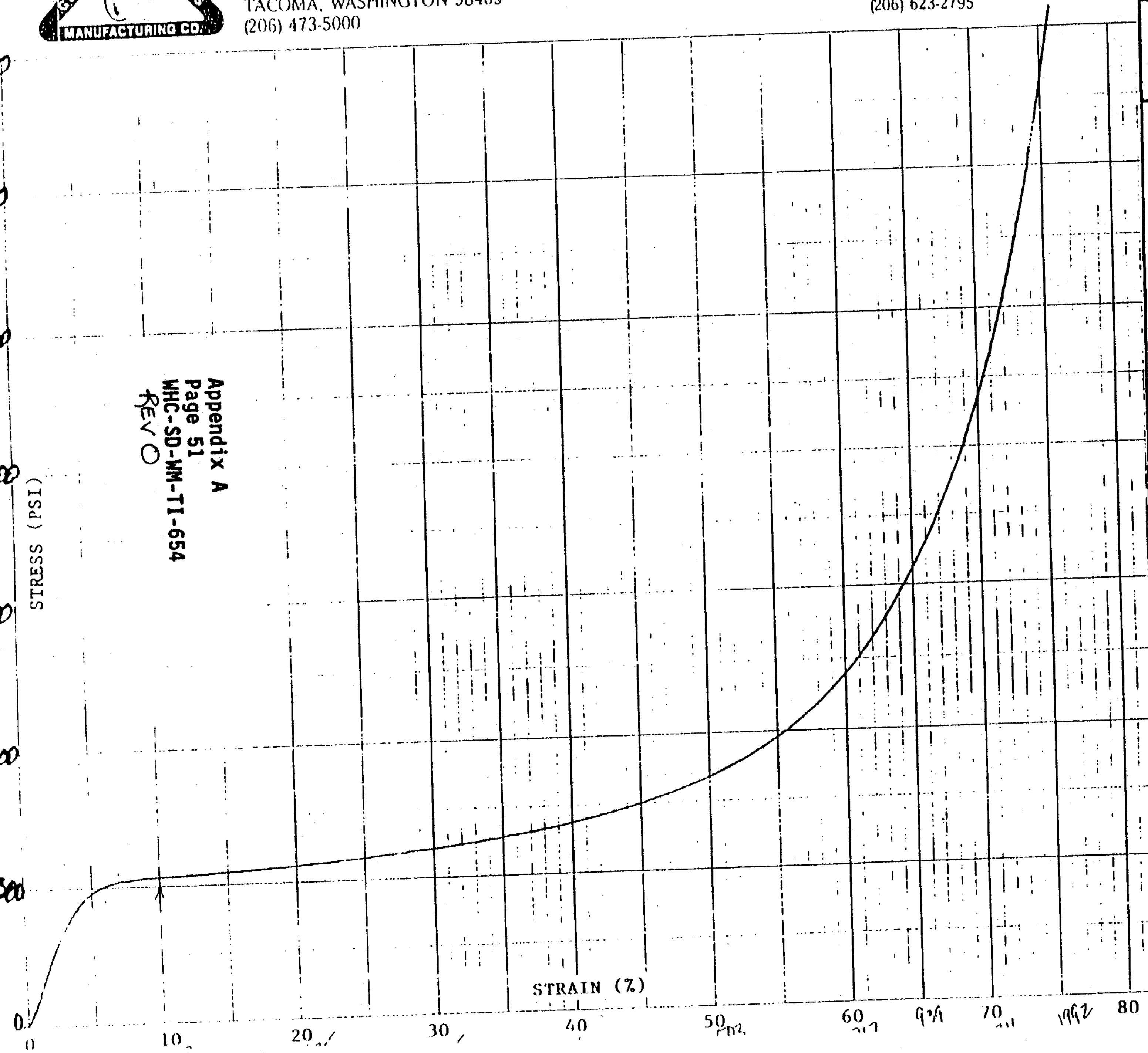
SPECIMEN CONFIGURATION
1.00"(T) x 2.00" x 2.00"
Pour #2 8/19/92
S/N: S48929-002
Batch #1393
Sample #4

DENSITY: 10.86 lbs./cu.ft.

MISC:
P.O. #66-7466

8E202(33)

BY: DATE: AUG 21 1992



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8E202(34)

FLAMMABILITY TEST REPORT — **GENERAL PLASTICS MANUFACTURING COMPANY**

Material Description * FRL 3710.75	.5 inch Thickness	Rigid Foam ✓ Flexible Foam	Bun No 081992	Test Report Number 920825-01	
Usage Sandia BOSS 48929-002, Pour #2			Bun __ Bell __ Cup __ Box ✓ PCup	Batch "A" 1215	Batch "B" 1393
Manufacturer/ Supplier GPMC		Model	Test Location	General Plastics Manufacturing Company Tacoma, Washington 98409	
Tested By QA 10	Witness By **		Test Date 8-25-92	Flame Temperature 1550 °F	

Pass/ Fail	√		BSS 7230	F.A.R. Specification	Ignition time - Material position	Exting Time	Burn Length	Drip Exting	Burn Rate	Flame Penetrn	After Glow
				TEST METHOD		**TEST REQUIREMENTS (MAXIMUM AVERAGE)**					
		A	F1.	BSS 7230	60 Second - Vertical	15 Sec	6 In	3 Sec			
		B	F2.	BSS 7230	12 Second - Vertical	15 Sec	8 In	5 Sec			
Pass	✓	C	F1.	FAR 25.853 (a)	60 Second - Vertical	15 Sec	6 In	3 Sec			
		D	F2.	FAR 25.853 (b)	12 Second - Vertical	15 Sec	8 In	5 Sec			
		E	F1.	BMS 8-133	60 Second-Vertical	6 Sec	6 In	2 Sec			
		F	F3.	FAR 25.853 (b-2)	15 Second - Horizontal				2.5 In/Min		
		G	F4.	FAR 25.853 (b-3)	15 Second - Horizontal			4 In/Min			
		H	F5.	FAR 25.853 (a-1)	30 Second - 45°	15 Sec		None	10 Sec		
		I	F6.	FAR 1359 (d)	30 Second - 60° Electrical	30 Sec		3 Sec			
		J	F7.	FAR 25.853 (b)	12 Second - Vertical	No Limit	8 In.				
		K	F8.	MIL-P-26514F	60 Second - Horizontal	No Limit	<5 In.				

SELF EXTINGUISHING BY THIS TEST

SJO 2630 PO# 66-7466

TEST VALUES

Sample No	Test Method	Exting. Time (Sec.s)	Burned Length (Inches)	Drips Exting. Time(Sec.s)	Burn Time (Sec.s)	Burn Rate (In/Min)	After Glow (Sec.s)
1	F1	Ø	4.6	D/N			
2	F1	Ø	4.2	✓			
3	F1	Ø	4.8	✓			
Average	--->	Ø	4.5				
4	F2	N/R					
5	F2						
6	F2						
Average	--->						

Sketch, comments (Penetration, etc.)

Sample Conditioned Yes ✓ No __
D/N= Does Not Apply

Dimensional Stability

Before Thick.	After Thick.	% Change
0.4870"	0.4856"	-0.29
0.4900"	0.4882"	-0.37
0.4904"	0.4888"	-0.33

Density= ______ lbs/cu. ft. H2O= ____ %
Methane Gas ✓ Propane __ Type B __

* Include Material type, construction, specifications, thickness, color, etc.
** Required for qualification only by FAA DER of FAA Staff.

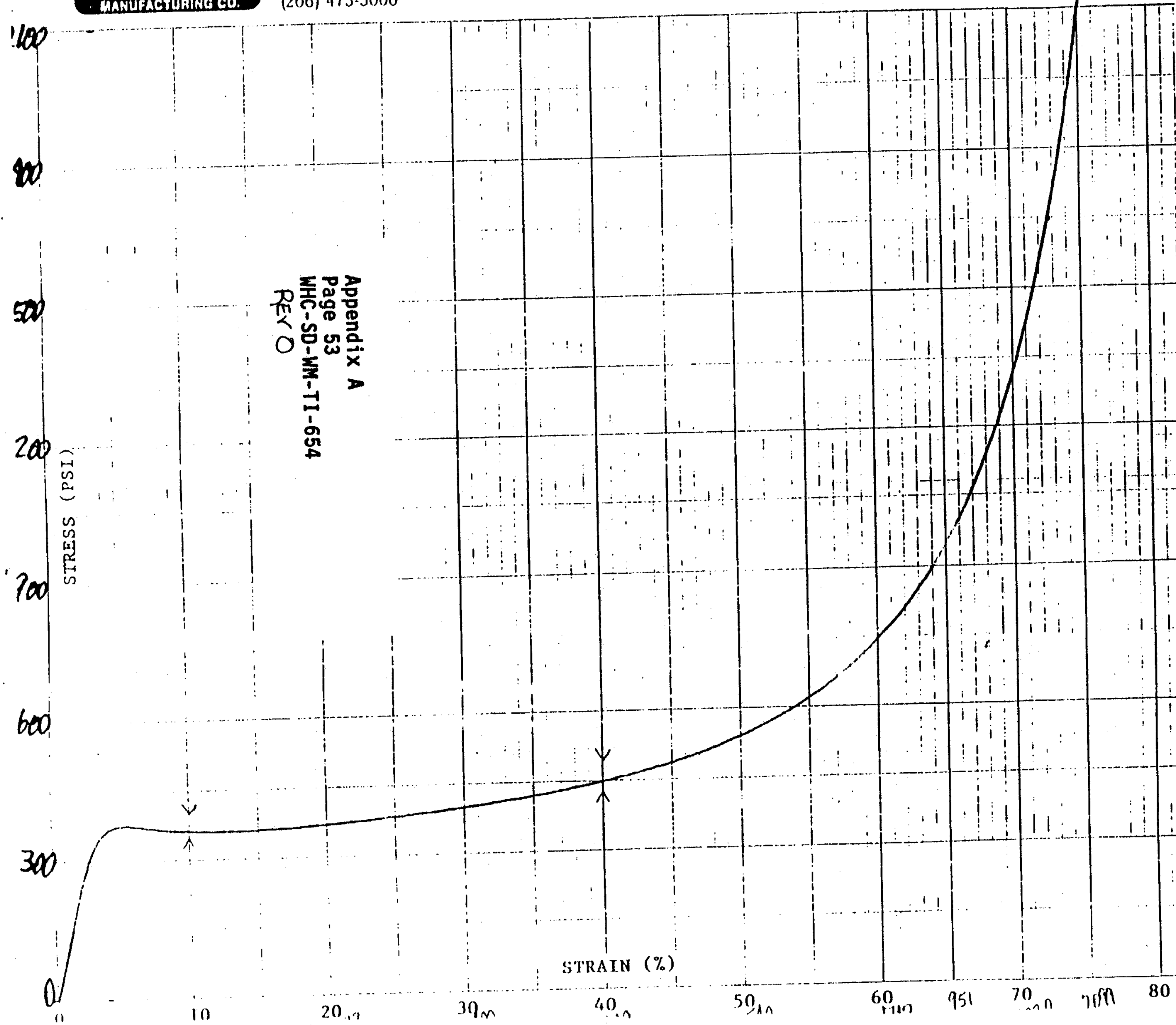
Intumescence

Density	Growth	% Growth
10.6[illegible]	2.8"	140 [illegible]

GP-7700336W

GENERAL PLASTICS
MANUFACTURING COMPANY
4910 BURLINGTON WAY/P.O. BOX 9097
TACOMA, WASHINGTON 98409
(206) 473-5000

TELEX 963154
FAX (206) 473-5104
TOLL FREE FROM
Seattle-Renton Area
(206) 623-2795



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DHJD

MATERIAL: LAST-A-FOAM -3710.75

PROPERTY TESTED:
Compressive Strength At 75°F

TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:

Crosshead Speed	0.10	in/min.
X-Axis	7.80	inches
Y-Axis	8400	lbs.
Load Cell	10K# @ 84%	
Shunt Calibration		
Input Module	164.55	
Recorder	84.00	
Load		
Parallel to Rise	✓	
Perpendicular		

SPECIMEN CONFIGURATION
1.00" (II) x 2.00" x 2.00"

Pour #3 8/20/92
S/N: S48929-002

Batch #1393
Sample #1

DENSITY: 10.73 lbs./cu.ft.

MISC:
P.O. #66-7466
SJO: 2630

8E202(35)

BY: [stamp] DATE: AUG 21 1992

MANUFACTURING COMPANY
4910 BURLINGTON WAY/P.O. BOX 9097
TACOMA, WASHINGTON 98409
(206) 473-5000

FAX (206) 473-5104
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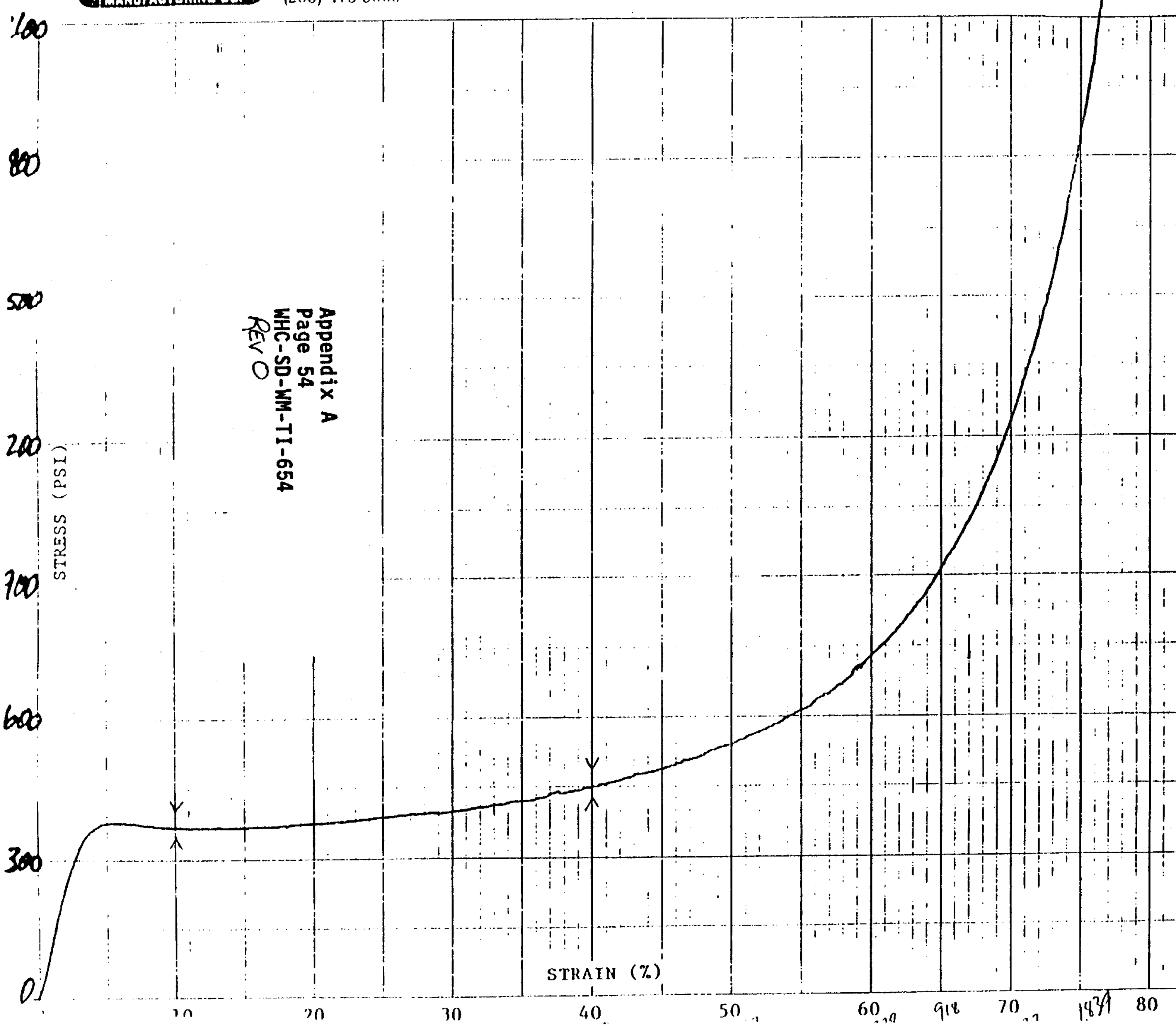

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MATERIAL:
LAST-A-FOAM R-3710.75

PROPERTY TESTED:
Compressive Strength At 75°F

TEST METHOD:
BUSS-001, Issue A

TEST PARAMETERS:
Crosshead Speed 0.10 in/min.
X-Axis 1.00 inches
Y-Axis 8400 lbs.
Load Cell 10K# @ 84%
Shunt Calibration
Input Module 164.55
Recorder Load 84.00
Parallel to Rise ✓
Perpendicular

SPECIMEN CONFIGURATION
1.00" (T) x 2.00" x 2.00"

Pour # 3 8/20/92
S/N: S48929-002

Batch # 1393
Sample # 2

DENSITY: 10.82 lbs./cu.ft.

MISC:
P.O. # 66-7466
SJO: 2630

8E202(36)

BY: DATE: AUG 21 1992

GENERAL PLASTICS MANUFACTURING CO.

MANUFACTURING COMPANY
4910 BURLINGTON WAY/P.O. BOX 9097
TACOMA, WASHINGTON 98409
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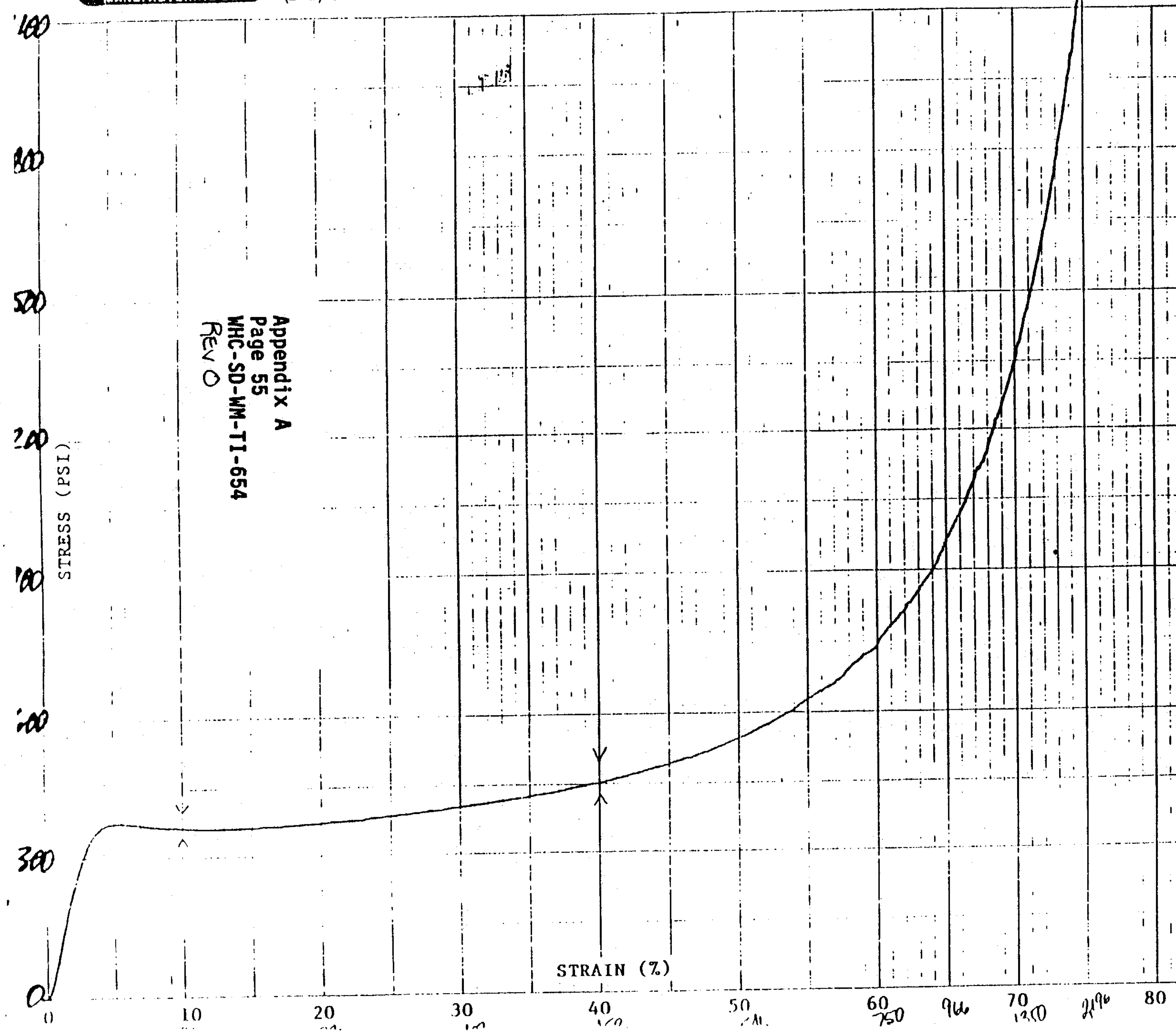
(206) 623-2795



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MATERIAL: LAST-A-FOAM	3710.75
PROPERTY TESTED:	Compressive Strength At 75°F
TEST METHOD:	BUSS-001, Issue A
TEST PARAMETERS:	
Crosshead Speed	0.10 in/min.
X-Axis	1.00 inches
Y-Axis	8400 lbs.
Load Cell	10K# @ 84%
Shunt Calibration	
Input Module	164.55
Recorder	84.00
Load Parallel to Rise	✓
Perpendicular	
SPECIMEN CONFIGURATION	1.00" (T) x 2.00" x 2.00"
	Pour # 3 8/20/92
	S/N: S48929-002
	Batch #1593
	Sample #3
DENSITY:	10.89 lbs./cu.ft.
MISC:	P.O. #66-7466 SJD: 2630
BY:	DATE: AUG 2 1 1992

8E202(37

GENERAL PLASTICS
MANUFACTURING COMPANY
4910 BURLINGTON WAY/P.O. BOX 9097
TACOMA, WASHINGTON 98409
(206) 473-5000

TELEX 989134
FAX (206) 473-5104
TOLL FREE FROM
Seattle-Renton Area
(206) 623-2795

BUSS

MATERIAL: LAST-A-FOAM® FR-3710.75

PROPERTY TESTED: Compressive Strength At 75°F

TEST METHOD: BUSS-001, Issue A

TEST PARAMETERS:

Crosshead Speed	0.10	in/min.
X-Axis	1.00	inches
Y-Axis	8400	lbs.
Load Cell	10K# @ 84%	
Shunt Calibration		
Input Module	164.55	
Recorder	84.00	
Load		
Parallel to Rise		
Perpendicular	✓	

SPECIMEN CONFIGURATION

1.00" (⊥) x 2.00" x 2.00"

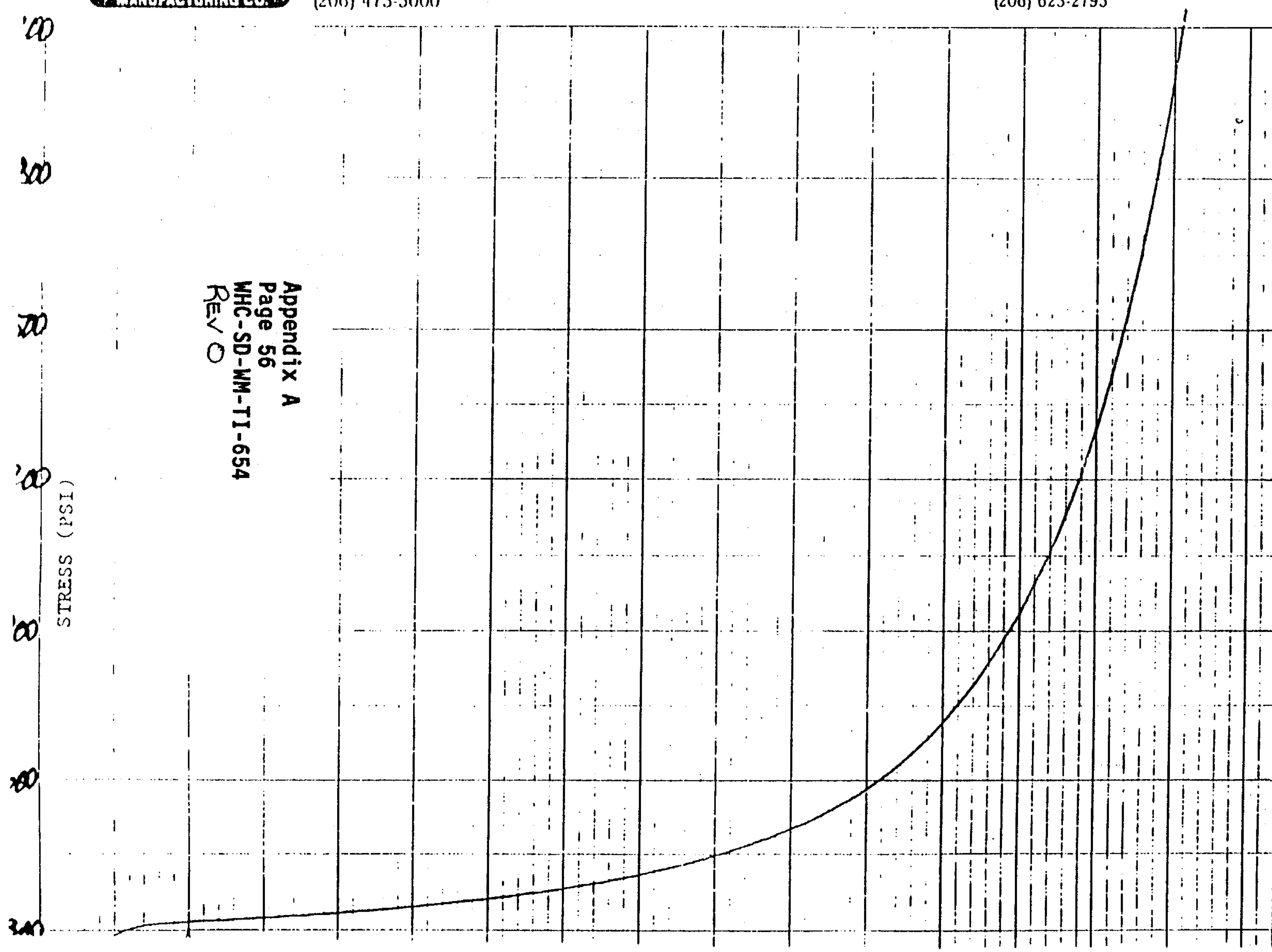
Pour #3 8/20/92
SN: S48929-002

Batch #1393
Sample #4

DENSITY: 11.93 lbs./cu.ft.

MISC: P.O.# 66-7466
SJO: 2630

8E202(38



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OE202(39)

FLAMMABILITY TEST REPORT

GENERAL PLASTICS MANUFACTURING, COMPANY

Material Description · FRL 3710.75	.5 inch Thickness	Rigid Foam / Flexible Foam	Bun No. 082092	Test Report Number 920825-1
			Bun ___ Bell Cup ___ Box ✓ PCup ___	Batch "A" 1215 / Batch "B" 1393
Usage Sandia BVSS 48929-002, Pour #3		Model	Test Location: General Plastics Manufacturing Company, Tacoma, Washington 98409	
Manufacturer/ Supplier GPMC			Test Date 8-25-92	Flame Temperature 1550 °F
Tested By (QA stamp 10)	Witness By **			

TEST METHOD / TEST REQUIREMENTS (MAXIMUM AVERAGE)

Pass/ Fail	√		BSS 7230	F.A.R. Specification	Ignition time - Material position	Exting Time	Burn Length	Drip Exting	Burn Rate	Flame Penetrn	After Glow
		A	F1.	BSS 7230	60 Second - Vertical	15 Sec	6 In	3 Sec			
		B	F2.	BSS 7230	12 Second - Vertical	15 Sec	8 In	5 Sec			
Passed	✓	C	F1.	FAR 25.853 (a)	60 Second - Vertical	15 Sec	6 In	3 Sec			
		D	F2.	FAR 25.853 (b)	12 Second - Vertical	15 Sec	8 In	5 Sec			
		E	F1.	BMS 8-133	60 Second-Vertical	6 Sec	6 In	2 Sec	2.5 In/Min		
		F	F3.	FAR 25.853 (b-2)	15 Second - Horizontal			4 In/Min			
		G	F4.	FAR 25.853 (b-3)	15 Second - Horizontal			None	10 Sec		
		H	F5.	FAR 25.853 (a-1)	30 Second - 45°	15 Sec		3 Sec			
		I	F6.	FAR 1359 (d)	30 Second - 60° Electrical	30 Sec					
		J	F7.	FAR 25.853 (b)	12 Second - Vertical	No Limit	8 In.				
		K	F8.	MIL-P-26514F	60 Second - Horizontal	No Limit	<5 In.				

SJO2630 PO# 66-7466

SELF EXTINGUISHING BY THIS TEST

TEST VALUES

Sample No	Test Method *	Exting. Time (Sec.s)	Burned Length (Inches)	Drips Exting. Time(Sec.s)	Burn Time (Sec.s)	Burn Rate (In/Min)	After Glow (Sec.s)
1	F1	Ø	4.7	D/N			
2	F1	Ø	4.2				
3	F1	Ø	4.4				
Average	--->	Ø	4.5				
4	F2	N/R					
5	F2						
6	F2						
Average	--->						

*Sketch, comments (Penetration, etc.)

Sample Conditioned Yes ✓ No ___

D/N= Does Not Apply

Dimensional Stability

Before Thick.	After Thick.	% Change
0.4762"	0.4751"	-0.23
0.4788"	0.4776"	-0.25
0.4806"	0.4794"	-0.25

(0.1)

Density= ______ lbs/cu. ft. H2O= ______ %

Methane Gas ✓ Propane ___ Type B ___

Intumescence

Density	Growth	% Growth
10.51	3.0"	150 > 135 %

* Include Material type, construction, specifications, thickness, color, etc.

** Required for qualification only by FAA DER of FAA Staff.

GP-7700336W

GENERAL PLASTICS MANUFACTURING COMPANY

P.O. Box 9097, Tacoma, WA. 98409
(206) 473-5000

8E202(40)

COPY

TE JUNE 16, 1992

P.O. NUMBER: 2846 CR486
THIS NUMBER MUST APPEAR ON ALL LABELS, PACKING SLIPS & INVOICES

PUGET SOUND COATINGS
9220 8TH AVE S.
SEATTLE, WA 98618

767-3800/TOBY Andrews

SHIPPING ADDRESS: 4910 BURLINGTON WAY
TACOMA, WA. 98409
DOOR

Send Invoices to: P.O. Box 9097, Tacoma, Wa. 98409

FOB: S/P

TERMS: N 30

OUTING YOUR TRUCK

REQ. NO.

PLEASE FURNISH certification that the materials furnished under this order meet all the specifications listed below.

☐ Unless this box is checked, Washington State Sales Tax is not applicable.

TAX REGISTRATION NO. C278036069

ITEM	QUANTITY	DESCRIPTION	SCHEDULE
1		SOLVENT CLEAN, ABRASIVE BLAST AND PASSIVATE BUSS CASK IMPACT LIMITERS PER SPECIFICATIONS SSPC-SP-1 SOLVENT CLEANING AND SSPC-SP-5, NACE 1, SWEDISH STANDARD SA3, WHITE METAL BLAST CLEANING (ATTACHED) PICK UP CRATED UNITS AT GENERAL PLASTICS AND RETURN IN SAME CRATES	

CERTIFY WORK & MATERIALS ~~CONFROM~~ CONFORM TO STATED SPECIFICATIONS, DATED AND SIGN

SMALL 1 OZ. SAMPLE OF BEAD MATERIAL TO BE DELIVERED WITH UNIT.

CALL DAVE EDMONDSON OR CHUCK WILLIAMSON (206) 473-5000) TO INSPECT UNIT AT Y
BEFORE CRATING FOR RETURN SHIPMENT.

CONFIRMING ORDER——————DO NOT DUPLICATE

THIS PURCHASE ORDER IS FOR SANIDA NATIONAL LABATORY PARTS. SANDIA NATIONAL LABATORY TOGETHER WITH GENERAL PLASTICS MFG. CO. HAS THE TO VERIFY THE QUALITY OF WORK AND MATERIALS AT ANY PLACE INCLUDING PLANT.

This is a rated order certified for National defense use and you are required to follow all the provisions of the defense prioritie and allocations system regulations (15 CFR 350).

DMS RATING: DX-E2

G 8 P QA

Purchase order subject to the ns and conditions on the reverse side hereof.

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INTERNAL ROUTING:

☐ Plant 1 ☐ Liquids ☐ Office
☐ Cutting ☐ QA

Floyd Henry, Project Sales Engineer

Q.A. COPY

8E202 (41)

CHANGE ORDER

SJO NUMBER 2630 DATE 8-10-92 P.O. NUMBER 66-7466 COPY

SOLD TO Sandia Nat'l Labs. P/N

CHANGE FROM: 2846CR486 per SNLA P.O. # 66-7466 Ch 2

CHANGE TO: Add to both units:

1) Clean units with DOD-P-15328

2) Apply MIL-P-53022 per MIL-F-18264

3) Apply MIL-C-22750D, Fed Std. 595 #36307 per MIL-C-22751 and MIL-F-18264

Weigh untis after foaming. PROVIDE CERTIFICATION

Ship units to Puget Sound Coatings after foaming for top coat.

Ship to Sandia on -8-22-92

'ICE USE ONLY:

___Original SJO

___SJO Copy

___Computer

___Shipping Label

OK'D BY ZC

770' 5G

8E202(42)

COPY

GP GENERAL PLASTICS MANUFACTURING CO.

FACSIMILE TRANSMITTAL SHEET

From: GENERAL PLASTICS MANUFACTURING COMPANY

Address: PO. BOX 9097, TACOMA, WA. 98409 USA

Fax: (206) 473-5104 (Auto answer direct line)

Telex: 98-9134 (GENERAL PLASTICS)

EasyLink: 62-924622

Phone (voice): (206) 473-5000

Sender: Floyd Henry

Pages: 1 (Includes this sheet) Date: 7/27/92

Attn: Toby Andrews

To Company: Puget Sound Coatings

1: ________ Mail Stop ________

Fax number: 767-5817 Phone(voice): ________

Message:

Change to P.O. 2846CR486

Add: Services for the BUSS Cask Impact Limiters, two units supplied:

1) clean units with DOD-P-15328

2) Apply MIL-P-53022 per MIL-F-18264

3) Apply MIL-C-22750D, Federal Standard 595 # 36307, per MIL-C-22751 and MIL-F-18264

Provide certification to the specified standards.

ARTICLE 2 - PERIOD OF PERFORMANCE

Add: Additional work described in this Amendment to be complete by August 15, 1992.

Additional Amount [redacted]

Total Contract [redacted]

8E202(43)

PSC
Puget Sound Coatings Inc
°220 8th Ave. South • Seattle, Washington 98108 • (206) 767-3800 • FAX (206) 767-5817

COPY

August 27, 1992

To Whom It May Concern:

Reference: General Plastics Purchase Order No. 2846CR486
Sandia National Laboratories Purchase Order No. 66-7466

This letter certifies that the Topcoat material meets MIL-C-22750D and was applied in accordance to the Manufacturers Specifications and Application Procedures.

Toby Andrews
Toby Andrews
Project Manager

TA:bc

8E202(44)

COPY

Daniel Boone
PAINTS

Daniel Boone Paints, Inc.
15701 Nelsen Place So.
Tukwila, Washington 98188
(206) 228-7767

August 27, 1992

Puget Sound Coatings
9220 8th Ave. South
Seattle, Washington 98108

Attn: Toby
Subject: Letter of Certification:

P.O. 7148 for General Plastic P.O.#2846CR486 Sandia Nat'l Laboratory P.O. 66746

This is to certify that the following material is of the same composition as material which previously has been found to comply with specifications when tested completely, or that the material complies with the specification based on complete tests which the manufacturer has conducted on the particular batch or lot.

Mil C 22750A	Batch #050122	Mfg. May, 1992
Mil C 22750B	Batch #080512	Mfg. August, 1992

Sincerely,

J.M. Boone

J.M. Boone, Secty-Treas.
DANIEL BOONE PAINTS, INC.

8E202(45)

CERTIFICATION

COPY

"Aircraft, Protective & Decorative Finishes"

Protective Coatings, Inc.

215 NORTH 2ND AVENUE, KENT, WA 98032-2993 • TELEPHONE: (206) 854-9330 • FACSIMILE: (206) 859-0749

PAGE: 1

PUGET SOUND COATINGS
P.O. BOX 80505
9220 EIGHTH AVE. S.
SEATTLE WA 98108

INVOICE # 0185954
DATE 07/29/92
CUST. P.O. # 7037

QUANTITY	UNIT	ITEM NO.
2.000	EACH	VESSELS

PASSIVATE PER SANDIA SPEC 9904301 ISSUE "J"
TREATMENT "B", EXCEPT FOR PARA. 3.3.2A
TEMP. 70 - 100 DEG. F. AND SEC. 3.3.2B
TIME 10-15 MINUTES
CLEAN UNITS PER DOD-P-15328
APPLY MIL-C-22750-D, FED-STD-595 #36307 PER
MIL-F-18264-D AND MIL-C-22751-D PER
MIL-F-18264-D
REF: PUGET SOUND COATINGS P.O. 2846CR486 AND
SNLA P.O. 66-7466, CHANGE 2

2250^00

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AUTO. SHOT PEEN	SHOT SIZE	ACTUAL INT.	COVERAGE	MANUAL SHOT PEEN	SHOT SIZE	ACTUAL INT.	COVERAGE

REJ. TAG#	MAGNETIC INSPECTION PER APPLIED SPECIFICATIONS	
REJ. TAG#	PENETRANT INSPECTION PER APPLIED SPECIFICATIONS	
RECEIVED	ACCEPTED	REJECTED
RECEIVED	ACCEPTED	REJECTED

☐ BAKED ______ °F FOR ______ HOURS
☐ BAKED ______ °F FOR ______ HOURS
☐ BAKED ______ °F FOR ______ HOURS

☐ BMS 10-20 ☐ BAC 5811

BATCH# DATE:

Tape test results MEK test results
Wet test results

DATE

RECEIVED BY [signature] 8-4-92

WE CERTIFY that all materials and processes used on the parts listed herein are as specified on the applicable drawings. Physical and/or chemical test reports are on file for inspection.

PCI 1

AUTHORIZED SIGNATURE [signature] 8-4-92

GENERAL PLASTICS MANUFACTURING COMPANY

P.O. Box 9097, Tacoma, WA. 98409
(206) 473-5000

COPY 8E202(46

DATE AUGUST 5, 1992

P.O. NUMBER: 3079 CB672

THIS NUMBER MUST APPEAR ON ALL LABELS, PACKING SLIPS & INVOICES

PHILLIPS SCALE CO., INC.
934 ELLIOTT AVE.
SEATTLE, WA 98119

284-6090

SHIPPING ADDRESS: 4910 BURLINGTON WAY
TACOMA, WA. 98409
DOOR

Send Invoices to: P.O. Box 9097, Tacoma, Wa. 98409

FOB: S/P

TERMS: N 30

ROUTING

REQ. NO.

☐ PLEASE FURNISH certification that the materials furnished under this order meet all the specifications listed below.

☐ Unless this box is checked, Washington State Sales Tax is not applicable.

TAX REGISTRATION NO. C278036069

ITEM	QUANTITY	DESCRIPTION	SCHEDULE
1		RENTAL OF 5000/LB PLATFORM SCALE, INCLUDING CERTIFICATE OF TRUE & ACCURATE WEIGHT	
2		TRANSPORTATION (BOTH WAYS)	

CONFIRMING ORDER———————DO NOT DUPLICATE

GP 6 QC

Purchase order subject to the terr and conditions on the rev e side hereof.

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INTERNAL ROUTING:

☐ Plant 1 ☐ Liquids ☐ Office
☐ Cutting ☐ QA

Floyd Henry, Project Sales Engineer

Q.A. COPY

8E202(47)

Phillips SCALE COMPANY, INC.

COPY

Certificate of Inspection
For:

Co. GENERAL PLASTICS At: 4910 BURLINGTON WAY TACOMA WA

Make West Weigh WS 1000 S/N

Inspected By James E Phillips Date 8/5/92

This certifies that the above listed device met all Weighing Requirements when tested on the above date with weights traceable to N.B.S.

Load		Reading	Load		Reading	Load		Reading
500	Lbs	500	3000	Lbs	2990		Lbs	
1000	Lbs	1000	4000	Lbs	4000		Lbs	
2000	Lbs	2000	5000	Lbs	5001		Lbs	

Next Inspection Date 8/5/93

LITHO IN U.S.A.

IMPACT LIMITER DENSITY CALCULATIONS

NG COMPANY APPROVI Y; Production: GS Contacts: FPH QA: DBE Date /92

Nomenclature: BUSS Impact Limiters, Operational Units Qty Of Parts: 1 each

Customer: Sandia National Labs SJO: 2630

Specification: BUSS-001, Issue: A Drawing: S48929 Issue: A

Serial Number: S48929-002 Start Date: AUG 12 1992 Due Date: Two weeks after Receipt

Op#	MANUFACTURING INSTRUCTIONS	SHOP / DATE	INSP / DATE
000	PREPARATION OF OPERATIONAL UNITS FOR FOAMING		8 QA AUG 12 1992
010	Receive BUSS Impact Limiters. Inspect material and dimensions for correct fabrication.		8 QA AUG 12 1992
020	Verify that interior surfaces are clean and dry. Inspect for damage.	GUY SHANKS 8-12-92	
030	Limiter Tare (empty) weight: 1845 lbs. Stamp tare weight on placard.		8 QA AUG 12 1992
040	Approve for foaming. PRODUCTION NOTES: Cask Interior & Exterior prep. per P.O# 2846CR486 (8 QA) Foam Batch #1393 Approval for use 8/16/92 (10 QA)		
050	OK TO PROCEED WITH FOAMING INCREMENT #1		8 QA AUG 12 1992
060	Verify limiter's wall temperature is between 55 and 85°F and record (= 69 °F). Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note: Consistency of Unit and Box Sample rise height is very important.	GUY SHANKS 8-18-92	10 QA AUG 18 1992
070	Record increment #1 pour date, crest height, and pour weight on page 3.	GUY SHANKS 8-19-92	8 QA AUG 19 1992
990	From box sample: Cut four each specimens parallel and two each perpendicular to rise 1.0 ±.01 X 2.0±.03 X 2.0±.03 in for compressive strength testing. Cut two each 2.0 inch cube specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density, Compressive Strength and Intumescence per BUSS-001, Rev. A. (Rejection Tag ? N/A)		10 QA AUG 19 1992

Op#	MAI		S/N: S-8929-002	SHOP/DATE	INSP/DATE
100		OK TO PROCEED WITH FOAMING INCREMENT #2			8 AUG 19 1992
110		Verify limiter's wall temperature is between 55 and 85°F and record (71 °F) Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note; Consistency of Unit and Box Sample rise height is very important.		GUY SHANKS 8-19-92	10 AUG 19 1992
120		Record increment #2 crest height and pour weight on page 3.		GUY SHANKS 8-20-92	8 AUG 20 1992
130		From box sample: Cut four each specimens parallel and two each perpendicular to rise, 1.0±.01 X 2.0±.03 X 2.0±.03 in for compressive strength testing. Cut two each 2.0 inch cube specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density, Compressive Strength and Intumescence per BUSS-001, Rev. A. (Rejection Tag ? N/A)			10 AUG 20 1992
140		OK TO PROCEED WITH FOAMING INCREMENT #3			8 AUG 20 1992
150		Verify limiter's wall temperature is between 55 and 85°F and record (71 °F) Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note; Consistency of Unit and Box Sample rise height is very important.		GUY SHANKS 8-20-92	10 AUG 20 1992
160		Record increment #3 crest height and pour weight on page 3.		GUY SHANKS 8-21-92	8 AUG 21 1992
170		From box sample: Cut four each specimens parallel and two each perpendicular to rise, 1.0±.01 X 2.0±.03 X 2.0±.03 in for compressive strength testing. Cut two each 2.0 inch cube specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density, Compressive Strength and Intumescence per BUSS-001, Rev. A. (Rejection Tag ? N/A)			10 AUG 21 1992
180		FINAL PREPARATION ON UNIT			
190		Trim foam flush to the surface of unit and clean all excess foam from unit.		GUY SHANKS 8-21-92	8 AUG 24 1992
200		Replace 4 each covers on foaming holes using supplied covers and screws.		GUY SHANKS 8-24-92	8 AUG 24 1992

Op# 'UFACTURING INSTRUCTIONS S/N: '29-002 SHOP/DATE INS' 'TE

210 FINAL INSPECTION:

1.) Verify the unit configuration is essentially unchanged from "As Received".
2.) Inspect unit for cleanliness or any damage.
3.) Attach Inspection test records and graphs to copies of this PCR.
4.) Prepare applicable certifications.

8 QA AUG 24 1992

220 POURING AND TESTING RECORD

SN: -002	Date	Increment Weight Lbs.	Pour Rise Height	Flame Test No.	Insp.	Date
Increment No. 1	8-18-92	430 - 3	15.25'	920820-02	10 QA	AUG 20 1992
Increment No. 2	8-19-92	436 - 2	+13.5" = 29.25"	920825-01	10 QA	AUG 25 1992
Increment No. 3	8-20-92	290 - 2	Full	920825-02	10 QA	AUG 25 1992
	Total Weight =	1149 #				

NOTES:

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230 Final Whole Part Foam Weight: 2774 #

240 Final Whole Part Foam Density: 10.54

8 QA AUG 24 1992

8 QA AUG 24 1992

... MANUFACTURING COMPANY
P.O. Box 9097, Tacoma, WA. 984..
(206) 473-5000

COPY 8E202(4..

DATE AUGUST 5, 1992

PHILLIPS SCALE CO., INC.
934 ELLIOTT AVE.
SEATTLE, WA 98119

234-6090

P.O. NUMBER: 3079 CB572

THIS NUMBER MUST APPEAR ON ALL LABELS, PACKING SLIPS & INVOICES

SHIPPING ADDRESS: 4910 BURLINGTON WAY
TACOMA, WA. 98409
DOOR

Send Invoices to: P.O. Box 9097, Tacoma, Wa. 98409

FOB: S/P

TERMS: N 30

ROUTING.

REQ. NO.

☐ PLEASE FURNISH certification that the materials furnished under this order meet all the specifications listed below.

☐ Unless this box is checked, Washington State Sales Tax is not applicable.

TAX REGISTRATION NO. C278036069

ITEM	QUANTITY	DESCRIPTION	SCHEDULE
1		RENTAL OF 5000/LB PLATFORM SCALE, INCLUDING CERTIFICATE OF TRUE & ACCURATE WEIGHT	
2		TRANSPORTATION (BOTH WAYS)	

CONFIRMING ORDER—————— DO NOT DUPLICATE

GPC DC

Purchase order subject to the terms and conditions on the reverse side hereof.

INTERNAL ROUTING:

☐ Plant 1 ☐ Liquids ☐ Office
☐ Cutting ☐ CA

Floyd Henry, Project Sales Engineer

COMPANY APPROVEL , Production: GS Contacts: FPH QA: DBE Date: 92

Nomenclature: BUSS Impact Limiters, Operational Units — Qty Of Parts: 1 each

SJO: 2630

Purchase Order No: 66-7466

Customer: Sandia National Labs

Specification: BUSS-001, Issue: A Drawing: S48929 Issue: A

Serial Number: S48929-001 Start Date: AUG 12 1992 Due Date: Two weeks after Receipt

Op #	MANUFACTURING INSTRUCTIONS	SHOP / DATE	INSP / DATE
000	PREPARATION OF OPERATIONAL UNITS FOR FOAMING		QA 8 P AUG 12 1992
010	Receive BUSS Impact Limiters. Inspect material and dimensions for correct fabrication.		QA 8 P AUG 12 1992
020	Verify that interior surfaces are clean and dry. Inspect for damage.	GUY SHANKS 8-12-92	
030	Limiter Tare (empty) weight: 1,846 lbs. Stamp tare weight on placard.		QA 8 P AUG 12 1992
040	Approve for foaming. PRODUCTION NOTES: Cask Interior cleaning & Exterior Coating per P.O.# Z846CR48C QA 8 P. Foam Batch # 1392 Approved for use 8/14/92 QA 10 P		QA 8 P AUG 12 1992
050	OK TO PROCEED WITH FOAMING INCREMENT #1		
060	Verify limiter's wall temperature is between 55 and 85°F and record (71 °F) Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note: Consistency of Unit and Box Sample rise height is very important.	GUY SHANKS 8-14-92	QA 10 P AUG 14 1992
070	Record increment #1 pour date, crest height, and pour weight on page 3.	GUY SHANKS 8-15-92	QA 8 P ~~SEP~~ AUG 15 1992
090	From box sample: Cut four each specimens parallel and two each perpendicular to rise, for compressive strength testing. Cut two each 2.0 inch cube 1.0±.01 X 2.0±.03 X 2.0±.03 in for compressive strength testing. Identify with increment number and direction of rise. Route specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density, Compressive Strength and Intumescence per BUSS-001, Rev. A. (Rejection Tag ? N/A)		QA 10 P AUG 16 1992

Make all entries in Ink

	TIONS S/N: S48929-001	SHOP/DATE	INS DATE
100	OK TO PROCEED WITH FOAMING INCREMENT #2		8 ~~SEP~~ AUG 1 5 1992
110	Verify limiter's wall temperature is between 55 and 85°F and record (69 °F) Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note: Consistency of Unit and Box Sample rise height is very important.	GUY SHANKS 8-15-92	10 AUG 1 5 1992
120	Record increment #2 crest height and pour weight on page 3.	GUY SHANKS 8-16-92	8 AUG 1 6 1992
130	From box sample: Cut four each specimens parallel and two each perpendicular to rise, 1.0±.01 X 2.0±.03 X 2.0±.03 in for compressive strength testing. Cut two each 2.0 inch cube specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density, Compressive Strength and Intumescence per BUSS-001, Rev. A. (Rejection Tag ? N/A)		10 AUG 1 8 1992
140	OK TO PROCEED WITH FOAMING INCREMENT #3		8 AUG 1 0 1992
150	Verify limiter's wall temperature is between 55 and 85°F and record (73 °F) Pour FRL-3710.75 into unit and into a 7" X 12" X 12" Sample Box from pour stream and identify with increment number and pour date. Note: Consistency of Unit and Box Sample rise height is very important.	GUY SHANKS 8-17-92	10 AUG 1 7 1992
160	Record increment #3 crest height and pour weight on page 3.	GUY SHANKS 8-18-92	8 AUG 1 8 1992
170	From box sample: Cut four each specimens parallel and two each perpendicular to rise, 1.0±.01 X 2.0±.03 X 2.0±.03 in for compressive strength testing. Cut two each 2.0 inch cube specimens for Intumescence test. Identify with increment number and direction of rise. Route Specimens to Quality Assurance for testing. Test specimen Density, Compressive Strength and Intumescence per BUSS-001, Rev. A. (Rejection Tag ? N/A)		10 AUG 1 8 1992
180	FINAL PREPARATION ON UNIT		8 AUG 2 4 1992
190	Trim foam flush to the surface of unit and clean all excess foam from unit.	GUY SHANKS 8-21-92	
200	Replace 4 each covers on foaming holes using supplied covers and screws.	GUY SHANKS 8-24-92	8 AUG 2 4 1992

2100 FINAL INSPECTION:

1.) Verify the unit configuration is essentially unchanged from "As Received".
2.) Inspect unit for cleanliness or any damage.
3.) Attach inspection test records and graphs to copies of this PCR.
4.) Prepare applicable certifications.

QA 8 AUG 24 1992

220 TESTING RECORD

SN: -001	Date	Increment Weight Lbs.	Pour Rise Height	Flame Test No.	Insp.	Date
Increment No. 1	8-14-92	461 - 4	17"	920818-05	QA 10	AUG 18 1992
Increment No. 2	8-15-92	420 - 4	+12" = 29"	920818-06	QA 10	AUG 18 1992
Increment No. 3	8-17-92	290 - 3	Full	920820-01	QA 10	AUG 20 1992
Total Weight =		1140#				

NOTES:

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QA 8 AUG 24 1992

220 Final Whole Part Foam Weight: 3006

230 Final Whole Part Foam Density: 10.64

QA 8 AUG 24 1992

TI 202(5)

IMPACT LIMITER WEIGHTS

Op#	MANUFACTURING INSTRUCTIONS	S/N: 18929-001	SHOP/DATE	INSP./DATE
2100	FINAL INSPECTION: 1.) Verify the unit configuration is essentially unchanged from "As Received". 2.) Inspect unit for cleanliness or any damage. 3.) Attach Inspection test records and graphs to copies of this PCR. 4.) Prepare applicable certifications.			9/8 QA AUG 24 1992

220 TESTING RECORD

SN: -001	Date	Increment Weight Lbs.	Pour Rise Height	Flame Test No.	Insp.	Date
Increment No. 1	8-14-92	461-4	17"	920818-05	9/10 QA	AUG 18 1992
Increment No. 2	8-15-92	420-4	+12" = 29"	920818-06	9/10 QA	AUG 18 1992
Increment No. 3	8-17-92	290-3	Full	920820-01	9/10 QA	AUG 20 1992
Total Weight =		1140#				

NOTES:

9/8 QA AUG 24 1992

220 Final Whole Part Foam Weight: 3006

9/8 QA AUG 24 19

230 Final Whole Part Foam Density: 10.64

Make all entries In Ink

210 FINAL INSPECTION:
1.) Verify the unit configuration is essentially unchanged from "As Received".
2.) Inspect unit for cleanliness or any damage.
3.) Attach Inspection test records and graphs to copies of this PCR.
4.) Prepare applicable certifications.

AUG 2 4 1992

220 POURING AND TESTING RECORD

SN: -002	Date	Increment Weight Lbs.	Pour Rise Height	Flame Test No.	Insp.	Date
Increment No. 1	8-18-92	430 - 3	15.25'	920820-02	10 QA	AUG 2 0 1992
Increment No. 2	8-19-92	436 - 2	+13.5" = 29.25"	920825-01	10 QA	AUG 2 5 1992
Increment No. 3	8-20-92	290 - 2	Full	920825-02	10 QA	AUG 2 5 1992
Total Weight =		1149 #				

NOTES:

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REV O

230 Final Whole Part Foam Weight: 2994 # AUG 2 4 1992

240 Final Whole Part Foam Density: 10.54 AUG 2 4 1992

Appendix B: Visual Inspection Before First Use

BUSS CASK SPARE PARTS

PART No.	DESCRIPTION	LOCATION	QTY	LOCATION	QTY
T99945-000	Port Seal, Metallic W/O-ring SHELF LIFE / USE BEFORE 9/31/97	2101M	6	IOTECH	34
T99945-000	Port Seal, Replacement O-ring only SHELF LIFE / USE BEFORE 9/30/97	2101M	2	IOTECH	2
T99945-000	Port Seal, Spacer	2101M	1	IOTECH	1
T99943-000	Port Seal, Retainer	2101M	2	IOTECH	1
T99946-000	Lid Seal, Metallic W/O-ring SHELF LIFE / USE BEFORE 9/31/97	2101M	3	IOTECH	13
T99946-000	Lid Seal, Replacement O-ring only SHELF LIFE / USE BEFORE 9/30/97	2101M	4	IOTECH	4
T99946-000	Lid Seal, Spacer	2101M	1	IOTECH	0
T99944-000	Lid Seal, Retainer	2101M	1	IOTECH	1
S55861-000	Port Valve Assembly	2101M	0	IOTECH	1
2-024-VO884-75	O-ring, SHELF LIFE/ USE BEFORE 6/30/97	2101M	25	IOTECH	25
2-012-VO884-75	O-ring, SHELF LIFE/ USE BEFORE 3/31/98	2101M	6	IOTECH	6
2-014-VO884-75	O-ring, SHELF LIFE/ USE BEFORE 12/31/97	2101M	6	IOTECH	6
2-114-VO884-75	O-ring, SHELF LIFE/ USE BEFORE 12/31/97	2101M	12	IOTECH	12
KNH82OJ-T	Lid Lift Lug/Bail, Insert	2101M	3	IOTECH	3
S66574-000	Lid Bolts	2101M	8	IOTECH	7
S66574-000	Lid Bolt, Inserts	2101M	7	IOTECH	5

MS20002C24	Lid Bolt, Washers	2101M	11	IOTECH	7
0.50-20X1.12	Port Cover Bolts, SB637, Material	2101M	11	IOTECH	7
TR24446-820	Tape Plug, Inserts	2101M	5	IOTECH	5
MS15795-818	Port Cover Bolt, Washers	2101M	17	IOTECH	7
1.0-12X3.25	Trunnion Bolts, SB637, Material	2101M	8	IOTECH	0
1.0-12X2.37	Lift Lug Bolts, SB637, Material	2101M	2	IOTECH	2
TR24445	Trunnion/Lift Lug, Inserts	2101M	5	IOTECH	5
MS15795-826	Trunnion/Lift Lug, Washers	2101M	3	IOETCH	3
5-HP5ON-SS	Fitting, Plug	2101M	0	IOTECH	1
3-905-VO747-75	O-ring, Leak Test Fitting SHELF LIFE/ USE BEFORE 6/30/95	2101M	22	IOTECH	12
4-5-F5OG5-SS	Fitting, Reducer	2101M	0	IOTECH	1
3-904-VO747-75	O-ring, Leak Test Fitting SHELF LIFE/ USE BEFORE 6/30/98	2101M	10	IOTECH	10
S52563-000	Cask Lid, Jacking Screw	2101M	1	IOTECH	1
S52565-000	Indicator Pin	2101M	1	IOTECH	1
S52566-000	Spring Retainer	2101M	1	IOTECH	1
S52564-000	Jacking Screw Tip	2101M	1	IOTECH	1
KNH1210JMXSP	Lid Lifting Assembly Insert, Jack Screw	2101M	4	IOTECH	3
S86213-000	ROD EYE, Tiedown	2101M	2	IOTECH	2
S48928-000	Fill Gasket, Impact Limiters SHELF LIFE / USE BEFORE 10/95	2101M	4	IOTECH	4

S58938-000	TAPE, Impact Limiter	2101M	2	IOTECH	2
LT15C4-C6-12	Lanyard Assembly	2101M	2	IOTECH	2
MS16995-9	Seal Retainer Screws, Upper/Lower Ports	2101M	6	IOTECH	6
MS16995-47	Seal Retainer Screws, Lid	2101M	6	IOTECH	6
S48958-000	KEY, Cask Body	2101M	1	IOTECH	1
MS24671-54	KEY Bolts	2101M	2	IOTECH	1
TR24446-616	KEY Inserts	2101M	8	IOTECH	2
KNQ-2S	Drain Plug Cover Inserts	2101M	5	IOTECH	4
2-328V0884-75	O-Ring (TEST COVER S94924) SHELF LIFE / USE BEFORE 3/31/96	2101M	3	IOTECH	0
S48955-000	Guide Pin #1	2101M	1	IOTECH	0
S48956-000	Guide Pin #2	2101M	1	IOTECH	0
S51100-000	Guide Pin Nose	2101M	1	IOTECH	1
CL-2-RH	Handle, Revolving	2101M	1	IOETCH	1
MS51831CA103	Insert, Basket Handle	2101M	18	IOTECH	2
NAS1352N5-16	Screws, Basket Handle	2101M	4	IOTECH	2
MS90727-276	Screws, Lifting Fixture Assembly	2101M	2	IOTECH	2
4550-03	Handling Frame, Transfer Ball	2101M	22	IOTECH	0
MS51959-115	Screws, Trunnion Brass Washer	2101M	3	IOTECH	0
AB-24Z-1	ROD END Bearing, Tiedown	2101M	1	IOETCH	0
NAS509-24	JAM NUT; Tiedown, Drilled	2101M	2	IOTECH	0

MS35691-95	JAM NUT, Tiedown Yoke	2101M	2	IOTECH	0
MS16995-71	Screws, Mounting Block Attachment	2101M	2	IOTECH	2
MS16995-82	Screws, Personnel Barrier Assembly	2101M	4	IOTECH	4
MS15795-814	Washers, Personnel Barrier Assembly	2101M	4	IOTECH	4
3/4"-10 X 1.0	Bolts, Impact Limiter Lift Support, SS	2101M	3	IOTECH	3
26S51-5	Stud Assembly, Drain Plug Cover	2101M	2	IOTECH	2
1/2"-20 X 1.5	Bolts, Lid Lift Fixture, Gr 8	2101M	4	IOTECH	4
1/2" FLAT	Washers, Lid Lift Fixture	2101M	4	IOTECH	4
S50064-000	Compression Spring, Basket	2101M	2	IOTECH	0
KNH420J-T	Lid Seal Insert	2101M	3	IOTECH	3
KNCA0440J-T	Port Seal Insert	2101M	3	IOTECH	3
SS-QC8-S-8PF	Quick-Connect Valve, Lower Port	2101M	1	IOTECH	1
S49922-000	Tool, Lid Bolt Insert	2101M	0	IOTECH	1
S94921-000	Tool, Port Valve Assembly, Lower Port	2101M	0	IOTECH	1
S55861-000	Port Valve Assembly, Lower Port	2101M	0	IOTECH	1
S84795-000	Retainer Washer, Quick-Release Pin	2101M	1	IOTECH	1
R35029-000	Surface Refinishing Tool	2101M	0	IOTECH	1
R35029-100	Surface Refinishing Tool	2101M	0	IOTECH	1
R35029-200	Surface Refinishing Tool	2101M	0	IOTECH	1
MS16997-58	Cap Screw, Impact Limiter Fill Cover	2101M	6	IOTECH	6
1-8 X 5-1/2 SS	Bolts, Skid-to-Trailer Tiedown	2101M	6	IOTECH	6

1-8 SS Nuts	*Hex Head, Skid-to Trailer Tiedown*	*2101M*	*6*	*IOTECH*	*6*
1" SS Washers	*Split Lock, Skid-to-Trailer Tiedown*	*2101M*	*6*	*IOTECH*	*6*
1" SS Washers	*Flat, Skid-to Trailer Tiedown*	*2101M*	*12*	*IOTECH*	*12*

The [illegible] components delivered to WHC by SNLA for spare parts

BUSS CASK SPARE PARTS

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
T99945-000	SEAL, DRAIN, METALLIC W/ORING	56	R 8-26	4/23/93	[illegible] DRB
T99945-000	SEAL, REPLACEMENT O-RING ONLY	4	R 8-26	4/23/93	MO. DRB
T99945-000	SEAL, SPACER, PORT	2	R 8-26	4/23/93	MO. DRB
T99943-000	SEAL RETAINER, PORT	3	R 4-23-93	4/23/93	MO. DRB
T99946-000	SEAL, LID, METALLIC W/O-RING	22	R 8-26	4/23/93	MO. DRB
T99946-000	SEAL, REPLACEMENT O-RING ONLY	8	R 8-26	4/23/93	MO. DRB
T99946-000	SEAL, SPACER, LID	1	R 8-26	4/23/93	MO. DRB
T99944-000	SEAL RETAINER, LID	2	R 4-23-93	4/23/93	MO. DRB
S55861-000	PORT VALVE ASSY	1	R 4-23-93	4/23/93	MO. DRB
2-024 V0747	O-RING	50	R 4-23-93	4/23/93	MO. DRB
2-012 V0747	O-RING	12	R 8-26	8-23-93	DRB
2-014 V0747	O-RING	12	R 8-26	8-23-93	DRB
2-114 V0747	O-RING	14	R 8-26	8-23-93	DRB
KNQ820J-T	LID LIFT LUG INSERT				

NOTES/COMMENTS:

BUSS CASK SPARE PARTS

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S66574-000	LID BOLTS	15	R 4-23-93	4/23/93	MG · DRB
S66575-000	LID BOLT INSERTS	14	R 4-23-93	4/23/93	MG · DRB
MS20002C24	LID BOLT WASHERS	18	R 4-23-93	4/23/93	MG · DRB
0.50-20X1.12	DRAIN PLUG BOLTS, SB637, MATL	18	R 8-26 (in 2 BAGS)	8-23-93	DRB
TR24446-820	DRAIN PLUG INSERTS	10	R 8-26	4/23/93	MG · DRB
MS15795-818	DRAIN PLUG BOLT WASKERS	24	R 8-26	8-23-93	DRB
1.0-12X3.25	TRUNNION BOLTS, SB637 MATL	8	R 8-26	8-23-93	DRB
1.0-12X2.37	LIFT LUG BOLTS, SB637 MATL	4	R 8-26	8-23-93	DRB
TR24445	TRUNNION/LIFT LUG INSERTS	10	R 8-26	4/23/93	MG · DRB
MS15795-826	TRUNNION/LIFT LUG WASHERS	6	R 4-23-93	4/23/93	MG · DRB
5-HP50N-SS	FITTING, PLUG	2	R 4-23-93	4/23/93	MG · DRB
3-905 V0747	O-RING	24	R 8-26	8-23-93	DRB
4-5-F50G5-SS	FITTING, REDUCER	2	R 4-23-93	4/23/93	MG · DRB
3-904 V0747	O-RING	24	R 8-26	8-23-93	DRB

NOTES/COMMENTS:

BUSS CASK SPARE PARTS

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S52563-000	LIFTING SCREW, CASK LID	2	R 4-23-93	4/23/93	NB · DRB
S52565-000	INDICATOR PIN	2	R 4-23-93	4/23/93	NB · DRB
S52566-000	SPRING RETAINER	2	R 4-23-93	4/23/93	NB · DRB
S52564-000	LIFTING SCREW TIP	2	R 4-23-93	4/23/93	NB · DRB
KNHIZ103MXSP ~~KNQ8203-T~~	LID LIFTING ASSY INSERT	8	R 8-26	8-23-93	DRB
S86213-000	ROD EYE, TIEDOWN	4	R 8-26	4/23/93	NB · DRB
S48928-000	FILL GASKET	8	R 8-26	8-23-93	DRB
S58938-000	TAPE, IMPACT LIMITER	4	R 8-26	4/23/93	NB · DRB
LT15C4-C6-12	LANYARD ASSY	4	R 4-23-93	4/23/93	NB · DRB
~~S84795-000~~	~~RETAINER-WASHER~~ DELETE DRB				
MS16995-9	SEAL RETAINER SCREW, DRAIN	12	R 8-26	8-23-93	DRB
KNHCA0440J-T	SEAL RETAINER INSERT, DRAIN	—	NA-DELETED		
MS16995-47	SEAL RETAINER SCREW, LID	12	R 8-26	8-23-93	DRB
KNH-420J-T	SEAL RETAINER INSERT, LID	---	NA-DELETED		

NOTES/COMMENTS: ______________________________

8E 3.

BUBB CASK SPARE PARTS

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S48958-000	KEY, CASK BODY	2	R 8-26	4/23/93	MP · DRB
MS24671-54	KEY BOLTS	3	R 8-26	8-23-93	DRB
TR24446-616	KEY INSERTS	10	R 8-26	4/23/93	MP · DRB
KNQ-25	DRAIN PLUG COVER INSERTS	10	R 4-23-93	4/23/93	MP · DRB
2-328V0884-75	O-RING (TEST COVER S94924)	3	R 4-23-93	4/23/93	MP · DRB
S48955-000	GUIDE PIN #1	1	R 4-23-93	4/23/93	MP · DRB
S48956-000	GUIDE PIN #2	1	R 4-23-93	4/23/93	MP · DRB
S51100-000	GUIDE PIN NOSE	2	R 4-23-93	4/23/93	MP · DRB
CL-2-RH	HANDLE, REVOLVING	2	No Records	4/23/93	MP · DRB
13672	EYEBOLT, FORGED W/NUT	2	R 8-26	4/23/93	MP · DRB
MS51831CA103	INSERT, BASKET HANDLE	20	R 8-26	4/23/93	MP · DRB
NAS1352N5-16	SCREW, BASKET HANDLE	6	R 8-26	4/23/93	MP · DRB
MS90727-276	SCREW, LIFTING FIXTURE ASSY	4	R 4-23-93	4/23/93	MP · DRB
– Note –	PAGE 5 ADDED TO THIS	LIST.			

Michael W. Pawlak - WHC - 4/23/93

[illegible] - [illegible] SNLA [illegible]

NOTES/COMMENTS:

BUSS CASK SPARE PARTS

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
4550-03	BALL TRANSFER, HANDLING FRAME	22	R 8-26	8-23-93	DRB
MS51959-115	SCREW, TRUNNION WASHER	3	No Records	8-23-93	DRB
AB-242-1	ROD END BEARING, TIEDOWN	1	R 8-26	8-23-93	DRB
NAS509-24	NUT, JAM, TIEDOWN, DRILLED	2	R 8-26	8-23-93	DRB
MS35691-95	NUT, JAM, TIEDOWN YOKE	2	R 8-26	8-23-93	DRB
MS16995-71	SCREW, MOUNTING BLOCK ATTACH.	4	R 8-26	8-23-93	DRB
MS16995-82	SCREW, BARRIER ASSY	8	R 8-26	8-23-93	DRB
MS15795-814	WASHER, BARRIER ASSY	8	R 8-26	8-23-93	DRB
3/4-10 X 1.0	BOLT, LIMITER LIFT SUPPORT, SS	6	R 8-26	8-23-93	DRB
26S51-5	STUD ASSY, DRAIN PLUG COVER	4	No Records	8-23-93	DRB
1/2-20 x 1.5	LID LIFT FIXTURE BOLT, GR 8	8	R 8-26	8-23-93	DRB
1/2 FLAT	LID LIFT FIXTURE WASHER	8	No Records. Bagged w/bolts	8-23-93	DRB
S50064-000	COMPRESSION SPRING, BASKET	2	R 8-26	8-23-93	DRB

NOTES/COMMENTS:

BUSS CASK ANCILLARY EQUIPMENT

TOOLS, TEST EQUIPMENT, HANDLING EQUIPMENT

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S49072-000	LIFTER (ref pg 8) DRB 5-10-93 -101	1 1	R -101 R -102	4/23/93	DRB / -102 DRB 8-4-93
S49069-000	LIFTING FIXTURE (ref pg 9-10)	2 1	R -102, -103 R -101	4/23/93	DRB / -101 DRB 8-4-93
S48501-000	HANDLING FRAME	1 (-101) R 1 (-102) R		5-10-93 8-4-93	DRB DRB
~~S94963-000~~ S49073-000 DRB 5-23-93	BASKET GUIDE ASSY (ref pg 10)	1 (-02) 1 (-01) R		4-23-93 8-4-93	DRB DRB
S48590-000	LID LIFT FIXTURE -101	1 R 1 (-102) R		4/23/93	DRB / -102 DRB 8-4-93
S52602-000	PALLET W/TIEDOWN HARDWARE	1	R 8-26-93	5-10-93	DRB
S50057-000	BASKET ASSY, 4H (ref pg 4)			5-10-93	DRB
S50058-000	BASKET ASSY, 6H (ref pg 5)			4-23-93	DRB
S50059-000	BASKET ASSY, 12H (ref pg 6)			5-10-93	DRB
1-5/8 x 1-in DRIVE	SOCKET, 12 POINT	1 1		8-4-93 7-26-93	DRB (10 TOUCH) DRB (HAND-CARRY)
R35032-000	HELIUM BACKFILL PLUMBING ASSY	1		4/23/93	DRB
R35032-100	HYDRO TEST PLUMBING ASSY	1		4/23/93	DRB
R35032-200	LID LEAK TEST PLUMBING ASSY	1		4/23/93	DRB
R35032-300	PORT LEAK TEST PLUMBING ASSY	1		4/23/93	DRB
	-CONTINUED ON NEXT PAGE-				

NOTES/COMMENTS:

BUSS CASK ANCILLARY EQUIPMENT

TOOLS, TEST EQUIPMENT, HANDLING EQUIPMENT - CONTINUED

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
BTS-606	HYD. CYLINDER W/PUMP & HOSE	1		4-23-93	DRB RB
122A-10	PRESSURE TRANSDUCER, 0-10T	1	HAND CARRY TO RICHLAND	7-26-93	DRB
122A-1000	PRESSURE TRANSDUCER, 0-1000T	1	HANDCARRY TO RICHLAND	7-26-93	DRB
PDR-D-1	PRESSURE TRANSDUCER READOUT	2	HANDCARRY TO RICHLAND	7-26-93	DRB
5404, TYPE K	THERMOCOUPLE READOUT	2		4/23/93	RG · DRB
AP1030-K	THERMOCOUPLE PROBE	3		4/23/93	RG · DRB
S94924-000	PORT TEST COVER	1	R	4/23/93	RG · DRB
R35028-000	LOAD TEST FIXTURE	1	R 8-26-93	4/23/93	RG · DRB
R35028-100	LOAD TEST FIXTURE	1	R 8-26-93	4/23/93	RG · DRB
6025	TORQUE WRENCH, PROTO, 2000 FT-lb	1	S/N 1392	6/23/93	DRB / RETURNED TO SNLA 8-21-93 DRB
S48955-000	GUIDE PIN #1	1/1		4/23/93	RG · DRB / DRB 8-4-93
S48956-000	GUIDE PIN #2	2/2		4/23/93	RG · DRB / DRB 8-4-93
S51100-000	GUIDE PIN NOSE	3/3		4/23/93	RG · DRB / DRB 8-4-93
	-CONTINUED ON NEXT PAGE-				

NOTES/COMMENTS:

BUSS CASK ANCILLARY EQUIPMENT

TOOLS, TEST EQUIPMENT, HANDLING EQUIPMENT - CONTINUED

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S94963-000	TAPE JOINT REMOVAL TOOL	1 1		4/23/93	RG. DEB / DEB 8-4-93
S94921-000	PORT VALVE ASSEMBLY TOOL	1		8-23-93	DEB
S94922-000	INSERT INSTALLATION TOOL	1		8-23-93	DEB
R35029-000	SURFACE REFINISHING TOOL	1		8-23-93	DEB
R35029-100	SURFACE REFINISHING TOOL	1		8-23-93	DEB
R35029-200	SURFACE REFINISHING TOOL	1		8-23-93	DEB
SS-QCB-S-8PF	QUICK-CONNECT VALVE FITTING	2 1		8-23-93 8-4-93	DEB DEB
1/2-20 X 1.5	LID LIFT FIXTURE BOLTS, GR 8	4 4	R 8-26-93	8-4-93 8-23-93	DEB DEB
1/2 FLAT	LID LIFT FIXTURE WASHERS	4 4	WASHERS PACKED W/BOLTS	8-4-93 8-23-93	DEB DEB
13672-DIAMOND 3/4-10 X 2.0	LIMITER EYEBOLT, FORGED W/NUT	3	R 8-26-93	4/23/93	RG. DEB
~~3/4-10~~	~~LIMITER EYEBOLT NUT~~	~~3~~			
SET OF 5	SILK SCREENS; FOR CASK MARKING	1		8-23-93	DEB
79167	LIFTING BRIDLE, 6FT x 3 LEG	2	R 8-26-93	8-23-93	DEB
No. 1	NEOLUBE LUBRICANT	3	R 8-26-93	8-23-93	DEB

NOTES/COMMENTS:

BUSS CASK ANCILLARY EQUIPMENT

BASKET ASSEMBLY, 4 HOLE REF. DRAWING NO. S50057

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50052-000	BASKET, 4 HOLE (ref pg 7)	1		5-10-93	DCB NKS
S50056-000	BASKET HANDLE ASSY(ref below)	1		5-10-93	DCB NKS
S50064-000	COMPRESSION SPRING	2		5-10-93	DCB NKS
NAS1352N5-16	SCREW, HANDLE ATTACHMENT	4		5-10-93	DCB NKS
	-LAST ITEM ON THIS ASSY-				

BASKET HANDLE ASSEMBLY REF. DRAWING NO. S50056 NOTE: THIS ASSY INSTALLED ON 4 HOLE BASKET

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50061-000	HANDLE GUIDE HOUSING	2		5-10-93	DCB NKS
S50062-000	HANDLE GUIDE	2		5-10-93	DCB NKS
S50065-000	HANDLE, BASKET	1		5-10-93	DCB NKS
S50066-000	HANDLE BRACKET	2		5-10-93	DCB NKS
D13-1250	DOWEL PIN (HOUSING)	2		5-10-93	DCB NKS
D13-1500	DOWEL PIN (HANDLE)	2		5-10-93	DCB NKS
	-LAST ITEM ON THIS ASSY-				

NOTES/COMMENTS:

BE 274(5)

BUSS CASK ANCILLARY EQUIPMENT

BASKET ASSEMBLY, 6 HOLE REF. DRAWING NO. S50058

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50053-000	BASKET, 6 HOLE (ref pg ~~8~~ 7)	1		4/23/93	MB · DRB
S50056-000	BASKET HANDLE ASSY(ref below)	1		4/23/93	MB · DRB
S50064-000	COMPRESSION SPRING	2		4/23/93	MB · DRB
NAS1352N5-16	SCREW, HANDLE ATTACHMENT	4		4/23/93	MB · DRB
	-LAST ITEM ON THIS ASSY-				

BASKET HANDLE ASSEMBLY REF. DRAWING NO. S50056 NOTE: THIS ASSY INSTALLED ON 6 HOLE BASKET

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50061-000	HANDLE GUIDE HOUSING	2		4/23/93	MB · DRB
S50062-000	HANDLE GUIDE	2		4/23/93	MB · DRB
S50065-000	HANDLE, BASKET	1		4/23/93	MB · DRB
S50066-000	HANDLE BRACKET	2		4/23/93	MB · DRB
D13-1250	DOWEL PIN (HOUSING)	2		4/23/93	MB · DRB
D13-1500	DOWEL PIN (HANDLE)	2		4/23/93	MB · DRB
	-LAST ITEM ON THIS ASSY-				

NOTES/COMMENTS:

BUSS CASK ANCILLARY EQUIPMENT

BASKET ASSEMBLY, 12 HOLE REF. DRAWING NO. S50059

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY	
S50054-000	BASKET, 12 HOLE (ref pg 8)	1		5-10-93	DRB	NRS
S50056-000	BASKET HANDLE ASSY(ref below)	1		5-10-93	DRB	NRS
S50064-000	COMPRESSION SPRING	2		5-10-93	DRB	NRS
NAS1352N5-16	SCREW, HANDLE ATTACHMENT	4		5-10-93	DRB	NRS
	-LAST ITEM ON THIS ASSY-					

BASKET HANDLE ASSEMBLY REF. DRAWING NO. S50056 NOTE: THIS ASSY INSTALLED ON 12 HOLE BASKET

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY	
S50061-000	HANDLE GUIDE HOUSING	2		5-10-93	DRB	NRS
S50062-000	HANDLE GUIDE	2		5-10-93	DRB	NRS
S50065-000	HANDLE, BASKET	1		5-10-93	DRB	NRS
S50066-000	HANDLE BRACKET	2		5-10-93	DRB	NRS
D13-1250	DOWEL PIN (HOUSING)	2		5-10-93	DRB	NRS
D13-1500	DOWEL PIN (HANDLE)	2		5-10-93	DRB	NRS
	-LAST ITEM ON THIS ASSY-					

NOTES/COMMENTS:

BASKET, 4 HOLE REF. DRAWING NO. S50052

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50063-000	PIN, BASKET	6		5-10-93	DRB NRS
S52830-000	CAPSULE SUPPORT	4		5-10-93	DRB NRS
MS51831CA103	INSERT, HANDLE BOLT	4		5-10-93	DRB NRS
	-LAST ITEM ON THIS ASSY-				

BASKET, 6 HOLE REF. DRAWING NO. S50053

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50063-000	PIN, BASKET	6		4/23/93	HB · DRB
S52830-000	CAPSULE SUPPORT	6		4/23/93	HB · DRB
MS51831CA103	INSERT, HANDLE BOLT	4		4/23/93	HB · DRB
	-LAST ITEM ON THIS ASSY-				

NOTES/COMMENTS:

BUSS CASK ANCILLARY EQUIPMENT

BASKET, 12 HOLE REF. DRAWING NO. S50054

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50063-000	PIN, BASKET	8		5-10-93	DRB NRS
S52830-000	CAPSULE SUPPORT	12		5-10-93	DRB NRS
MS51831CA103	INSERT, HANDLE BOLT	4		5-10-93	DRB NRS
	-LAST ITEM ON THIS ASSY-				

LIFTER (HORIZONTAL) REF. DRAWING NO. S49072 FIXTURE SERIAL NO. ~~-102~~ -101 DRB

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
MS17985C1635	QUICK-RELEASE PIN	2	R	4/23/93	MG DRB
(CL-16-BLPT-7.50-5)					

LIFTER (HORIZONTAL) REF. DRAWING NO. S49072 FIXTURE SERIAL NO. -102

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
MS17985C1635	QUICK-RELEASE PIN	2	SER NOS. -01 & -02	8-4-93	DRB

NOTES/COMMENTS:

BUSS CASK ANCILLARY EQUIPMENT

LIFTING FIXTURE (VERTICAL) REF. DRAWING NO. S49069 **FIXTURE SERIAL NO.** -102

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S49070-000	STRONGBACK	1	R	4/23/93	MG DRB
S49071-000	HOOK	2	R	4/23/93	MG DRB
S58999-000	LEG, STANDOFF	1	R	4/23/93	MG DRB
MS90727-276	HOOK ATTACHMENT BOLT	4	R	4/23/93	MG DRB
MS90728-230	LEG ATTACHMENT BOLT	2	R	4/23/93	MG DRB

LIFTING FIXTURE (VERTICAL) REF. DRAWING NO. S49069 **FIXTURE SERIAL NO.** -103

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S49070-000	STRONGBACK	1	R	4/23/93	MG DRB
S49071-000	HOOK	2	R	4/23/93	MG DRB
S58999-000	LEG, STANDOFF	1	R	4/23/93	MG DRB
MS90727-276	HOOK ATTACHMENT BOLT	4	R	4/23/93	MG DRB
MS90728-230	LEG ATTACHMENT BOLT	2	R	4/23/93	MG DRB

NOTES/COMMENTS:

BUSS CASK ANCILLARY EQUIPMENT

LIFTING FIXTURE (VERTICAL) REF. DRAWING NO. S49069 **FIXTURE SERIAL NO.** -101

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S49070-000	STRONGBACK	1		8-4-93	DRB
S49071-000	HOOK	2		8-4-93	DRB
S58999-000	LEG, STANDOFF	1		8-4-93	DRB
MS90727-276	HOOK ATTACHMENT BOLT	4		8-4-93	DRB
MS90728-230	LEG ATTACHMENT BOLT	2		8-4-93	DRB

BASKET GUIDE ASSEMBLY REF. DRAWING NO. S49073 **FIXTURE SERIAL NO.** -02

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S49074-000	GUIDE, BASKET	1		4-23-93	DRB
S49075-000	HANDLE	1		4-23-93	DRB
1/2-13 X 1.0	HANDLE BOLTS (5/8 SHOULDER)	2		4-23-93	DRB

BASKET GUIDE ASSEMBLY REF. DRAWING NO. S49073 **FIXTURE SERIAL NO.** -01

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S49074-000	GUIDE, BASKET	1		8-4-93	DRB
S49075-000	HANDLE	1		8-4-93	DRB
1/2-13 X 1.0	HANDLE BOLTS (5/8 SHOULDER)	2		8-4-93	DRB

NOTES/COMMENTS: [signature] - WHC - 4/23/93
[signature] - SNLA 6643 4-23-93

SHIPPE TO I.T. TECH, INC.
SHIPPER # A03950

TOOLS, TEST EQUIPMENT, HANDLING EQUIPMENT

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S49072-000	LIFTER (ref pg 8)	1	-102	8-4-93	DRB
S49069-000	LIFTING FIXTURE (ref pg 9-10)	1	-101	8-4-93	DRB
S48501-000	HANDLING FRAME	1	-102	8-4-93	DRB
S94963-000	BASKET GUIDE ASSY (ref pg 10)	1	-01	8-4-93	DRB
S48590-000	LID LIFT FIXTURE	1	-102	8-4-93	DRB
S50057-000	BASKET ASSY, 4H (ref pg 4)				
S50058-000	BASKET ASSY, 6H (ref pg 5)				
S50059-000	BASKET ASSY, 12H (ref pg 6)				
5/8 x 1-IN DRIVE	SOCKET, 12 POINT	1		8-4-93	DRB
R35032-000	HELIUM BACKFILL PLUMBING ASSY				
R35032-100	HYDRO TEST PLUMBING ASSY				
R35032-200	LID LEAK TEST PLUMBING ASSY				
R35032-300	PORT LEAK TEST PLUMBING ASSY				
	-CONTINUED ON NEXT PAGE-				

NOTES/COMMENTS: THESE ITEMS ADDED TO ORIGINAL LIST, DOCUMENT NO. 8E274, STARTED ON 4-23-93

TOOLS, TEST EQUIPMENT, HANDLING EQUIPMENT - CONTINUED

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
BTS-606	HYD. CYLINDER W/PUMP & HOSE				
122A-10	PRESSURE TRANSDUCER, 0-10T				
122A-1000	PRESSURE TRANSDUCER, 0-1000T				
PDR-D-1	PRESSURE TRANSDUCER READOUT				
5404, TYPE K	THERMOCOUPLE READOUT				
AP1030-K	THERMOCOUPLE PROBE				
S94924-000	PORT TEST COVER				
R35028-000	LOAD TEST FIXTURE				
R35028-100	LOAD TEST FIXTURE				
S48955-000	GUIDE PIN #1	1		8-4-93	DRB
S48956-000	GUIDE PIN #2	2		8-4-93	DRB
S51100-000	GUIDE PIN NOSE	3		8-4-93	DRB
	-CONTINUED ON NEXT PAGE-				

NOTES/COMMENTS: THESE ITEMS ADDED TO ORIGINAL LIST, DOCUMENT NO. BE274, STARTED 4-23-93

BUSS CASK ANCILLARY EQUIPMENT

TOOLS, TEST EQUIPMENT, HANDLING EQUIPMENT - CONTINUED

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S94963-000	TAPE JOINT REMOVAL TOOL	1		8-4-93	DRB
S94921-000	PORT VALVE ASSEMBLY TOOL				
S94922-000	INSERT INSTALLATION TOOL				
R35029-000	SURFACE REFINISHING TOOL				
R35029-100	SURFACE REFINISHING TOOL				
R35029-200	SURFACE REFINISHING TOOL				
SS-QCB-S-8PF	QUICK-CONNECT VALVE FITTING	1		8-4-93	DRB
1/2-20 X 1.5	LID LIFT FIXTURE BOLTS, GR 8	4		8-4-93	DRB
1/2 FLAT	LID LIFT FIXTURE WASHERS	4		8-4-93	DRB
3/4-10 X 2.0	LIMITER EYEBOLT, FORGED				
3/4-10	LIMITER EYEBOLT NUT				

NOTES/COMMENTS:

BASKET ASSEMBLY, 4 HOLE REF. DRAWING NO. S50057

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50052-000	BASKET, 4 HOLE (ref pg 7)				
S50056-000	BASKET HANDLE ASSY(ref below)				
S50064-000	COMPRESSION SPRING				
NAS1352N5-16	SCREW, HANDLE ATTACHMENT				
	-LAST ITEM ON THIS ASSY-				

BASKET HANDLE ASSEMBLY REF. DRAWING NO. S50056 NOTE: THIS ASSY INSTALLED ON 4 HOLE BASKET

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50061-000	HANDLE GUIDE HOUSING				
S50062-000	HANDLE GUIDE				
S50065-000	HANDLE, BASKET				
S50066-000	HANDLE BRACKET				
D13-1250	DOWEL PIN (HOUSING)				
D13-1500	DOWEL PIN (HANDLE)				
	-LAST ITEM ON THIS ASSY-				

NOTES/COMMENTS: ______________________________

BUSS CASK ANCILLARY EQUIPMENT

BASKET ASSEMBLY, 6 HOLE REF. DRAWING NO. S50058

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50053-000	BASKET, 6 HOLE (ref pg 5)				
S50056-000	BASKET HANDLE ASSY(ref below)				
S50064-000	COMPRESSION SPRING				
NAS1352N5-16	SCREW, HANDLE ATTACHMENT				
	-LAST ITEM ON THIS ASSY-				

BASKET HANDLE ASSEMBLY REF. DRAWING NO. S50056 NOTE: THIS ASSY INSTALLED ON 6 HOLE BASKET

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50061-000	HANDLE GUIDE HOUSING				
S50062-000	HANDLE GUIDE				
S50065-000	HANDLE, BASKET				
S50066-000	HANDLE BRACKET				
D13-1250	DOWEL PIN (HOUSING)				
D13-1500	DOWEL PIN (HANDLE)				
	-LAST ITEM ON THIS ASSY-				

NOTES/COMMENTS: ____________________

BASKET ASSEMBLY, 12 HOLE REF. DRAWING NO. S50059

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50054-000	BASKET, 12 HOLE (ref pg 8)				
S50056-000	BASKET HANDLE ASSY(ref below)				
S50064-000	COMPRESSION SPRING				
NAS1352N5-16	SCREW, HANDLE ATTACHMENT				
	-LAST ITEM ON THIS ASSY-				

BASKET HANDLE ASSEMBLY REF. DRAWING NO. S50056 NOTE: THIS ASSY INSTALLED ON 12 HOLE BASKET

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50061-000	HANDLE GUIDE HOUSING				
S50062-000	HANDLE GUIDE				
S50065-000	HANDLE, BASKET				
S50066-000	HANDLE BRACKET				
D13-1250	DOWEL PIN (HOUSING)				
D13-1500	DOWEL PIN (HANDLE)				
	-LAST ITEM ON THIS ASSY-				

NOTES/COMMENTS:

BASKET, 4 HOLE REF. DRAWING NO. S50052

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50063-000	PIN, BASKET				
S52830-000	CAPSULE SUPPORT				
MS51831CA103	INSERT, HANDLE BOLT				
	-LAST ITEM ON THIS ASSY-				

BASKET, 6 HOLE REF. DRAWING NO. S50053

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50063-000	PIN, BASKET				
S52830-000	CAPSULE SUPPORT				
MS51831CA103	INSERT, HANDLE BOLT				
	-LAST ITEM ON THIS ASSY-				

NOTES/COMMENTS: ______

BUSS CASK ANCILLARY EQUIPMENT

BASKET, 12 HOLE REF. DRAWING NO. S50054

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S50063-000	PIN, BASKET				
S52830-000	CAPSULE SUPPORT				
MS51831CA103	INSERT, HANDLE BOLT				
	-LAST ITEM ON THIS ASSY-				

LIFTER (HORIZONTAL) REF. DRAWING NO. S49072 FIXTURE SERIAL NO.

MS17985C1635	QUICK-RELEASE PIN				

LIFTER (HORIZONTAL) REF. DRAWING NO. S49072 FIXTURE SERIAL NO. -102

MS17985C1635	QUICK-RELEASE PIN	2	SER. NOS. -01 + -02	8-4-93	DRB
CL-16-BLPT-	3.50-S)				

NOTES/COMMENTS: THESE ITEMS ADDED TO ORIGINAL LIST, DOCUMENT NO. 8E274, STARTED ON 4-23-93.

LIFTING FIXTURE (VERTICAL) REF. DRAWING NO. S49069 **FIXTURE SERIAL NO.** ____________

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S49070-000	STRONGBACK				
S49071-000	HOOK				
S58999-000	LEG, STANDOFF				
MS90727-276	HOOK ATTACHMENT BOLT				
MS90728-230	LEG ATTACHMENT BOLT				

LIFTING FIXTURE (VERTICAL) REF. DRAWING NO. S49069 **FIXTURE SERIAL NO.** ____________

S49070-000	STRONGBACK				
S49071-000	HOOK				
S58999-000	LEG, STANDOFF				
4S90727-276	HOOK ATTACHMENT BOLT				
4S90728-230	LEG ATTACHMENT BOLT				

)TES/COMMENTS: ____________

BUSS CASK ANCILLARY EQUIPMENT

LIFTING FIXTURE (VERTICAL) REF. DRAWING NO. S49069 FIXTURE SERIAL NO. -101

PART NUMBER	DESCRIPTION	QTY.	PKG/SHIPPED	DATE	VERIFIED BY
S49070-000	STRONGBACK	1		8-4-93	DRB
S49071-000	HOOK	2		8-4-93	DRB
S58999-000	LEG, STANDOFF	1		8-4-93	DRB
MS90727-276	HOOK ATTACHMENT BOLT	4		8-4-93	DRB
MS90728-230	LEG ATTACHMENT BOLT	2		8-4-93	DRB

BASKET GUIDE ASSEMBLY REF. DRAWING NO. S49073 FIXTURE SERIAL NO.

S49074-000	GUIDE, BASKET				
S49075-000	HANDLE				
1/2-13 X 1.0	HANDLE BOLTS (5/8 SHOULDER)				

BASKET GUIDE ASSEMBLY REF. DRAWING NO. S49073 FIXTURE SERIAL NO. -01

S49074-000	GUIDE, BASKET	1		8-4-93	DRB
S49075-000	HANDLE	1		8-4-93	DRB
1/2-13 X 1.0	HANDLE BOLTS (5/8 SHOULDER)	2		8-4-93	DRB

NOTES/COMMENTS: THESE ITEMS ADDED TO ORIGINAL LIST, DOCUMENT NO. 8E274, STARTED ON 4-23-93

IMPACT LIMITER INSPECTION

Impact Limiter Inspection is performed upon BUSS Cask receipt at the IOTECH Facility, verification that no damage has occurred during transportation is performed in accordance with WHC Inspection Plan No. WI-NRS-1293-115, Item # 4. See Attachment

WHC INSPECTION PLAN	JCS NO. N/A	PAGE 1 of 6
	IMPACT LEVEL [ ] D [ ] E [ ] S [X] Q	SAFETY CLASS

ITEM/DESCRIPTION	DWG/SPEC NO.	REV	ECN NO.
BUSS Cask SARP Quality Assurance Check Points	SAND83-0698 TCC-0430	4	N/A
WHC Quality Assurance Check Points during Loading Operations at IOTECH	WI-NRS-1293-115		N/A

Location	Initiated by:	Date	Cog. Engineer	Date
IOTECH Facility Northglenn, Co	D. D. McAfee C A Colun for	4/20/94	P. T. Saueressig Paul T Saueressig	04/20/94

NOTE: Notify QC prior to start of work for each HOLD or WITNESS point !

No.	Inspection Step	H/W/V	NCR	QC Sign/Stamp
1	Verify the documents are available for the the following tests (Note: Sandia National Laboratories has a NQA1 quality assurance program in place for verification that the documented test results met the test criteria): • helium leak test, • structural integrity during first hydrostatic leak test, • radiation shielding criteria (inspection item number 25, WHC will supply the required documentation). • Thermal design criteria, and (Attach copy of letter documenting completion of acceptance testing).	V		
2	Verify the acceptance criteria of the periodic inspections described in Table 8.2-1, Chapter 8 are met. (Attach copy of the table and a letter documenting completion of periodic inspections and listed expiration date).	V		
3	Verify a copy of the acceptance test and periodic inspections for the BUSS cask are maintained at the IOTECH facility.	V		
4	Verify that no damage occurred to the impact limiters during transport to IOTECH. (Inspect only for obvious damage such as dents)	V		

WHC INSPECTION PLAN	JCS NO. N/A	PAGE 2 of 6
	IMPACT LEVEL ☐ D ☐ E ☐ S ☒ Q	SAFETY CLASS N/A

NOTE: Notify QC prior to start of work for each HOLD or WITNESS point !

No.	Inspection Step	H/W/V	NCR	QC Sign/Stamp
5	Verify the sixteen hole basket is placed in the BUSS cask for loading with cesium capsules.	V		
6	Verify the upper port bore (radiation shield) plug is installed in the upper port hole.	V		
7	Verify the capsule identification numbers for the capsules loaded into the BUSS cask sixteen hole basket. (Attach copy of RUST source loading sheet, WI-NRS-1293-115).	V		
8	Verify the small ring gauge testing of the source capsules prior to loading in the BUSS cask (Attach copy of RUST data sheet, WI-NRS-1293-115).	V		
9	Verify the clunk testing of the source capsules prior to loading in the BUSS cask (Attach copy of RUST source loading data sheet, WI-NRS-1293-115).	V		
10	Verify the wattage and curie (decayed to shipment window) content obtained from the Westinghouse Hanford Company (WHC) Encapsulation Database System (EDS) are for the capsules loaded into the BUSS cask and are consistent with the shipping papers (Attach copies of the EDS listing and shipping papers).	V		
11	Verify the wattage obtained from the WHC EDS for the capsules loaded in the BUSS cask is less than 4000 watts (Attach copy of WHC EDS data).	V		

WHC INSPECTION PLAN	JCS NO. N/A	PAGE 3 of 6
	IMPACT LEVEL [ ] D [ ] E [ ] S [X] Q	SAFETY CLASS N/A

NOTE: Notify QC prior to start of work for each HOLD or WITNESS point !

No.	Inspection Step	H/W/V	NCR	QC Sign/Stamp
12	Verify the following preparations of the BUSS cask: • drained of water, • dried (no visual moisture/dry to the touch, • backfilled with helium.	V		
13	Witness the installation of the lid bolts and the final torquing value of 1250 ft-lbs. NOTE: Assure that no bolt movement occurs during the final torquing sequence. If bolt movement occurs perform an additional torque sequence. Bolt movement occurred [ ] No [ ] Yes	W		
14	Verify the serial number and the expiration date of the torque wrench used to install the lid bolts. Serial Number:____________ Expiration Date:__________________	V		
15	Witness the installation of the upper and lower port bolts and the final torquing value of 60 ft-lbs.	W		
16	Verify the serial number and the expiration date of the torque wrench used to install the port bolts. Serial Number:____________ Expiration Date:__________________	V		

WHC INSPECTION PLAN	JCS NO. N/A IMPACT LEVEL ☐ D ☐ E ☐ S ☒ Q	PAGE 4 of 6 SAFETY CLASS N/A

NOTE: Notify QC prior to start of work for each HOLD or WITNESS point !

No.	Inspection Step	H/W/V	NCR	QC Sign/Stamp
17	Verify leak tightness for the sum of the three BUSS cask seals is less than 1.0×10^{-4} atm-cc/sec leak rate obtained from the NonDestructive Examination (NDE) [Attach a copy of the NDE test report]	V		
18	Verify the leak rate standard used is no greater than 5.0×10^{-6} atm-cc/sec and is documented on the NDE test report and is current.	V		
19	Verify mass spectrometer system sensitivity is documented on the NDE test report at less than 5.0×10^{-6} atm-cc/sec.	V		
20	Verify the installation of the upper and lower impact limiter tapes.	V		
21	Verify the installation of the four turnbuckle assemblies between the upper and lower impact limiters.	V		
22	Verify the installation of the tamper seals on the impact limiter tape plugs.	V		
23	Verify the installation of the four turnbuckle assemblies securing the BUSS cask to the trailer (skid assembly).	V		
24	Verify the installation of the personnel barrier by bolting the upper section of the barrier to the lower section of the barrier.	V		
25	Verify the completion of the radiation and contamination surveys for the exterior surface of the BUSS cask (Attach copies of surveys from RUST loading procedures).	V		

WHC INSPECTION PLAN	JCS NO. N/A	PAGE 5 of 6
	IMPACT LEVEL ☐ D ☐ E ☐ S ☒ Q	SAFETY CLASS N/A

NOTE: Notify QC prior to start of work for each HOLD or WITNESS point !

No.	Inspection Step	H/W/V	NCR	QC Sign/Stamp
	Radiation surveys meet the radiation level limits of 49 CFR 173.441 and the SARP: • less than 200 mrem/hr on the external surface of the package, • less than 10 mrem/hr two meters from the external surface of the package, and Contamination surveys meet the contamination control limits of 49 CFR 173.443 for non-fixed (smearable) contamination on the external surfaces of the cask: • less than 22 dpm/cm^2 beta-gamma, and • less than 2.2 dpm/cm^2 alpha Contamination surveys are taken as described in 49 CFR 173.443. NOTE: Steps 26 through 30 are for documentation retention and do not require completion prior transporting of the BUSS cask.			
26	Obtain the original RUST loading procedures listed below and attach to this inspection plan. WI-NRS-1293-112 WI-NRS-1293-113 WI-NRS-1193-108 WI-NRS-1293-114 WI-NRS-1293-115 WI-NRS-1293-116 WI-NRS-1293-117 WI-NRS-1193-118	H		
27	Verify completion of all data within the RUST loading procedures from inspection item 26.	V		
28	Obtain a copy of the drivers packet and attach to this inspection plan.	H		

WHC INSPECTION PLAN	JCS NO. N/A	PAGE 6 of 6
	IMPACT LEVEL ☐ D ☐ E ☐ S ☒ Q	SAFETY CLASS N/A

NOTE: Notify QC prior to start of work for each HOLD or WITNESS point !

No.	Inspection Step	H/W/V	NCR	QC Sign/Stamp
29	Obtain a copy of the data sheets for unloading the BUSS cask, inspection of the capsules and storing of the capsules in the WESF storage pools and attach to this inspection plan. EO-100-023, Unload BUSS Cask EO-100-012, Operate Go-No Go Gage and Examine Capsules EO-906-003, Transfer and Store Capsules	H		
30	Verify completion of all data within WESF operating procedures from inspection item 29.	V		

WHC INSPECTION PLAN	JCS NO. N/A	PAGE 1 of 6
	IMPACT LEVEL: [ ] D [ ] E [ ] S [X] O	SAFETY CLASS

ITEM/DESCRIPTION	DWG/SPEC NO.	REV	ECN NO.
BUSS Cask SARP Quality Assurance Check Points	SAND83-0698 TCC-0430	4	N/A
WHC Quality Assurance Check Points during Loading Operations at IOTECH	WI-NRS-1293-115		N/A

Location	Initiated by:	Date	Cog. Engineer	Date
IOTECH Facility Northglenn, Co	D. D. McAfee D D McAfee	5/2/94	P. T. Saueressig for PTS	5/2/94

NOTE: Notify QC prior to start of work for each HOLD or WITNESS point !

No.	Inspection Step	H/W/V	NCR	QC Sign/Stamp
1	Verify the documents are available for the the following tests (Note: Sandia National Laboratories has a NQA1 quality assurance program in place for verification that the documented test results met the test criteria): • helium leak test, • structural integrity during first hydrostatic leak test, • radiation shielding criteria (inspection item number 26, WHC will supply the required documentation). • Thermal design criteria, and (Attach copy of letter documenting completion of acceptance testing).	V		T.W. Thompson 5/9/94
2	Verify the acceptance criteria of the periodic inspections described in Table 8.2-1, Chapter 8 are met. (Attach copy of the table and a letter documenting completion of periodic inspections and listed expiration date).	V		T.W. Thompson 5/9/94
3	Verify a copy of the acceptance test and periodic inspections for the BUSS cask are maintained at the IOTECH facility.	V		T.W. Thompson 5/9/94
4	Verify that no damage occurred to the impact limiters during transport to IOTECH. (Inspect only for obvious damage such as dents)	V		T.W. Thompson 5/9/94

Appendix C: Pressure Tests

8E176

date: January 11, 1993

to: E. R. Yoshimura, 6642

DRBronowski

from: David Bronowski, 6643

subject: Performance of BUSS cask hydrostatic and leak tests.

Following is a description of the processes followed to perform the annual/fabrication tests of the BUSS cask.

The disassembled cask lid and body were thoroughly cleaned. This included cleaning the lid bolt insert holes with alcohol and cotton swabs and then flushing the holes with deionized water to remove all debris. The cask payload cavity was dried and then wiped down with wipers dampened with denatured alcohol. No basket was installed.

The cask lid and port covers were assembled with new Helicoflex seals from the latest order received (PO# AD4059). The port covers used for the tests were the pair recently fabricated (PO# TD1623). One port cover (serial no. 01) was installed on the upper port of the cask per the operating manual procedure.

Hydrostatic Test

The cask was filled with deionized water to within 6 inches of the lid seal surface (approximately 35 gallons). This fill height at the approximate centerline of the upper port penetration in the cask cavity.

The cask lid was lowered, expelling the excess water. More water was expelled as the lid jack screws were retracted. The lid bolts were lubricated and installed. (Note: only slight resistance was felt as a result of the water in the insert holes. No problem with hydraulic lock-up.) The lid bolts were tightened to 50 ft-lb following the sequence in the operating manual. Torqued the bolts to 100, 200, then 600 ft-lbs.

Before torquing to the final 1125 ft-lb valves, one of the lid leak test fitting plugs were removed. Pressurized water was expelled. At this point the hydrostatic test plumbing assembly (part no. R35032-100 and a pump) was installed. Installation was difficult due to pressure in the payload cavity.

The lid bolts were tightened to the final torque of 1125 ft-lb per the operating manual procedure.

CAM

The hydrostatic test was then performed per the maintenance manual with satisfactory results. Test documentation is on the attached hydrostatic test data sheet.

Next the cask was prepared for the helium leak test of the containment boundary. This involved removing the water from the cask without disassembling the lid or upper port cover, as this would have required the use of another seal(s) upon reassembly.

The quick connect fitting assembly was removed from the lower port to allow the water to drain out (using a mating fitting to open the valve did not allow water to drain). The payload cavity was then pumped out with a vacuum pump with a liquid nitrogen cold trap in the line. Pumping time was approximately 45 minutes to remove the water.

<u>Assembled Containment Boundary Leak Test</u>

The cask was placed on two timbers to raise off the floor. The entire cask was "bagged" in preparation for the helium leak test. The bag consisted of a cylindrical shaped tent of heavy gage plastic approximately 56 inches in diameter and 48 inches tall. The helium backfill plumbing assembly (part no. R35032-000) was used to connect the leak detector to the lower port quick-connect valve. One line to a helium supply and another line to a large vacuum pump were placed under the bag. The bottom edge of the bag was then taped to the floor.

The containment boundary leak test was then performed with satisfactory results (data sheet attached). Permeation was noted during the test and is due to the elastomeric o-rings in the lower port quick-connect fitting assembly. The bag was removed after the test.

<u>Lid Seal Leak Test</u>

The lid test plumbing assembly (part no. R35032-300) was used to connect the leak detector to one of the lid leak test port fittings. The helium backfill plumbing assembly (part no. R35032-000) was installed in the lower port fitting and connected to the vacuum pump, pressure transducer, and helium supply. The test was conducted for a period of five minutes after completing the helium backfill (backfilling took 2 minutes). There was no detectable leak in this seal. Data sheets are attached. The helium was removed from the payload cavity after the test.

Upper Port Seal Leak Test

The port test plumbing assembly (part no. R35032-200) was used to connect the leak detector to one of the lid leak test port fittings. The helium backfill plumbing assembly (part no. R35032-000) was installed in the lower port fitting and connected to the vacuum pump, pressure transducer, and helium supply.

The test was conducted for a period of five minutes after completing the helium backfill (backfilling took 1 minute). There was no detectable leak in this seal. Data sheets are attached. The helium was removed from the payload cavity after the test.

Lower Port Seal Leak Test

The upper port cover was removed and the test port cover, part no. S94924, was installed in its place. The helium backfill plumbing assembly, part no. R35032-000 was attached the the quick connect fitting in this cover.

A port cover was assembled for use on the lower cask port using the remaining cover from PO# TD1623 (serial no. 02) and a new seal from PO# AD4059. The quick-connect valve assembly was removed from the lower port of the cask and the port cover installed per the operations manual procedure.

The test was conducted for a period of five minutes after completing the helium backfill (backfilling took 1 minute). There was no detectable leak in this seal. Data sheets are attached. The helium was removed from the payload cavity after the test.

Copy w/enclosures: BUSS Cask File

STRUCTURAL PRESSURE TEST DATA SHEET

Test Date: 12-22-92 Cask Serial No. USA/9511/B

Hydro Pump Type: X Manual ____ Power Operated

Hydro Pump Mfg. DAYTON Co Model No. 4Z480

Pressure Gage Mfg. U.S. GAUGE Serial No. 090792

Cal Expiration Date: 2-1-93 Gage Resolution 1 PSIG

New seals in lid and upper port cover? DRB (initials)

Cavity filled with demin/deion water? DRB

Lid and upper port cover bolts properly tightened? DRB

Water at thermal equilibrium (min T = 2 hours) DRB

Cavity pressure 76 PSIG (INDICATED) psig (min. test P = 75 psig)

Test start time 08:53

Test end time 09:25

Test pressure held for 32 minutes (min. T = 30 minutes)

Cavity pressure at end of test 75 PSIG

Pressure decay 1 PSIG

Final Disposition:

Acceptable ____ Unacceptable X

Comments: SUSPECT THAT THE PRESSURE INCREASE MAY HAVE CAUSED AN INCREASE IN WATER TEMP WHICH THEN COOLED. TEST WILL BE RE-RUN AFTER ALLOWING TO THERMALLY EQUALIZE.

Conducted by: DR Brenneke 12-22-92
Date

Witnessed by: W.G. [signature] 12/22/92
Date

STRUCTURAL PRESSURE TEST DATA SHEET

Test Date: 12-22-92 Cask Serial No. USA/9511/B

Hydro Pum Type: X Manual ____ Power Operated

Hydro Pump Mfg. Dayton Model No. 4Z480

Pressure Gage Mfg. U.S. GAUGE Serial No. 090792

Cal Expiration Date: 2-1-93 Gage Resolution 1PSIG

New seals in lid and upper port cover? DRB (initials)

Cavity filled with demin/deion water? DRB

Lid and upper port cover bolts properly tightened? DRB

Water at thermal equilibrium (min T = 2 hours) ~1/2 HOURS AFTER INITIAL PUMP UP TO 76 PSIG

Cavity pressure 76 (INDICATED) psig (min. test P = 75 psig)

Test start time 10:13

Test end time 10:44

Test pressure held for 31 minutes (min. T = 30 minutes)

Cavity pressure at end of test 76 PSIG

Pressure decay 0

Final Disposition:

Acceptable X Unacceptable ____

Comments: ______

Conducted by: D R Bronowski 12-22-92 Date

Witnessed by: W. G. [illegible] 12/22/92 Date

TRANSDUCER CALIBRATION REPORT
SANDIA LABS 2414 7/21/1992

MANUFACTURER US-GAUGE
MODEL 0-100PSI
SERIAL 090792 DATAFILE # 1
TRANSDUCER TYPE DIAL GAGE
CERTIFIED BY DS
EXPIRATION DATE 2/ 1/1993
TEMPERATURE AMBIENT
FACILITY USED KING
REQUESTING ORG. 6643
COMMENTS: BRONOWSKI...MOUNTED IN VERTICAL POSITION

REFERENCE UNITS PSIG	DIAL GAGE READING	% DEVIATION FULLSCALE
.110896E+02	.10000E+02	-1.090
.207494E+02	.20000E+02	-.749
.308795E+02	.30000E+02	-.880
.409551E+02	.40000E+02	-.955
.508902E+02	.50000E+02	-.890
.608522E+02	.60000E+02	-.852
.710625E+02	.70000E+02	-1.062
.811584E+02	.80000E+02	-1.158
.913257E+02	.90000E+02	-1.326
.101320E+03	.10000E+03	-1.320
.811694E+02	.80000E+02	-1.169
.507841E+02	.50000E+02	-.784
.207808E+02	.20000E+02	-.781
.811861E+02	.80000E+02	-1.186

Appendix D: Leak Tests

LEAK TEST DATA SHEET

Test Date 1-7-93 Cask Serial No. USA/9511/B

Item/Area Tested ASSEMBLED BOUNDARY
(Lid seal, port seal, assembled boundary)

Leak Detector Mfg/Model ALCATEL ASM 110 Serial No. 2100

Pressure Gage Mfg/Model MKS 122AA-01000AB Serial No. 78751-4

Temp Indicator Mfg/Model BECKMAN 412A Serial No. 90040209
THERMOCOUPLES (SERIAL 92103-2 AND 92103-3)

Standard Leak Mfg/Model VARIAN 0981-0221 Serial No. 71F-373

Leak Rate of Standard 8.96 E-8 cc/s STP (20°C, 760 TORR)

Temperature: Standard: 72.9°F 22.7°C Cask: 69.8°F 21.0°C

Temperature Corrected Standard Leak Rate 7.9 E-8 cc/s STP

Leak Detector Background Reading: 0

Leak Detector Calibration Reading: 8.0 E-8

Test Cavity Background Reading: 7.5 E-10

Tracer Gas Cavity Evac Pressure (if applicable) NA

Tracer Gas Backfill Pressure or Flow Rate 4244 TORR / 100 LPM

Start Time: 09:18:30 Leak Detector Reading: 7.5E-10

Stop Time: 09:33:30 Leak Detector Reading: 6.5E-8

Final Calculated Leak Rate: 1.3 E-7 cc/s STP He (FOR 50% CONCENTRATION)
= 6.0 E-8 std cc/s AIR (NIKS REFERENCE)

Final Disposition:

Acceptable X Unacceptable ___

Comments: NO DETECTABLE LEAK FOR ~2 MINUTES, THEN A SLOW INCREASE BEGAN. THIS INCREASE IS BELIEVED TO BE PERMEATION THROUGH THE SMALL O-RINGS IN THE QUICK CONNECT VALVE ASSEMBLY. POST TEST CALIBRATION CHECK = 8.0 E-8; NO CHANGE. SEE ATTACHED SHEETS FOR ADDITIONAL TEST NOTES AND CAL DATA.

Conducted by: [signature] 1-7-93
Date

Witnessed by: [signature] "

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ASSEMBLED BOUNDARY LEAK LOG

7.5×10^{-10}

624.4 TORR = BAR

HE ON AT 0918:30

0918:30	7.5×10^{-10}	100 lpm
19:30	7.5×10^{-10}	
20:00	7.5×10^{-10}	
21:00	9×10^{-10}	
22:00	1.2×10^{-9}	
23:00	2×10^{-9}	
24:00	3.5×10^{-9}	
25:00	4.3×10^{-9}	
26:00	1.0×10^{-8}	
27:00	1.4×10^{-8}	
28:00	2.0×10^{-8}	
28:30	2.3×10^{-8}	10 MIN
29:00	2.7×10^{-8}	
30:00	3.3×10^{-8}	
31:00	4.2×10^{-8}	
32:00	5.0×10^{-8}	
33:00	6.0×10^{-8}	
33:30	6.5×10^{-8}	

ADDITIONAL NOTES:

HELIUM CONCENTRATION VERIFICATION -- THE CASK WAS BAGGED WITH A TENT OF HEAVY PLASTIC SHEET WITH DIMENSIONS OF 56"Ø × 48" HIGH. VOLUME OF THE BAG MINUS THE CASK WAS ~550 LITERS. THE BAG WAS COLLAPSED AGAINST THE CASK USING A VACUUM PUMP, REMOVING INITIAL VOLUME (QUANTITY UNKNOWN, ESTIMATE 50%). AT START OF TEST, TECHNICAL GRADE HELIUM WAS FLOWED INTO THE BAG AT A RATE OF 100 LITERS PER MINUTE, CONTINUING FOR 15 MINUTES. THIS HELIUM FLOW ALLOWED FOR APPROXIMATELY 3 EXCHANGES OF THE ATMOSPHERE IN THE BAG. ASSUMING A 50% CONCENTRATION INCREASE WITH EACH EXCHANGE, THE CONCENTRATION AT THE END OF 15 MINUTES WAS 87%. TO BE CONSERVATIVE, A 50% CONCENTRATION WAS ASSUMED, AND THE MEASURED LEAK RATE WAS DIVIDED BY THE PARTIAL PRESSURE RATIO (0.5).

PRIMARY STANDARDS LABORATORY

CERTIFICATE

Sandia National Laboratories, Albuquerque, New Mexico 87185

File No. 3836

LEAK-HELIUM

Varian
Model No. 0981-F8473-301
Serial No. 71F-373
Property No. None

Submitted by: Organization 6323

Certified: November 19, 1991
Expires: May 19, 1993

TEST RESULTS

At 26.57°C, the helium leak rate is 4.00E-12 moles/s [8.96E-8 cm^3/s STP (0°C, one atm)]. If this gas leak is used at other temperatures (T), a temperature correction must be applied as follows:

$$Q_T = Q_{T1}[1 - A(T - T1)] \quad \text{where } T1 = 26.57°C$$

Temperature Coefficient (A): 0.0352/°C

This temperature correction is applicable if this device is to be used within ±5°C of the reported temperature. If the device is to be used at other temperatures, the Primary Standards Laboratory should be consulted.

The uncertainty in the calibrated leak rate is estimated to be no greater than ±15% of stated value at stated temperature. It is recommended that this leak be allowed to vent while not in use.

Note: Control curve value reported.

Technical Consultant: S. Metzger, 4343

Certified by: F. Burns, 4343

Copy to:
Organization 6323 (2)
4343 File

TRANSDUCER CALIBRATION REPORT

[illegible]

MANUFACTURER MKS

MODEL 122AA-01000AB

SERIAL 78731-4 DATAFILE # 4

TRANSDUCER TYPE DIAL GAGE

CERTIFIED BY FR Gralibzewski EXPIRATION DATE 6/ 1/1990

TEMPERATURE 74 FACILITY USED BARATRON

REQUESTING ORG. 8843

COMMENTS: BRONOWSKI; CAL'D WITH PDR-C-1 SER. 78731-5A;
VERTICAL POS., STEM DOWN; NO ADJUSTMENTS.

REFERENCE UNITS TORR	DIAL GAGE READING	% DEVIATION READING
.500000E-03	.504000E-03	.800
.100000E-03	.100700E-03	.700
.150000E-03	.150500E-03	.333
.200000E-03	.200900E-03	.450
.250000E-03	.251000E-03	.400
.300000E-03	.301100E-03	.367
.350000E-03	.351000E-03	.286
.400000E-03	.401000E-03	.250
.450000E-03	.450300E-03	.067
.500000E-03	.500700E-03	.140
.550000E-03	.550400E-03	.073
.600000E-03	.600300E-03	.050
.650000E-03	.650000E-03	0.000
.700000E-03	.699800E-03	-.029
.750000E-03	.749500E-03	-.067
.800000E-03	.799200E-03	-.100

Standards Laboratory Certificate

Sandia National Laboratories
Albuquerque, New Mexico 87185

File No. 2414

THERMOCOUPLE READOUT
BECKMAN
Model No. 412A
Serial No. 90040209

Submitted by: 6323

Certified: November 25, 1992
Expires: May 25, 1993

This instrument was tested at selected points across its range for compliance to the temperature vs mV values listed in IPTS-68. Tests were preformed for the thermocouple type, range, and accuracy listed below:

Type	Range	Accuracy
K	-100 to 1371 deg C	+ - 0.8 deg C

This instrument was adjusted to be within the above accuracy. It is probable that this instrument will remain within the above accuracy for the certification interval.

Note: This accuracy statement applies only to the above instrument and does not include the thermocouple used in your measurement.

Metrologist: J. J. LaMarr, 2414

Georgia Brown

Certified by: J. M. Simons, 2414

TLCL/JJL
5/12/92

Standards Laboratory Certificate

Sandia National Laboratories
Albuquerque, New Mexico 87185

THERMOCOUPLE
ATTACHED TO CASK

File No. 4148

THERMOCOUPLE TYPE K
UNKOWN

Model No.	20' PROBE
Serial No.	92108-2
Submitted by:	6643
Certified:	May 7, 1992
Expires:	May 7, 1993

Tests preformed over the temperature range of -95 to 550 deg F show this thermocouple to be in agreement within +/-(4 dig F or .4% of rdg) of the values published in IPTS-68.

Under normal use conditions it is probable this thermocouple will remain within the above accuracies for the certification interval.

Metrologist: J. J. LaMarr, 0414

Certified by: R. L. Crabb, 0414

tlc29:JJL
1/30/92

Standards Laboratory Certificate

Sandia National Laboratories
Albuquerque, New Mexico 87185

THERMOCOUPLE
ATTACHED TO LEAK STD.

File No. 4149

THERMOCOUPLE TYPE K
UNKNOWN
Model No. 20' PROBE
Serial No. 92108-3

Submitted by: 6643

Certified: May 7, 1992
Expires: May 7, 1993

Tests preformed over the temperature range of -95 to 650 deg F show this thermocouple to be in agreement within +/-(4 deg F or .4% of rdg) of the values published in IPTS-68.

Under normal use conditions it is probable this thermocouple will remain within the above accuracies for the certification interval.

Metrologist: J. J. LaMarr, 2414

Certified by: R. L. Crabb, 2414

tlc29:JJL
1/30/92

LEAK TEST DATA SHEET

Test Date 1-7-93 Cask Serial No. USA/9511/B

Item/Area Tested LID SEAL
(Lid seal, port seal, assembled boundary)

Leak Detector Mfg/Model ALCATEL ASM 10 Serial No. 2100

Pressure Gage Mfg/Model MKS 122AA-01000AE Serial No. 76751-4

Temp Indicator Mfg/Model BECKMAN 412A Serial No. 90040209

Standard Leak Mfg/Model VARIAN 0981-F8473-301 Serial No. 71F-373

Leak Rate of Standard 8.96 E-8

Temperature: Standard 71.4°F 21.9°C Cask 69.6°F 20.9°C

Temperature Corrected Standard Leak Rate 7.5 E-8

Leak Detector Background Reading: —

Leak Detector Calibration Reading: 7.5 E-8

Test Cavity Background Reading: 4.5 E-10

Tracer Gas Cavity Evac Pressure (if applicable) 0.5 TORR

Tracer Gas Backfill Pressure or Flow Rate 766 TORR

Start Time: 13:33:45 Leak Detector Reading: 4.5 E-10

Stop Time: 13:40:45 Leak Detector Reading: 4.5 E-10

Final Calculated Leak Rate: NO DETECTABLE LEAK

Final Disposition: Acceptable ~~X~~ Unacceptable X

Comments: CASK PAYLOAD CAVITY TOOK 2 MINUTES TO FILL WITH HELIUM TO 1 ATM PRESSURE. LEAK TEST CONTINUED FOR 5 MINUTES AFTER COMPLETING BACKFILL.
POST TEST CALIBRATION CHECK = 7.5 E-8 NO CHANGE
SEE ATTACHED SHEET FOR ADDITIONAL TEST NOTES AND CALIBRATION SHEETS

Conducted by: [signature] 1-7-93
Date

Witnessed by: [signature] 1-7-93
Date

SEE MEMO
9-1 BRONOWSKI

TES

ADDITIONAL NOTES OF LID SEAL LEAK TEST

766 TORR BACKFILL OF He

He on AT	13 33:45	$4.?\times10^{-10}$ cc/s @ STP
	34:00	"
	:15	"
	:30	"
	34:45	"
	35:00	"
	35:15	"
	35:30	"
	35:45	" LEAK FILL COMPLETED
	36:00	"
	36:15	"
	36:30	"
	36:45	"
	37:00	"
	37:15	
	37:30	"
	37:45	
	38:00	"
	38:15	"
	38:30	"
	38:45	"
	39:00	"
	39:15	"
	39:30	"
	39:45	"
	40:00	"
	40:15	"
	40:30	"
	40:45	"

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* CHECKED SYSTEM BY OPENING NEEDLE VALVE TO ATM - RESPOND [illegible] AS IT SHOULD HAVE.

* CAL READS $?.?\times10^{-8}$ cc/s @ STP, [illegible]

[illegible] 1/?/93

THERMOCOUPLES USED
[illegible] — [illegible]
LEAK STD — [illegible]

LEAK TEST DATA SHEET

Test Date 1-8-93 Cask Serial No. USA/9511/B

Item/Area Tested Lower Port Seal
(Lid seal, port seal, assembled boundary)

Leak Detector Mfg/Model ALCATEL-ASM 51 Serial No. 2100

Pressure Gage Mfg/Model MKS 122AA-01000 AB Serial No. 77751-4

Temp Indicator Mfg/Model Beckman 4174 Serial No. [illegible]

Standard Leak Mfg/Model Varian 0981-F8473-301 Serial No. T/F-373

Leak Rate of Standard 8.96E-8 cc/s STP (0 °C, 760 TORR)

Temperature: Standard 74.2°F 23.4°C Cask 70.5°F

Temperature Corrected Standard Leak Rate 7.9E-8 cc/s STP

Leak Detector Background Reading: 0

Leak Detector Calibration Reading: 7.0E-8

Test Cavity Background Reading: 1.5E-10

Tracer Gas Cavity Evac Pressure (if applicable) 0.8 TORR

Tracer Gas Backfill Pressure or Flow Rate 753 TORR

Start Time: 15:33 Leak Detector Reading: 1.5E-10

Stop Time: 15:39 Leak Detector Reading: 1.5E-10

Final Calculated Leak Rate: NO DETECTABLE LEAK

Final Disposition: ~~Acceptable~~ Unacceptable X

Comments: TRACER GAS CAVITY TOOK ONE MINUTE TO FILL WITH He TO ONE ATM PRESSURE. LEAK TEST WAS PERFORMED FOR FIVE MINUTES AFTER COMPLETING BACKFILL. GAS ANALYSIS SHEET FOR ADDITIONAL TEST NOTES AND CALIBRATION INFORMATION

Conducted by: [signature] 1-8-93
Date

Witnessed by: [signature] 1/8/93
Date

TEL MEMO SRONGWSKI TO YOSHIMURA DATED 2-26-93

1010

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CAVITY .6 TORR, FACTOR 7.
1.5×10^{-10}

Lower ~~[illegible]~~ wall PORT

He on AT 1533:00

T	READ	
0	1.5×10^{-10}	
33:15	"	
:30	"	
:45	"	
34:00	"	FULL 75 % TORR
:15	"	
:30	"	
:45	"	
35:00	"	
:15	"	
:30	"	
:45	"	
36:00	"	
:15	"	
:30	"	
:45	"	
37:00	"	
:15	"	
:30	"	
:45	"	
38:00	"	
:15	"	
:30	"	
:45	"	
39:00	"	

NO LEAK INDICATION

* CAL CHECK 8×10^{-8} ZERO READS 0
* LOCATION PATTERN AT PORT LOWER SPRAY He. CAL [illegible]

[signature] 1/8/93

QUICK-CONNECT VALVE ASSEMBLY WAS REMOVED FROM THE LOWER PORT PRIOR TO INSTALLATION OF THE LOWER PORT COVER DKB 4-95

LEAK TEST DATA SHEET

Test Date 1-8-93 Cask Serial No. USA/9511/B

Item/Area Tested UPPER PORT SEAL
(Lid seal, port seal, assembled boundary)

Leak Detector Mfg/Model ALCATEL ASM 10 Serial No. 2100

Pressure Gage Mfg/Model MKS 122AA-01000AB Serial No. 73751-4

Temp Indicator Mfg/Model BECKMAN 4IZA Serial No. 90040209

Standard Leak Mfg/Model VARIAN 0981-F8473-301 Serial No. 71F-373

Leak Rate of Standard 8.96 E-8 cc/s std (20°C, 760 torr)

Temperature: Standard 71.8°F 22.1°C Cask 70.1°F

Temperature Corrected Standard Leak Rate 7.52 E-8 cc/s std

Leak Detector Background Reading: 0

Leak Detector Calibration Reading: 7.5 E-8

Test Cavity Background Reading: 1.5 E-10

Tracer Gas Cavity Evac Pressure (if applicable) 1.0 torr

Tracer Gas Backfill Pressure or Flow Rate 765 torr

Start Time: 09:24 Leak Detector Reading: 1.5 E-10

Stop Time: 09:30 Leak Detector Reading: 1.5 E-10

Final Calculated Leak Rate: NO DETECTABLE ~~LEAK~~

Final Disposition: ~~Acceptable X~~ Unacceptable X

Comments: CASK PAYLOAD CAVITY TOOK [illegible] TO FILL WITH HELIUM TO 1 ATM PRESSURE. LEAK TEST CONDUCTED FOR FIVE MINUTES AFTER COMPLETING He BACKFILL. THERE WAS A SMALL DECREASE IN DETECTOR SENSITIVITY OVER THE TEST PERIOD (FROM 7.5 TO 7.0 E-8 CAL READINGS). NO ACTION TAKEN. SEE ATTACHED SHEETS FOR ADDITIONAL TEST NOTES AND CAL DATA.

Conducted by: [signature] 1-8-93
Date

Witnessed by: [signature] 1-8-93
Date

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See Memo Brzenowski to Hoffman dated [illegible]

TEST VOID

UPPER PORT SEAL PAGE 2 of 2

He on AT 0924:00

T
O
0924:00 1.5×10^{-10}

:30	"	
:45	"	
5:00	"	FULL 765 TORR
:15	"	
:30	"	
:45	"	
6:00	"	
:15	"	
:30	"	
[illegible]		
[illegible]		
[illegible]		
:30		
:45		
8:00	"	
:15	"	
:30	"	
:45	"	
9:00	"	
:15	"	
:30	"	
:45	"	
09:30:00	"	

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NO LEAK INDICATED

* CAL CHECK READS 7×10^{-8} cc/s [illegible]

* LOOSE FITTING [illegible] [illegible] CHECK SPRAY He [illegible] [illegible]

[illegible] [illegible] [illegible]

[illegible] THERMOCOUPLE [illegible] NO: 9[illegible]

[illegible] THERMOCOUPLE [illegible] NO: 9[illegible]

Silent Power, Ltd.
Attn: M. McNamee
Davy Road, Astmoor
Runcorn, Cheshire
UNITED KINGDOM WA7 1PZ

Solarex
Attn: G. Brawn
630 Solarex Ct.
Frederick, MD 21701

Southern California Edison (2)
Attn: A. Rodriguez
R. Scheffler
2244 Walnut Grove Avenue
P.O. Box 800
Rosemeade, CA 91770

SRI International
Attn: C. Seitz
333 Ravenswood Ave.
Menlo Park, CA 94025

Stuart Kuritzky
347 Madison Avenue
New York, NY 10017

Superconductivity, Inc.
Attn: J. Emerick
2114 Eagle Drive
Middleton, WI 53562

Texas Utilities Electric
Attn: J. Fangue
Skyway Tower
400 N. Olive, L.B.81
Dallas, TX 75201

United Engineers and Contractors
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Denver, CO 80217

University of Missouri - Rolla
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Dept. of Electrical & Computer Eng.
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Energy Information Administration
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Washington, DC 20585

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1310 Beulah Road
Pittsburgh, PA 15235

W. R. Grace & Company
Attn: S. Strzempko
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Cambridge, MA 02140

Yuasa-Exide
Attn: N. Magnani
P.O. Box 14145
Reading, PA 19612-4145

Yuasa-Exide
Attn: F. Tarantino
P.O. Box 14205
Reading, PA 19612-4205

Zaininger Engineering Co., Inc.
Attn: H. Zaininger
1590 Oakland Road, Suite B211
San Jose, CA 95131

MS 0513	H. Schmitt (Org. 2000)
MS 1070	R. Bair (Org. 2200)
MS 0613	R. Clark (Org. 2206)
MS 0613	L. Lachenmeyer (Org. 2206)
MS 0613	K. Grothaus (Org. 2222)
MS 0613	D. Doughty (Org. 2223)
MS 0613	P. Butler (Org. 2225) (30)
MS 0613	A. Akhil (Org. 2225)
MS 0613	J. Braithwaite (Org. 2225)
MS 0613	N. Clark (Org. 2225)
MS 0613	G. Corey (Org. 2225)
MS 0613	J. Freese (Org. 2225)
MS 0613	R. Jungst (Org. 2225)
MS 0214	J. Kerr, Attn: A. Phillips (Org. 10214)
MS 0735	D. Arvizu (Org. 6200)
MS 0752	T. Bickel (Org. 6213)
MS 0753	W. Bower (Org. 6218)
MS 0753	R. Bonn (Org. 6218)
MS 9103	P. Falcone (Org. 8111)
MS 9054	W. McLean (Org. 8300)
MS 9018	Central Technical Files (Org. 8523-2)
MS 0899	Technical Library (Org. 7141) (5)
MS 0619	Technical Publications (Org. 7151)
MS 0100	Document Processing for DOE/OSTI (Org. 7613-2) (10)

Lower Port Seal Leak Test

A new Helicoflex port seal was modified by adding the bleed hole feature (.067 inch diameter) at the location specified in the fabrication drawing. Verification was made that the quick-connect valve was removed from the lower port. The seal was installed to the port cover (serial no. -01) and the cover install on the cask. The port cover bolts were tightened to 60 ft-lb. The test cover (part no. S94924) was installed in the upper port for evacuation and helium backfill of the cask contents cavity.

The test was conducted for a period of four minutes after completing the helium backfill (backfilling to 760 torr took one minute). The measured leakage rate was 3.0E-6 scc/c. This equates to the N14.5 air reference leak rate of 1.7E-6 scc/s. The backfill pressure was increased to 50 psig. Measured leak under these conditions was 1.8E-5 scc/s (5.1E-6 scc/s air). Data sheets are attached.

Upper Port Seal Leak Test

A new Helicoflex port seal was modified by adding the .067 inch diameter bleed hole. The seal was install to port cover serial no. -02. The cover was installed to the upper port of the cask and the attachment bolts tightened to 60 ft-lb. The lower port cover was removed and the test cover (part no. S94924) was installed in it's place for evacuation and helium backfill of the cask contents cavity.

The test was conducted for a period of five minutes after completing the helium backfill to 760 torr. There was no detectable leak in this seal. The test was repeated after increasing the helium backfill pressure to 50 psig. Again, there was no detectable leak. Test sensitivity was 1.0E-10 cc/s. Data sheets are attached.

copy w/enclosures: BUSS Cask file

LEAK TEST DATA SHEET

Test Date 2-23-93 Cask Serial No. USA/9511/B

Item/Area Tested LID SEAL
(Lid seal, port seal, assembled boundary)

Leak Detector Mfg/Model ALCATEL ASM10 Serial No. 2100

Pressure Gage Mfg/Model MKS 122AA-01000AB Serial No. 78751-4

Temp Indicator Mfg/Model BECKMAN DORIC 412A Serial No. 90040209
THERMOCOUPLE! T.C. S/N 92108-2

Standard Leak Mfg/Model V.I.C OM-6 Serial No. 06-019

Leak Rate of Standard 2.9E-6 STD cc/s @23°C

Temperature: Standard 78.0°F 25.8°C Cask 69.6°F

Temperature Corrected Standard Leak Rate 2.9E-6

Leak Detector Background Reading: 2E-90(×10) = 2E-9

Leak Detector Calibration Reading: 2.9E-7(×10) = 2.9E-6

Test Cavity Background Reading: 22E-10(×10) = 2.2E-9

Tracer Gas Cavity Evac Pressure (if applicable) 0.8 TORR

Tracer Gas Backfill Pressure ~~or Flow Rate~~ 758 TORR (THEN 50 PSIG)

Start Time: 09:54 Leak Detector Reading: BACKGROUND (2E-9(E-10))

Stop Time: 09:59 Leak Detector Reading: BACKGROUND

Final Calculated Leak Rate: NO DETECTABLE LEAK (WITHIN A E9 SENSITIVITY)

Final Disposition: Acceptable X Unacceptable ___

Comments: LEAK DETECTOR DE-TUNED ONE ORDER OF MAGNITUDE SO THAT A LARGER LEAK WOULD BE MEASURABLE (IF NEEDED). 2.9E-6 LEAK RATE WAS INDICATED AS 2.9E-7 ON DETECTOR. ALL READINGS FROM DETECTOR MUST BE MULTIPLIED BY 10. LEAK TEST ALSO CONDUCTED WITH A 50 PSIG HELIUM BACKFILL PRESSURE. THIS TEST ALSO SHOWED NO DETECTABLE LEAK.

Conducted by: DR Boronda 2-23-93
Date

Witnessed by: WB Leish ~~2/25/93~~ wbl 2/23/93
Date

2/23/93

* LID SEAL

* LD CALIBRATED SO 2.9E-6 READS 2.9E-7 atm cc/s
SO MULTIPLY READINGS BY 10 TO GET ACTUAL

CASK BACKGROUND = 2×10^{-9} atm cc/s = BG (ACTUAL)

0953:00	BG	OPEN VALVE TO He
:~~15~~	BG	
:30	BG	400 T
:45	BG	700 T
0954 :00	BG	~ 760 T
:30	BG	
0955 :00	BG	758 T
:30	BG	
0956 :00	BG	
:30	BG	
0957 :00	BG	
:30	BG	
0958 :00	BG	
:30	BG	
0959 :00	BG	

NO DETECTABLE LEAK AT A SENSITIVITY OF 1×10^{-8} atm cc/s

RAISE TO 50 PSIG

1000:00	BG	38 PSIG
:30	BG	50 PSIG
1001:00	BG	
:30	BG	
1002:00	BG	
:30	BG	
1003:00	BG	
:30	BG	
1004:00	BG	
:30	BG	
1005:00	BG	
:30	BG	

NO DETECTABLE LEAK AT A SENSITIVITY OF 1×10^{-9} atm cc/s

WB Leslie

LEAK TEST DATA SHEET

Test Date 2-26-93 Cask Serial No. USA/9511/B

Item/Area Tested LOWER PORT
(Lid seal, port seal, assembled boundary)

Leak Detector Mfg/Model ALCATEL ASM 10 Serial No. 2100

Pressure Gage Mfg/Model MKS 122AA-01000AB Serial No. 78751-4
THERMOCOUPLE S/N 92108-2

Temp Indicator Mfg/Model BECKMAN 412A Serial No. 90040209

Standard Leak Mfg/Model VARIAN 0981-F8473-301 Serial No. 71F-373

Leak Rate of Standard 8.96E-8 scc/s (@0°C + 760 TORR)

Temperature: Standard 75°F 24.3°C Cask 69.5°F

Temperature Corrected Standard Leak Rate 8.2E-8 scc/s

Leak Detector Background Reading: 0

Leak Detector Calibration Reading: 8.2E-8

Test Cavity Background Reading: 4.2E-10

Tracer Gas Cavity Evac Pressure (if applicable) 5.4 TORR

Tracer Gas Backfill Pressure ~~or Flow Rate~~ 765 TORR [50 PSIG, 2ND TEST]

Start Time: 13:32 Leak Detector Reading: 2.8E-6 scc/s He

Stop Time: 13:36 Leak Detector Reading: 3.0E-6 scc/s He

Final Calculated Leak Rate: 1.65 x10-6 scc/s AIR (N14.5 REFERENCE)

Final Disposition: Acceptable X Unacceptable ____

Comments: AFTER INITIAL TEST W/765 TORR He, BACKFILL PRESSURE WAS INCREASED TO 50 PSIG. THE LEAK RATE SATURATED THE DETECTOR @9.9E-6 WITH ~30 PSIG PRESSURE. THE LEAK DETECTOR WAS RETUNED SO THAT THE 8.2E-8 STANDARD LEAK WAS INDICATED AS 8.2E-9 ON THE DETECTOR. THE MEASURED LEAK RATE AT 50 PSIG WAS 1.8E-6 x 10 = 1.8E-5 scc/s ACTUAL. (CALCULATED = 5.1E-6 scc/s AIR ANSI N14.5 REFERENCE)

Conducted by: DR Bernardi 2-26-93
Date

Witnessed by: W. B. [signature] 2/26/93
Date

LOWER PORT SEAL LEAK TEST 2/25/93

COVER S/N 01

BACKGROUND = 4.2×10^{-10} scc/s

1330:30	START BACKFILL	
:45	5×10^{-7}	400 T
1331:00	2×10^{-6}	1 atm
:30	2.8×10^{-6}	"
1332:00	2.8×10^{-6}	765 T
:30	3×10^{-6}	
1333:00	3×10^{-6}	
:30	3×10^{-6}	
1334:00	3×10^{-6}	
:30	3×10^{-6}	
1335:00	3×10^{-6}	
:30	3×10^{-6}	
1336:00	3×10^{-6}	

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RAISE PRESSURE

:30	6.5×10^{-6}	20 psig

SATURATED @ ~ 30 psig
RETUNE DETECTOR TO PERMIT HIGHER READING.

LD READS 8.2×10^{-9} FOR ACTUAL OF 8.2×10^{-8} scc/s

1354:30	START FILL	
:45	4.2×10^{-6}	16 psig
1355:00	6.5×10^{-6}	24
:15	8.2×10^{-6}	32
:30	1.3×10^{-5}	40
:45		
1356:00	1.8×10^{-5}	50
:30	1.8×10^{-5}	50
1357:00	1.8×10^{-5}	
:30	1.8×10^{-5}	
1358:00	1.8×10^{-5}	
:30	1.8×10^{-5}	
1359:00	1.8×10^{-5}	READINGS GETTING A BIT NOISY
:30	1.5×10^{-5}	
1360:00	1.4×10^{-5}	
:30	1.4×10^{-5}	
1401:00	1.3×10^{-5}	

(ABOVE ARE ACTUAL scc/s.)

W.B. Leach
2/25/93

LEAK TEST DATA SHEET

Test Date 3/2/93 . Cask Serial No. USA/9511/B

Item/Area Tested UPPER PORT SEAL (COVER SERIAL #-02)
(Lid seal, port seal, assembled boundary)

Leak Detector Mfg/Model ALCATEL ASM10 Serial No. 2100

Pressure Gage Mfg/Model MKS 122AA-01000AB Serial No. 78751-4

Temp Indicator Mfg/Model BECKMAN 412A Serial No. 90040209
THERMOCOUPLE S/N 92108-2 SERIAL NO. 92108-2
Standard Leak Mfg/Model VARIAN 0981-F8473-301 Serial No. 71F-373

Leak Rate of Standard 8.96E-8 scc/s (0°C, 760 TORR)

Temperature: Standard 72.2°F 22.7°C Cask 70.2°F

Temperature Corrected Standard Leak Rate 7.7E-8 scc/s

Leak Detector Background Reading: 0

Leak Detector Calibration Reading: 7.7E-8 (7.8E-8 POST-TEST)

Test Cavity Background Reading: 1.5E-10

Tracer Gas Cavity Evac Pressure (if applicable) 2.2 TORR

Tracer Gas Backfill Pressure ~~or Flow Rate~~ 760 TORR [2ND TEST: 50 PSIG]

Start Time: 14:48 Leak Detector Reading: 1.5E-10 (BACKGROUND)

Stop Time: 14:53 Leak Detector Reading: 1.5E-10

Final Calculated Leak Rate: NO DETECTABLE LEAK

Final Disposition: Acceptable X Unacceptable ___

Comments: AFTER INITIAL TEST WITH 760 TORR BACKFILL PRESSURE, THE BACKFILL PRESSURE WAS INCREASED TO 50 PSIG AND RETESTED. THIS TEST ALSO RESULTED IN NO DETECTABLE LEAK. TEST SENSITIVITY WAS 1E-10 cc/s.

Conducted by: [signature] 3-2-93
Date

Witnessed by: W.B. [signature] 3/2/93
Date

3/2/93 UPPER PORT SEAL LEAK TEST

$\alpha = .0352/C$ $T = 22.7C$

$Q_L = 8.96 \times 10^{-8} * (1 + .0352(22.7 - 26.7)) = 7.7 \times 10^{-8}$ scc/s

CAL LEAK FILE 3836, EXPIRES 5/19/93

BACKGROUND = 1.5×10^{-10} scc/s

1447:30	START FILL	WBL
:45	BG	3450 WBL
1448 :00	BG	700
:15	BG	730
WBL 1448 :30	BG	760
1449 :00	BG	"
:30	BG	
1450 :00	BG	
1450 :30	BG	
1451:00	BG	
:30	BG	
1452:00	BG	
:30	BG	
1453:00	BG	
:30	BG	5 minutes

FILL TO 50 PSIG

1454:00	BG	18 PSIG
:30	BG	30 PSIG
1455 :00	BG	40
:30	BG	50 -
1456 :00	BG	
:30	BG	
1457:00	BG	
:30	BG	
1458:00	BG	
:30	BG	
1459 :00	BG	
:30	BG	
1500:00	BG	
:30	BG	5 minutes

WB Leach 3/2/93

PRIMARY STANDARDS LABORATORY

CERTIFICATE

Sandia National Laboratories, Albuquerque, New Mexico 87185

File No. 8888

LEAK-HELIUM

Vacuum Instrument Corporation
Model No. OM-6
Serial No. 06-019
Property No. None

Submitted by: Sandia National Laboratories
Organization 6323

Certified: December 19, 1991
Expires: June 19, 1992

TEST RESULTS

At 24.13°C the helium leak rate is 1.18×10^{-10} moles/s [2.65×10^{-6} cm^3/s STP (0°C, one atm)]. If this gas leak is used at other temperatures (T), a temperature correction must be applied as follows:

$$Q_T = Q_{T1}\ [1 + A\ (T - T1)] \quad \text{where } T1 = 24.13^\circ C$$

Temperature Coefficient (A): NONE DETERMINED/°C

This temperature correction is applicable if this device is to be used within ± 5° of the reported temperature. If the device is to be used at other temperatures, the Primary Standards Laboratory should be consulted.

The uncertainty in the calibrated leak rate is estimated to be no greater than ± 15% of stated value at stated temperature. It is recommended that this leak be allowed to vent while not in use.

Technical Consultant: Mark S. Benner, 4343

Certified by: Frank B. Burns, 4343

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4343 File
6323 (2)

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PRIMARY STANDARDS LABORATORY

Sandia National Laboratories, Albuquerque, New Mexico 87185

CERTIFICATE

File No. 3836

LEAK-HELIUM

Varian
Model No. 0981-F8473-301
Serial No. 71F-373
Property No. None

Submitted by: Organization 6323

Certified: November 19, 1991
Expires: May 19, 1993

TEST RESULTS

At 26.67°C, the helium leak rate is 4.00E-12 moles/s [8.96E-8 cm^3/s STP (0°C, one atm)]. If this gas leak is used at other temperatures (T), a temperature correction must be applied as follows:

$$Q_T = Q_{T1}[1 + A(T - T1)] \quad \text{where } T1 = 26.67°C$$

Temperature Coefficient (A): 0.0352/°C

This temperature correction is applicable if this device is to be used within ±5°C of the reported temperature. If the device is to be used at other temperatures, the Primary Standards Laboratory should be consulted.

The uncertainty in the calibrated leak rate is estimated to be no greater than ±15% of stated value at stated temperature. It is recommended that this leak be allowed to vent while not in use.

Note: Control curve value reported.

Technical Consultant: S. Metzger, 4343

Certified by: F. Burns, 4343

Copy to:
Organization 6323 (2)
4343 File

TRANSDUCER CALIBRATION REPORT

SANDIA LAB [illegible]

MANUFACTURER MKS
MODEL 122AA-01000AB
SERIAL 78751-4 DATAFILE # 4
TRANSDUCER TYPE DIAL GAGE
CERTIFIED BY FR [signature] EXPIRATION DATE 8/ 1/1993
TEMPERATURE 74 FACILITY USED BARATRON
REQUESTING ORG. 6643
COMMENTS: BRONOWSKI; CAL'D WITH PDR-D-1 SER. 78751-6A; VERTICAL POS.. STEM DOWN; NO ADJUSTMENTS.

REFERENCE UNITS TORR	DIAL GAGE READING	% DEVIATION READING
.500000E+02	.50400E+02	.800
.100000E+03	.10070E+03	.700
.150000E+03	.15080E+03	.533
.200000E+03	.20090E+03	.450
.250000E+03	.25100E+03	.400
.300000E+03	.30110E+03	.367
.350000E+03	.35100E+03	.286
.400000E+03	.40100E+03	.250
.450000E+03	.45090E+03	.200
.500000E+03	.50070E+03	.140
.550000E+03	.55040E+03	.073
.600000E+03	.60030E+03	.050
.650000E+03	.65000E+03	0.000
.700000E+03	.69980E+03	-.029
.750000E+03	.74950E+03	-.067
.800000E+03	.79920E+03	-.100

Standards Laboratory Certificate

Sandia National Laboratories

Albuquerque, New Mexico 87185

File No. 2414

THERMOCOUPLE READOUT
BECKMAN
Model No. 412A
Serial No. 90040209

Submitted by: 6323

Certified: November 25, 1992
Expires: May 25, 1993

This instrument was tested at selected points across its range for compliance to the temperature vs mV values listed in IPTS-68. Tests were preformed for the thermocouple type, range, and accuracy listed below:

Type	Range	Accuracy
K	-100 to 1370 deg C	+/- 0.5 deg C

This instrument was adjusted to be within the above accuracy. It is probable that this instrument will remain within the above accuracy for the certification interval.

Note: This accuracy statement applies only to the above instrument and does not include the thermocouple used in your measurement.

Metrologist: J. J. LaMarr, 2414

Georgia Brown

Certified by: J. M. Simons, 2414

TLC1/JJL
5/12/92

SA 5710-OA(8-85)

Standards Laboratory Certificate

Sandia National Laboratories
Albuquerque. New Mexico 87185

THERMOCOUPLE
ATTACHED TO CASK

File No. 4148

THERMOCOUPLE TYPE K
UNKOWN
Model No. 20' PROBE
Serial No. 92108-2

Submitted by: 6643

Certified: May 7, 1992
Expires: May 7, 1993

Tests preformed over the temperature range of -95 to 650 deg F show this thermocouple to be in agreement within +/-(4 deg F or .4% of rdg) of the values published in IPTS-68.

Under normal use conditions it is probable this thermocouple will remain within the above accuracies for the certification interval.

Metrologist: J. J. LaMarr, 2414

Certified by: R. L. Crabb, 2414

tlc29:JJL
1/30/92

SA 5710-DA(8-85)

Appendix E: Test for Shielding Integrity

RUST

Nuclear Remedial Services **Operations**

RCS/SSHS Memorandum **RCS memo 733027.022**

Date: May 18, 1994

To: Paul Saueressig, WHC Location: Denver

From: Ben Poff, OHST B. Poff Location: Denver

Subject: BUSS Cask Survey - Test for Shielding Integrity

The information included in this memorandum provides the radiological survey data required to document the shielding performance of the BUSS Cask containing 16 cesium 137 capsules. A copy of RUST survey #051894-02 is attached providing documentation of the survey. Below is a summary of the findings.

RADIATION LEVELS

Location	Dose Rate on Contact	Dose Rate at 1 meter
Top (Lid)	40 mRem/hr	1.3 mRem/hr
Sides	10 mRem/hr	0.6 mRem/hr
Bottom	0.9 mRem/hr	0.3 mRem/hr
Upper Port	11 mRem/hr	0.3 mRem/hr
Lower Port	70 mRem/hr	1.4 mRem/hr

Dose rates taken on the upper and lower ports were obtained following installation of the thermal shields. The indicated dose rate(s) indicated for the "sides" are maximum levels found in the vicinity of the lifting trunnions. Map "A" of the attached survey provides a visual representation of the maximum radiation levels detected during the survey. Map "B" of the attached survey provides information on the characteristics of the detected radiation "beam" associated with the open bolt holes and test ports.

/brp

cc: File
J. Stevens, PM
D. Higgins, PS
J. Harverson, RE

CONT IN. JN / RADIATION SURVEY REPORT

LOCATION IOTECH Inc.	PROJECT NUMBER 733027
11080 Irma Dr.	SURVEYOR E. Polser
Northglenn, CO. 80233	SURVEY NUMBER 051894-02
	MAP ID A + B

PERMISSIBLE LEVELS	CSCA CONTROL LEVELS	
N/A dpm/100cm² Alpha dpm/100cm² Beta-Gamma	N/A dpm/100cm² Alpha dpm/100cm² Beta-Gamma	☐ OTHER (SEE COMMENTS) ☑ NO ACTION REQUIRED

Source Check Data	Contamination Surveys				Radiation Surveys
	α (Loose)	α (Fixed)	β-γ (Loose)	β-γ (Fixed)	Beta-Gamma
Instrument model	N/A	N/A	N/A	N/A	E-520
Source I.D.					Cs-137
Source Strength	dpm	dpm	dpm	dpm	38 μCi
Instrument Response	cpm	cpm	cpm	cpm	25 Qualitative check
Efficiency					
MDA	dpm	dpm	dpm	dpm	Sat. ☑ Unsat. ☐
Background	cpm	cpm	cpm	cpm	.02 mrem/hr.

REASON FOR SURVEY ☐ ~~PROCEDURE NO.~~ Buss Cask SARP -

☒ SPECIAL Shielding Integrity Test

☐ ~~ROUTINE~~

Contamination ☐	By Shift ☐	Daily ☐	Weekly ☐	Monthly ☐	
Radiation ☑	By Shift ☐	Daily ☐	Weekly ☐	Monthly ☐	

COMMENTS: ND = Not Detectable, SPDS = See Protean Data Sheet

Contamination Survey INSTRUMENT/PROBE SERIAL #s	ALPHA (LOOSE) N/A	BETA-GAMMA (LOOSE) N/A
	ALPHA (FIXED) N/A / N/A	BETA-GAMMA (FIXED) N/A / N/A
Radiation Survey INSTRUMENT/PROBE SERIAL #s	NEUTRON N/A / N/A	BETA-GAMMA E-520 5512 / 5272

THE KNOWING & WILLFUL RECORDING OF FALSE, FICTITIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

DATE 5/18/94	TIME START 0630		TIME COMPLETE 0700			PAGE 1 OF 4
	Alpha		Beta Gamma		Beta-Gamma mrem/hr ☒ rem/hr ☐ Neutron ☐	Item or Location
Item #	Equiv (Loose) dpm/100cm²	Equiv (Fixed) dpm/100cm²	Equiv (Loose) dpm/100cm²	Equiv (Fixed) dpm/100cm²		
1	N/A	N/A	N/A	N/A	25	on contact Bolt hole # 1
2					35	2
3					22	3
4					19	4
5					17	5
6					12	6
7					10	7
8					10	8
9					8	9
10					11	10
11					16	11
12					15	12
13					11	on contact upper port
14					.3	at 1 meter upper port
16					70	on contact lower port
16					1.4	at 1 meter lower port
17					.6	Right hand Trunnion at 1 meter
18					.5	Left hand Trunnion at 1 meter
19					8	Jacking screw near # 3 Bolt hole on contact
20					6	Jacking screw near # 7 Bolt hole on contact
21					6	Jacking screw near # 11 Bolt hole on contact
22					12	Test fitting near # 7 & 8 Bolt holes on contact
23					40	Test fitting near # 1 & 2 Bolt holes on contact
24					7	guide pin hole near # 5 & 6 Bolt hole on contact
26					10	guide pin hole near # 1 & 2 Bolt hole on contact

RADCON REVIEW B. R. [signature] DATE 5/18/94

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CONTAMINATION / RADIATION SURVEY REPORT (CONTINUATION SHEET)

LOCATION IOTECH Inc.	SURVEYOR E Olsen
11080 Irma Dr.	SURVEY NUMBER 051594-02
Northglenn, CO. 80233	MAP ID A + B
RADCON REVIEW B. L. [illegible]	DATE 5/18/94

PROJECT NUMBER: 730027 DATE: 5/18/94 PAGE 2 OF 4

COMMENTS: ND = Not Detectable, SPDS = See Protean Data Sheet

Item #	Alpha Equiv (Loose) dpm/100cm²	Alpha Equiv (Fixed) dpm/100cm²	Beta-Gamma Equiv (Loose) dpm/100cm²	Beta-Gamma Equiv (Fixed) dpm/100cm²	Beta-Gamma mrem/hr ☑ / µrem/hr ☐ / Neutron ☐	Item or Location
26	N/A	N/A	N/A	N/A	6	guide pin hole near [illegible] Bolt hole [illegible]
27	↓	↓	↓	↓	1.3	Rad level above lid at 1 meter
28	↓	↓	↓	↓	6	Rad level ~~[illegible]~~ on contact on lid
29	↓	↓	↓	↓	.35 5/18/94	Rad level 1 meter below bottle
30	↓	↓	↓	↓	.9	Rad level on contact on bottle

EA

Item #	Alpha Equiv __ (Loose) dpm/100cm²	Alpha Equiv __ (Fixed) dpm/100cm²	Beta-Gamma Equiv __ (Loose) dpm/100cm²	Beta-Gamma Equiv __ (Fixed) dpm/100cm²	Beta-Gamma mrem/hr ☐ / µrem/hr ☐ / Neutron ☐	Item or Location

EA

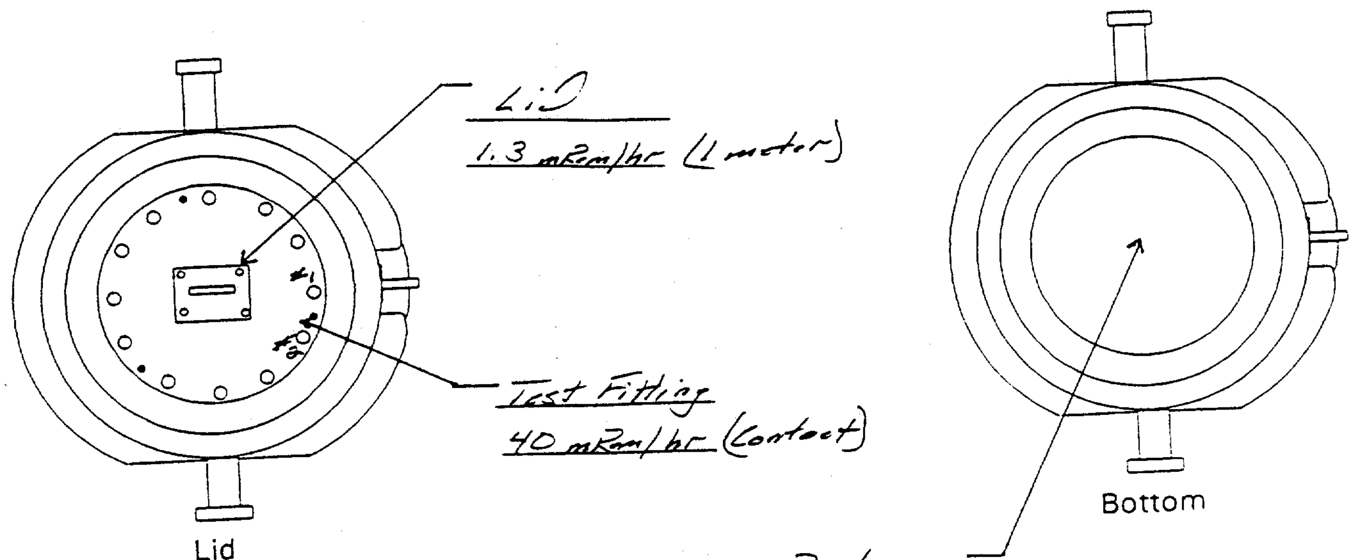
WILLFUL RECORDING OF FALSE, FICTICIOUS, OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHABLE AS A FELONY UNDER FEDERAL STATUTES.

WRN 8982

Shielding Integrity Test

BUSS Cask Survey

Maximum Radiation Levels



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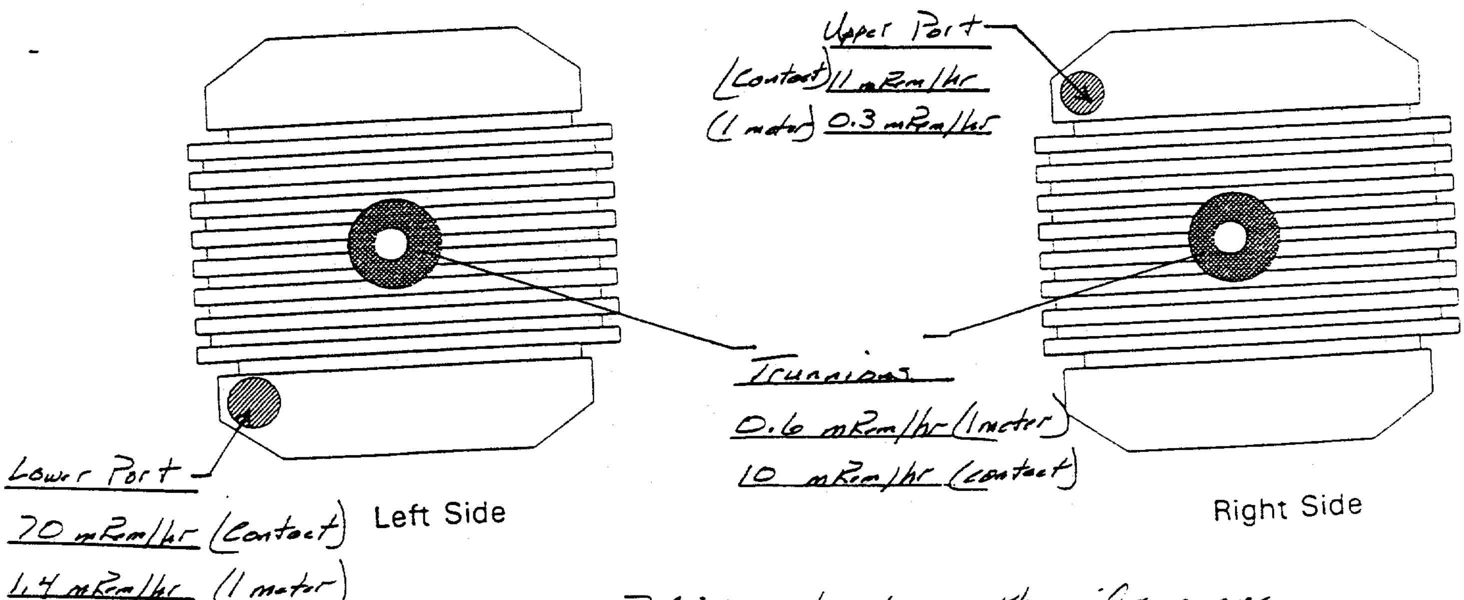

Note: Radiation levels on the sides range from 0.3 to 0.5 mRem/hr.

051894-02
733027
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" 4

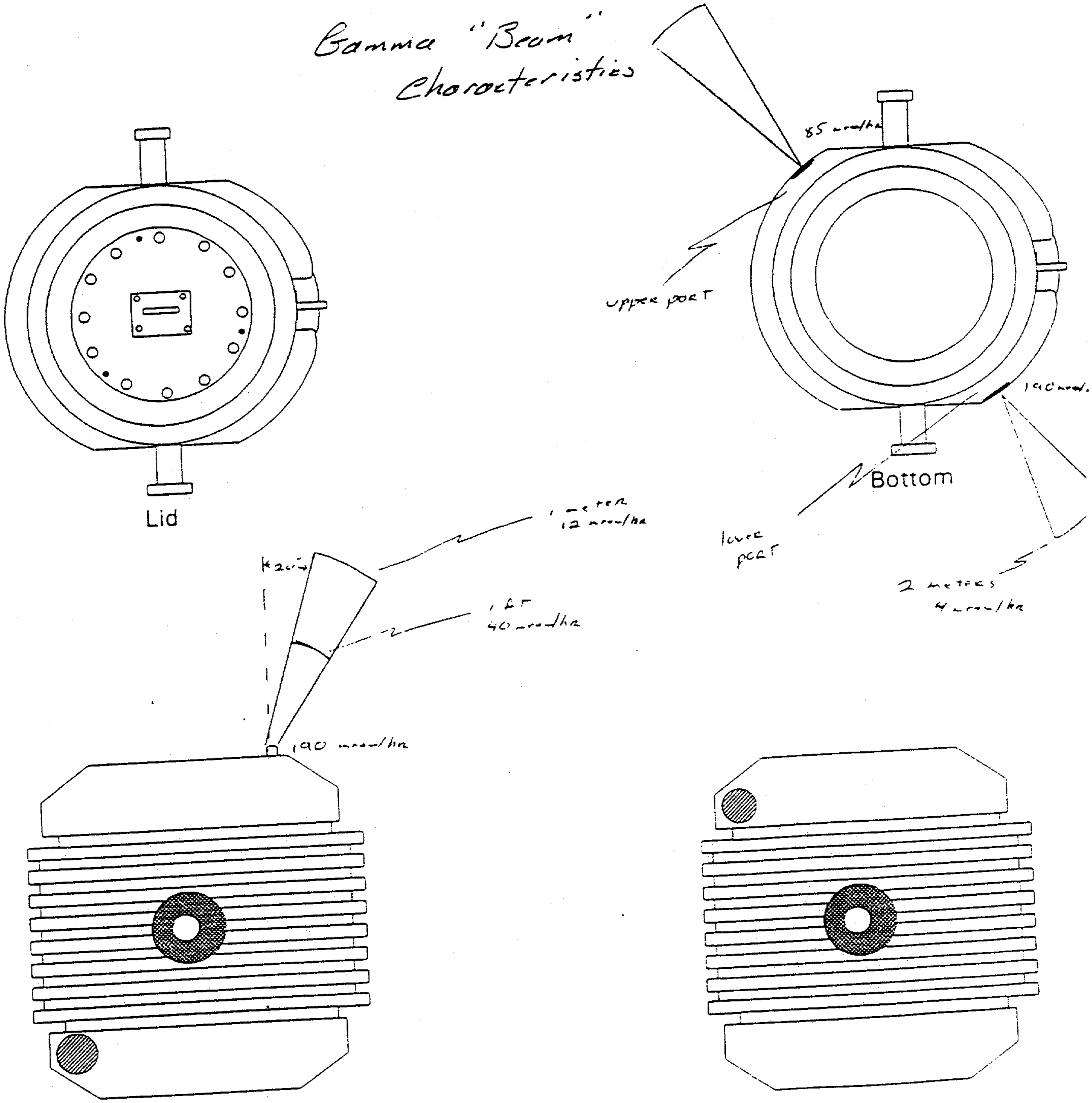
B. R. P.
5/18/94

WI-NRS-1293-116, Rev. 2

WRN 8982

BUSS Cask Survey

Gamma "Beam" Characteristics



Reading taken with port plugs removed and no bolts installed

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753027
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MAP 13

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Appendix F: Thermal Testing

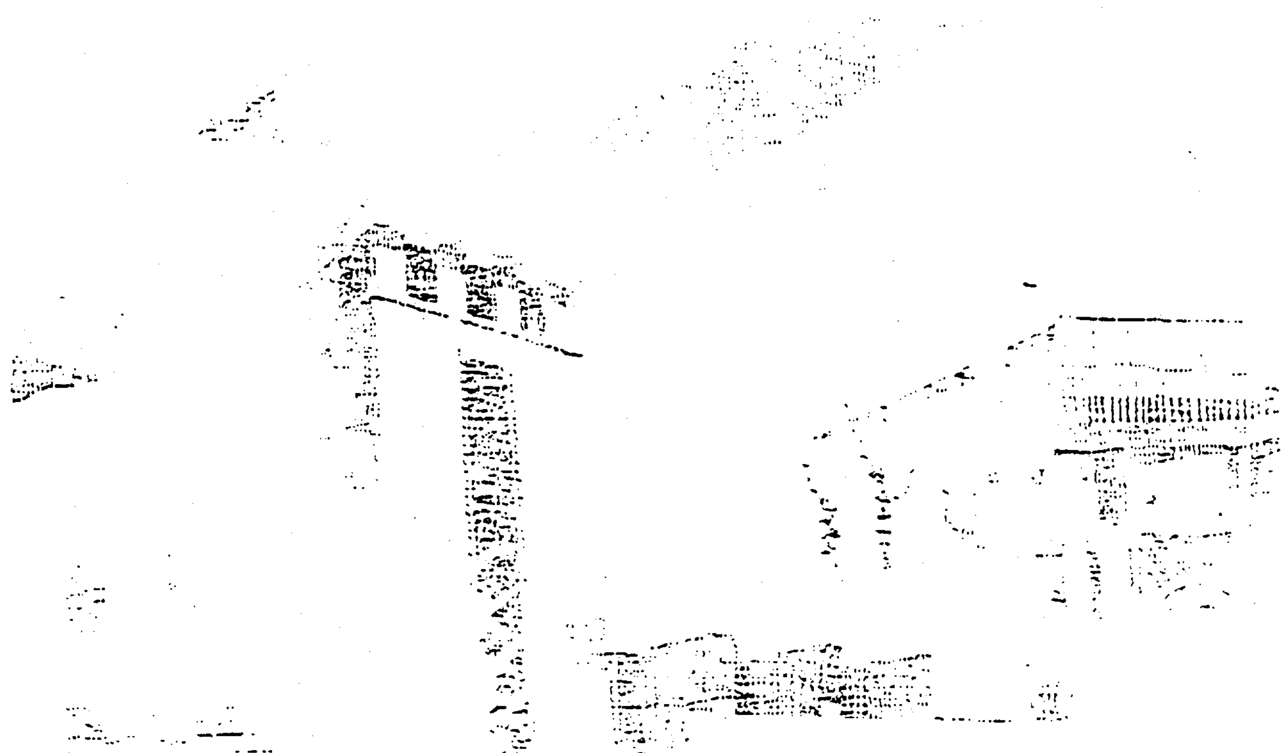
0323
Yoshimura

SANDIA REPORT
SAND87–2715 • TTC–767 • UC–71
Unlimited Release
Printed September 1988

A Full-Scale Thermal Test and Analytical Evaluation of the Beneficial Uses Shipping System Cask

Jaime L. Moya, Ronald L. Akau

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550
for the United States Department of Energy
under Contract DE-AC04-76DP00789



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TTC—767
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Category UC—71

A Full-Scale Thermal Test and Analytical Evaluation of the Beneficial Uses Shipping System Cask

Jaime L. Moya
Transportation Systems Development and Testing Division
Ronald L. Akau
Fluid Mechanics and Heat Transfer Division III
Sandia National Laboratories
Albuquerque, NM 87185

Abstract

A thermal test of the Beneficial Uses Shipping System (BUSS) cask containing irradiation source capsules was conducted to verify a two-dimensional axisymmetric thermal model developed for the Safety Analysis Report. The BUSS cask is a Type B package developed to transport irradiation source capsules of cesium chloride or strontium fluoride to commercially licensed food and pharmaceutical irradiating facilities. The uniqueness of this test is that it was performed on an internally instrumented, full-scale cask with actual radioactive capsules. This resulted in more realistic system temperatures than those obtained if heaters were used to simulate the large gamma source. In addition, the thermal test provides benchmark data for other thermal codes.

Contents

Figures

Figures (continued)

Tables

Nomenclature

A_m	Surface area of the m surface
A_n	Surface area of the n surface
A_o	Heat-transfer surface area, $2\pi r_o (H - Nt)$
C_p	Specific heat of the cask body
dT	Temperature change of the cask body
dt	Time interval
F_{m-n}	Shape factor from surface m to surface n (Ref. 1)
h	Convective heat-transfer coefficient
H	Height of the cylinder
$I_n(\,)$	Modified Bessel function of the first kind and order n
k	Thermal conductivity
$K_n(\,)$	Modified Bessel function of the second kind and order n
M	Mass of the cask body
m	Fin performance factor $(2h/kt)^{1/2}$
N	Number of fins
q_c	Total convective heat-transfer rate
q_f	Convective heat-transfer rate for the fin surfaces
q_o	Convective heat-transfer rate for the unfinned surface
r_c	Fictitious fin radius, $r_e + t/2$
r_e	Radius at fin edge
r_o	Radius at fin base
t	Fin thickness
T_b	Temperature at the base of the fin
T_f	Temperature of the fin
T_t	Temperature of the fin tip
T_∞	Temperature of the environment
ϵ_m	Emissivity of the m surface
ϵ_n	Emissivity of the n surface
η	Fin efficiency
σ	Stefan-Boltzmann constant
τ	Time

A Full-Scale Thermal Test and Analytical Evaluation of the Beneficial Uses Shipping System Cask

1. Introduction

A full-scale thermal test was conducted on the Beneficial Uses Shipping System (BUSS) cask to verify a two-dimensional axisymmetric thermal model developed for the Safety Analysis Report (SARP).[2] The thermal test consisted of loading the instrumented BUSS cask with 12 cesium chloride capsules and of monitoring the system temperatures continuously for 10 days. Since the energy deposition as the result of gamma absorption cannot be easily simulated with heaters, actual radioactive capsules were used. This resulted in more realistic system temperatures than those obtained if heaters had been used to simulate the large gamma source. After completion of the test, the radioactive decay of the individual capsules was measured.

The thermal model was developed using the finite-element thermal code Q/TRAN.[3] The thermal test and model provide understanding of the effect of air gaps (located between cask components) on the overall heat-transfer process, and validate the adequacy of the boundary conditions used to approximate the heat transfer from a finned surface. The test and model results also verify the gamma energy deposition profile that was calculated using a finite-element transport code. And, finally, the thermal test provides benchmark data for future thermal codes to be used in the analysis of nuclear transportation systems.

Because Q/TRAN is a fairly new code, another thermal model was developed using the Systems Integrated Numerical Differencing Analyzer code (SINDA).[4] Results from SINDA were compared to Q/TRAN to validate the Q/TRAN results. This report summarizes the results recorded from the thermal test and compares them with temperatures calculated from the two thermal models.

2. Background

The BUSS cask was developed at Sandia National Laboratories in support of the US Department of Energy (DOE) effort to encourage the use of by-product isotopes resulting from the production of plutonium. The BUSS cask will be used to transport irradiation source capsules of cesium chloride or strontium fluoride from the Waste Encapsulation Storage Facility (WESF) at Hanford, Washington, to commercially licensed food and pharmaceutical irradiating facilities. The goal of the BUSS cask development program is to obtain DOE and Nuclear Regulatory Commission (NRC) regulatory approval of the design. A full-scale prototype of the BUSS cask and handling equipment was fabricated and assembled for operational testing (Figure 1).

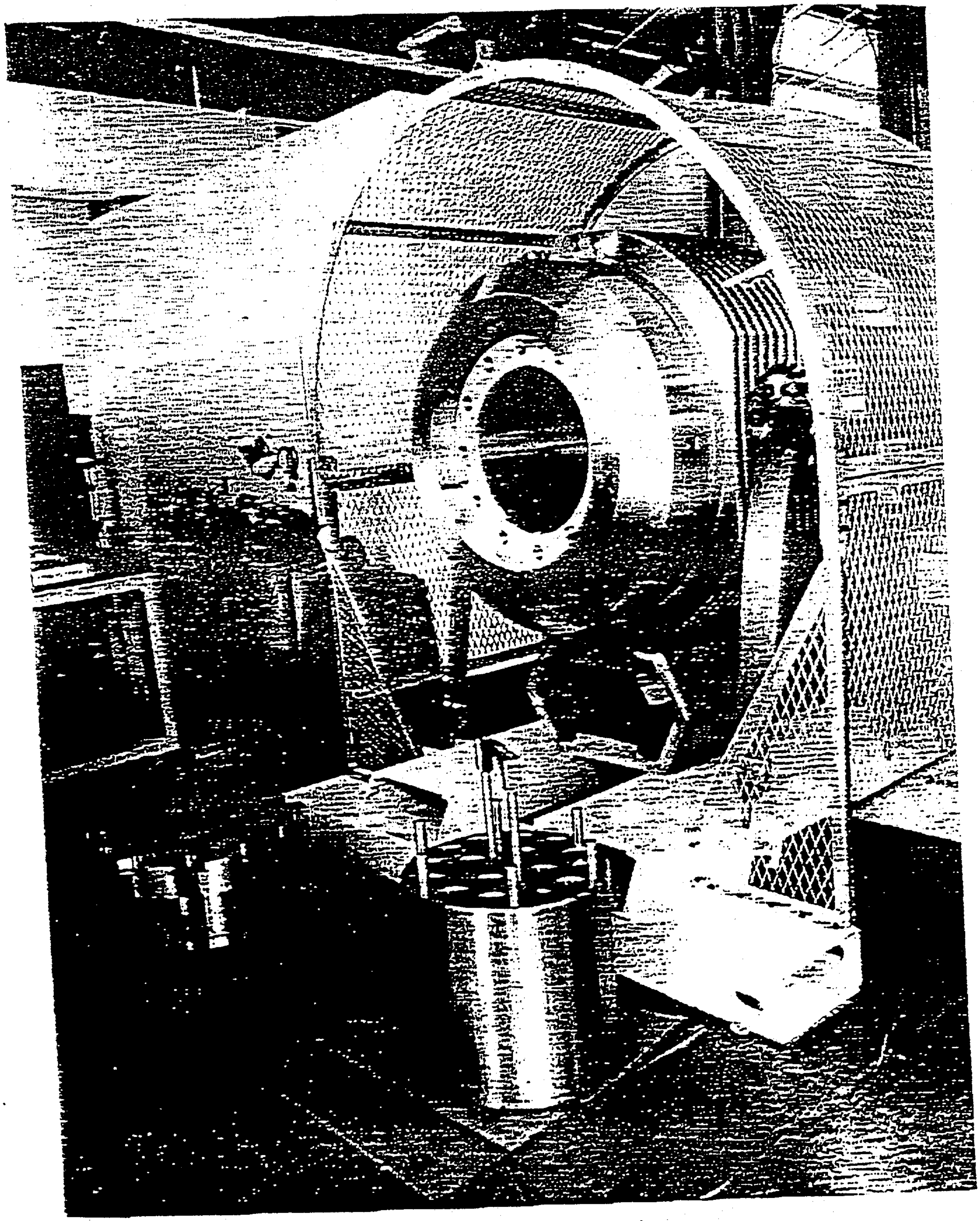


Figure 1. Full-scale prototype of the BUSS cask and handling equipment

3. Description of the Cask

The BUSS cask is a "dry" cask that uses an inert gas in the cask cavity as a cooling medium. There is no forced circulation of the gas. A schematic of the BUSS cask is shown in Figure 2. The ferritic cask body is a one-piece, forged structure with nickel plating. This type of fabrication improves heat conduction in the BUSS cask body as compared to a composite structure, which introduces gaps and interfaces between dissimilar materials.

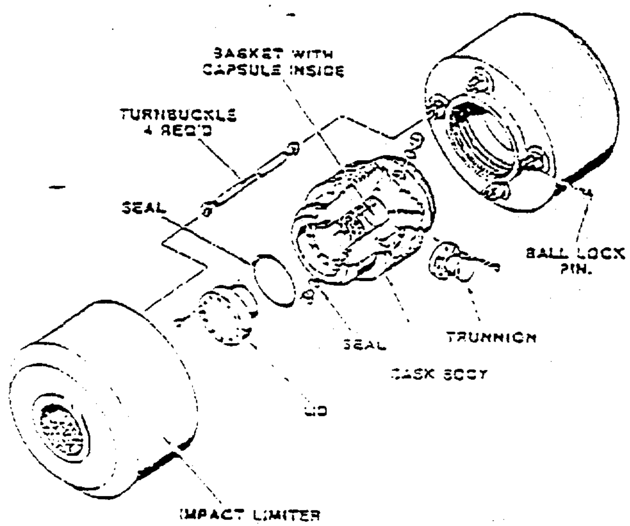


Figure-2. Exploded view of the BUSS cask

The cask body has an outer diameter of 137.8 cm and is 124.5 cm high. It has a cylindrical cavity 51.4 cm in diameter and 58.4 cm long. The walls and end of the cask body are at least 33 cm thick.

Eleven circumferential fins, 10.2 cm in height, are located on the outer cylindrical surface of the cask to promote heat transfer from the cask body to the ambient air. The fins, an integral nonwelded part of the container walls, are complete except where portions are removed to enable attachment of the trunnions and lifting fixtures.

The solid-stainless-steel basket is 51.1 cm in diameter and 58.2 cm high. Holes are bored in the basket to house the radioactive capsules. Four baskets (4-, 6-, 12-, 16-hole) were designed to allow the transport of a specific number of capsules according to their thermal power level.

Impact limiters are attached to each end of the cask to reduce large forces induced on the cask by an accident. They are made of polyurethane foam encased in stainless steel.

4. Experimental Apparatus

4.1 Test Hardware and Instrumentation

Sixty-four Chromel-Alumel (Type-K) thermocouples were used to monitor cask temperatures during the test. The thermocouples were protected by a magnesium oxide insulation and an Inconel sheath 0.159 cm in diameter. The calibration ($\pm 0.75\%/^{\circ}C$) of all thermocouples was verified by a comparison method using a tube furnace.[5]

The calibration procedure consisted of measuring (1) the net thermal electromotive force (emf) of the thermocouple being calibrated (from ambient to 650°C) at 12 calibration points, and (2) the temperature of each calibration point with a Type S reference thermocouple. In addition, before and after installation of all thermocouples, a resistance check and an operational test were performed. An Autodata-10 data logger with two magnetic tape recorders was used to monitor the thermocouple voltage signals.

Thermocouples were placed on the cask body, the 12-hole basket, and the two insulator end-caps. The placement of the thermocouples within the basket provided data for axial and radial temperature profiles. The axial locations for the thermocouples on the cask body were selected to correspond to the elevations of the internal thermocouples. The external thermocouples on the cask body provided circumferential temperature profiles at three elevations and axial surface temperatures at four locations.

The basket was instrumented with 26 thermocouples (Figure 3). The capsule holes at 45°, 135°, 225°, and 315° were instrumented with three thermocouples each at the indicated elevations. The centerline of the basket had two thermocouples. The remaining 12 thermocouples were placed at three different elevations in vertical grooves on the periphery of the basket. The thermocouple leads were routed to the top of the basket and bundled (Figure 4). The wires were secured to the top of the basket with nichrome strips, taking care to ensure that the wires and connectors did not interfere with installation of the source capsules. Extension wires were connected to the thermocouple leads and routed out the bottom port.

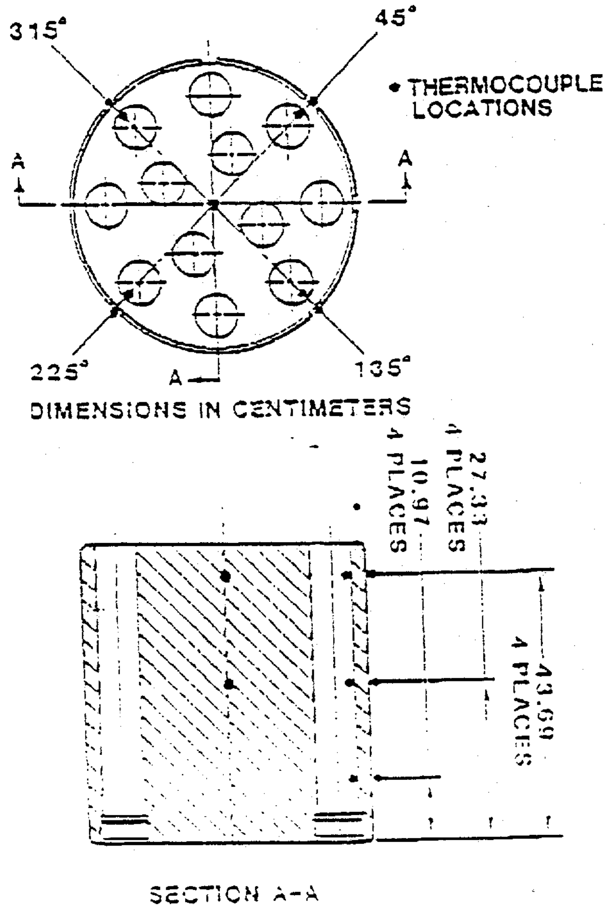


Figure 3. Locations of the thermocouples on the basket

Thermocouple locations on the cask body are shown schematically in Figure 5. The cask was instrumented with 20 thermocouples internally and 18 thermocouples externally. The thermocouples were spot-welded in place at different elevations on the interior surface of the cask, with the leads routed to the bottom of the cask and out the bottom port. The exterior thermocouples were spot-welded between fins.

To provide a worst-case situation in terms of cask temperatures, the top and bottom of the cask were insulated with preconstructed insulating end-caps. The insulators are low-carbon-steel shells, with an outer diameter of 182.9 cm and a height of 124.5 cm. They are filled with moderate-density (128 kg/m^3) fibrous insulation. Each end-cap insulator was instrumented with one thermocouple. Two thermocouples were used to measure the environmental temperature. Figure 6 shows the relative size of the insulators and how they fit on the cask body. Construction details are given in Appendix A.

4.2 Calorimeter Description and Operation

The WESF calorimeter was used to measure the energy output from the radioactive decay of the individual capsules. The calorimeter is shown schematically in Figure 7. It is constructed of 304 stainless steel, except for the lead shield and fiberglass insulation.

The inner tank contains the calorimeter bath water. During operation, the tank is filled with ~22 L of demineralized water. The air sparge is used to agitate the water in the inner tank. This agitation maintains a uniform temperature throughout the inner tank and dilutes any hydrogen build-up caused by radiolytic decomposition of the water.

Before it is placed in the calorimeter, the capsule is quenched in cooling water for ~1 hr. Once it reaches steady state within the water, the capsule is quickly transferred to the calorimeter. The rate at which the water temperature rises within the calorimeter is recorded for 30 min.

After the temperature data are collected, the capsule is removed from the calorimeter. If the radioactive decay of another capsule is to be measured, the calorimeter is refilled with water 2°C to 3°C cooler than the ambient air temperature, and the procedure is repeated. Reference 6 details the calibration and accuracy (—10% to 5%) of the WESF calorimeter.

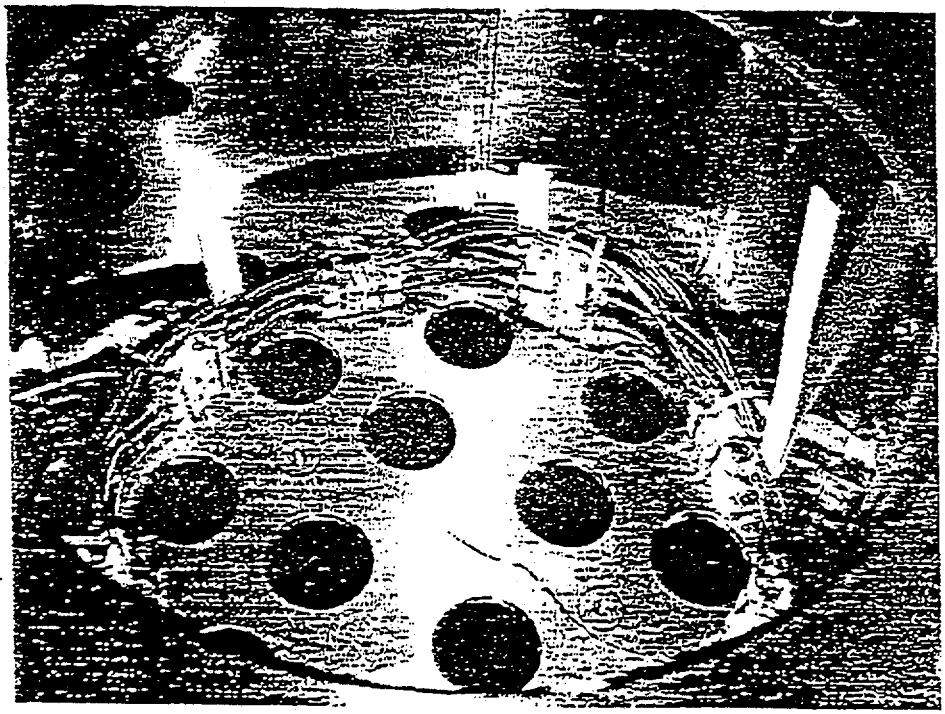


Figure 4. BUSS cask with the instrumented basket in place

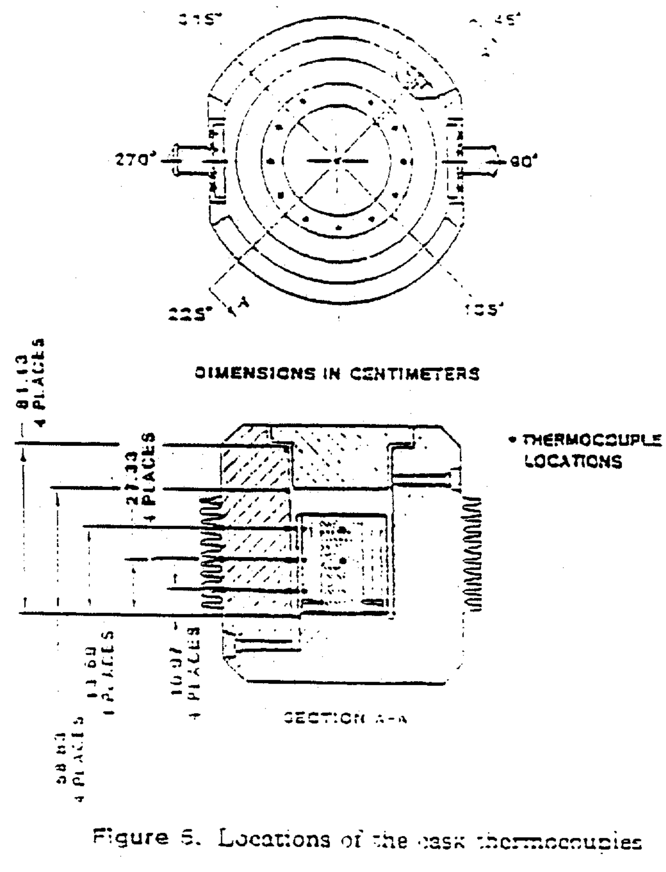


Figure 5. Locations of the cask thermocouples

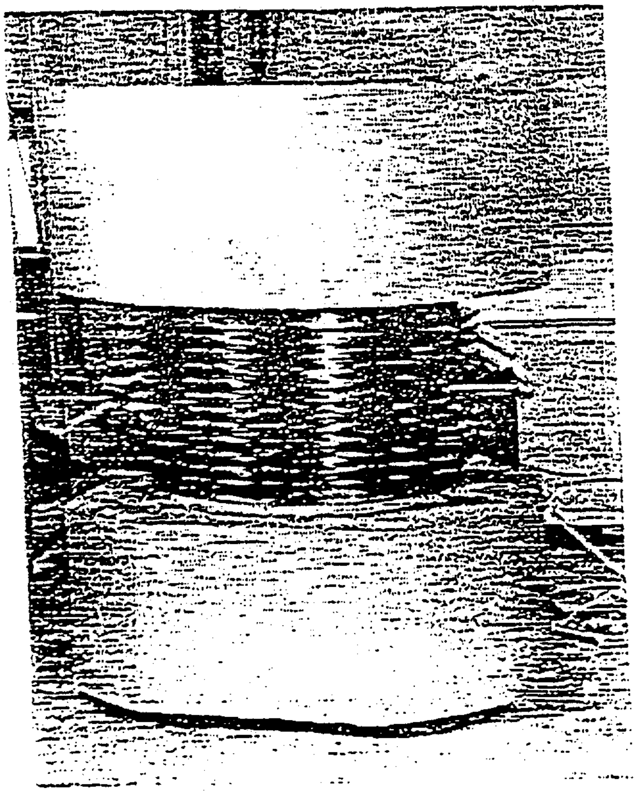


Figure 6. Cask body with insulators

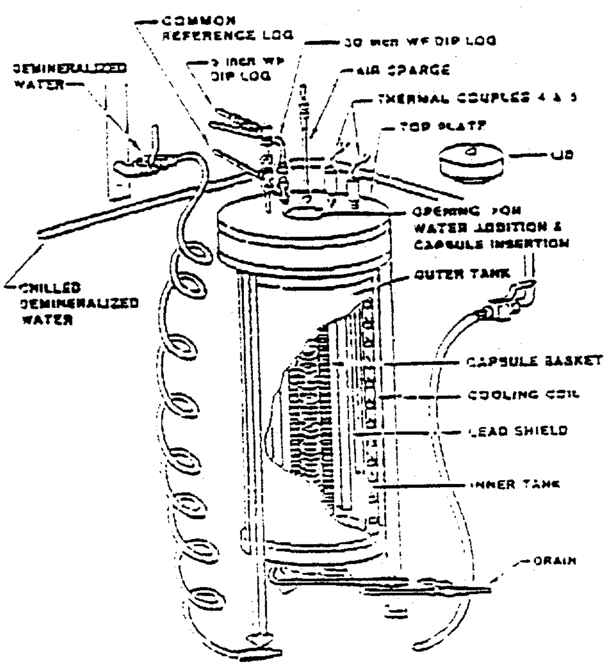


Figure 7. WESF capsule calorimeter

5. Test Procedure

Before the hot-cell operations (i.e., the BUSS thermal test) started, a model of the BUSS cask and basket was fabricated for training and verification of the remote-handling operations for the capsule. The BUSS cask model was fabricated from rolled, mild-steel sheets (Figure 8). The interior of the model (Figure 9) included a mockup of the basket and the thermocouple connectors. The hot-cell operators used the model, in a hot-cell simulator, for training in remote handling of the source capsules with the eccentric lock-lifting device (Figure 10).

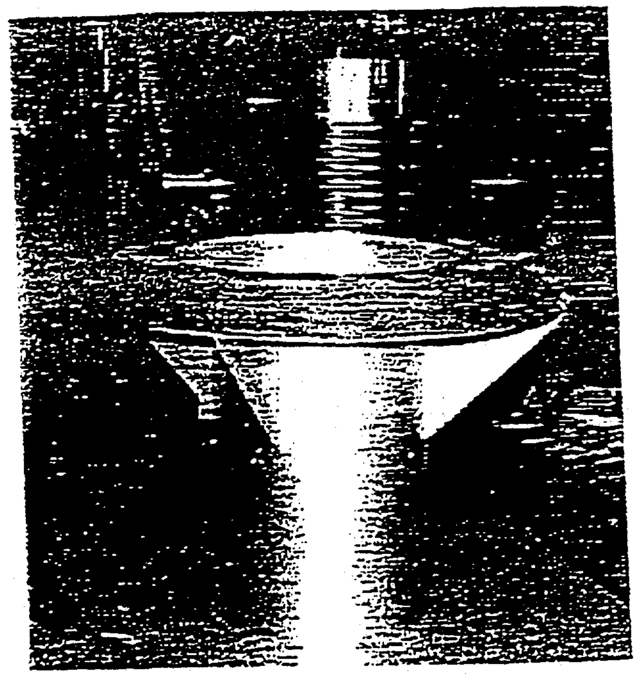


Figure 8. Model of the BUSS cask fabricated for operational test and training

The full-scale thermal test was conducted at the Rockwell International Hot Laboratory (RIHL) in Santa Susanna, California. The floor plan of RIHL is shown in Figure 11. The test was performed in HOT-CELL-1, whose physical dimensions were 4.2 m × 3.0 m × 5.2 m. The BUSS cask will be transported in a horizontal configuration (Figure 1). However, because of the large size of the cask and the difficulties in rotating the cask within the hot cell, the BUSS cask was tested in the vertical position.

The data acquisition system was moved through the operation gallery and placed just outside the hot cell (Figure 12). All instrumentation wires were routed from the recording system into the cell through a shielded "through-tube."

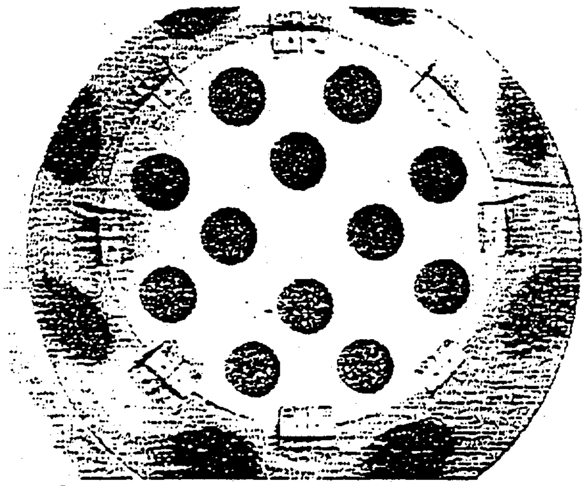


Figure 9. Interior mockup of the BUSS cask

The cask and end-cap insulators were moved into the cell through the service gallery using forklifts and heavy-duty carts. The cask body, basket, and bottom end-insulator assembly were first placed in the hot cell. Then, a transportation cask carrying the 12 cesium chloride capsules was moved through the service gallery into the cell and placed near the BUSS cask.

Once the cell was secured, the lid of the transportation cask was removed remotely by using the in-cell crane. The baskets were removed from the transportation cask, and each capsule was visually inspected and smear-surveyed to assure that it was free of removable contamination. The 12 cesium chloride capsules then were unloaded remotely from the transportation cask and loaded into the instrumented BUSS cask. Figure 13 shows the BUSS cask loaded with the 12 cesium chloride capsules.

Once the BUSS cask was loaded, the lid was placed on it. The transportation cask was removed from the cell, and the top end-cap insulator was moved into the cell and installed.

The two thermocouples used to monitor the cell temperature were draped from the top insulating end-cap (Figure 14). The BUSS cask temperatures were recorded continuously for ~10 days. When the thermal test was completed, the thermal energy resulting from the radioactive decay of the individual capsules was measured by calorimetry.

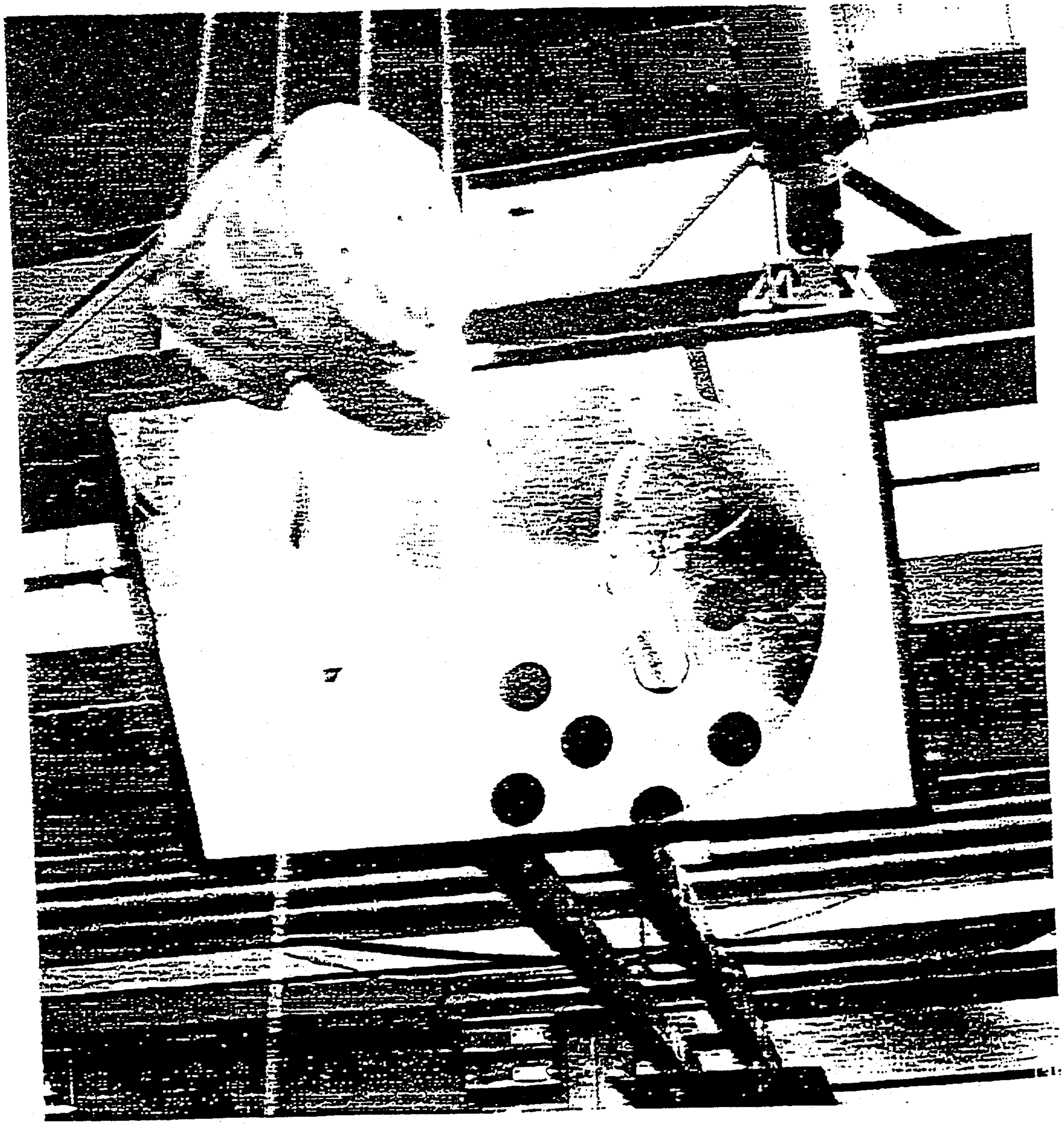
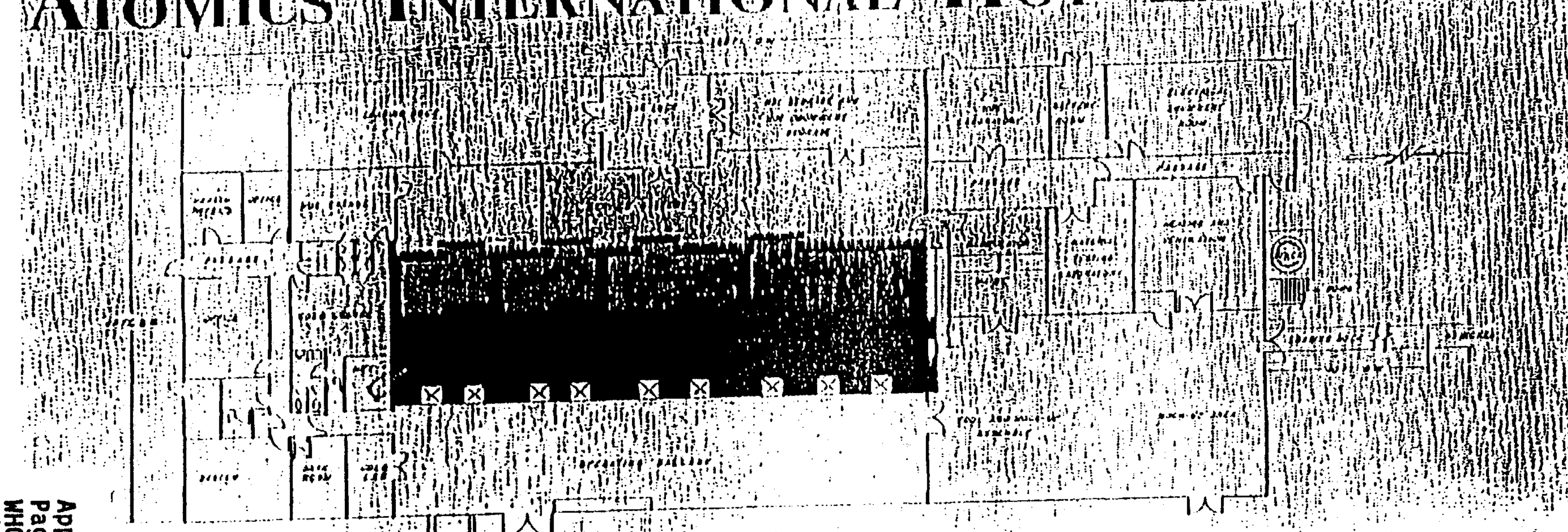


Figure 10. Operator training in the use of the capsule's eccentric lock-lifting device

ATOMICS INTERNATIONAL HOT LABORATORY



FACILITY

- 16,000 SQUARE FEET
- 4 HOT CELLS (MULTI MEGACURIE)
- OPERATING GALLERY
- 4 DECONTAMINATION ROOMS
- SERVICE GALLERY
- CONTAMINATED EQUIPMENT STORAGE AREA
- MECHANICAL TEST LABORATORY
- MOCK UP AREA - SAME SIZE AS CELL
- SUPPORT ASSEMBLY SHOP
- CHANGE ROOM
- PHOTO LABORATORY
- OFFICE AREA
- BASEMENT WITH ABSOLUTE FILTER SYSTEM
- CASK HANDLING EQUIPMENT (UP TO 50 TON, 30 FEET LONG)

HOT CELLS

- CELL WALLS: 42 INCH THICK DENSE CONCRETE
- CELLS ARE INTERCONNECTED
- CELLS CAN BE INDEPENDENTLY OPERATED WITH NITROGEN ATMOSPHERE, < 4% OXYGEN
- CELL 1 & 2 - 16 FT x 10 FT x 17 FT HIGH
- CELL 3 - 20 FT x 10 FT x 17 FT HIGH
- CELL 4 - 33 FT x 10 FT x 17 FT HIGH
- WINDOWS - 24 INCHES x 19 INCHES x 42 INCHES THICK

CELL EQUIPMENT

- 6,000 POUND HOIST
- C R L MODEL 8 MANIPULATORS
- GENERAL MILLS OR P A R MANIPULATORS
- KOLLMORGEN PERISCOPES
- AIR CONDITIONING
- CLOSED LOOP WATER SYSTEM
- NITROGEN PURGE SYSTEMS
- THRU TUBES

Rockwell International
Atomics International Division

Figure 11. Floor plan of the Rockwell International Hot Laboratory

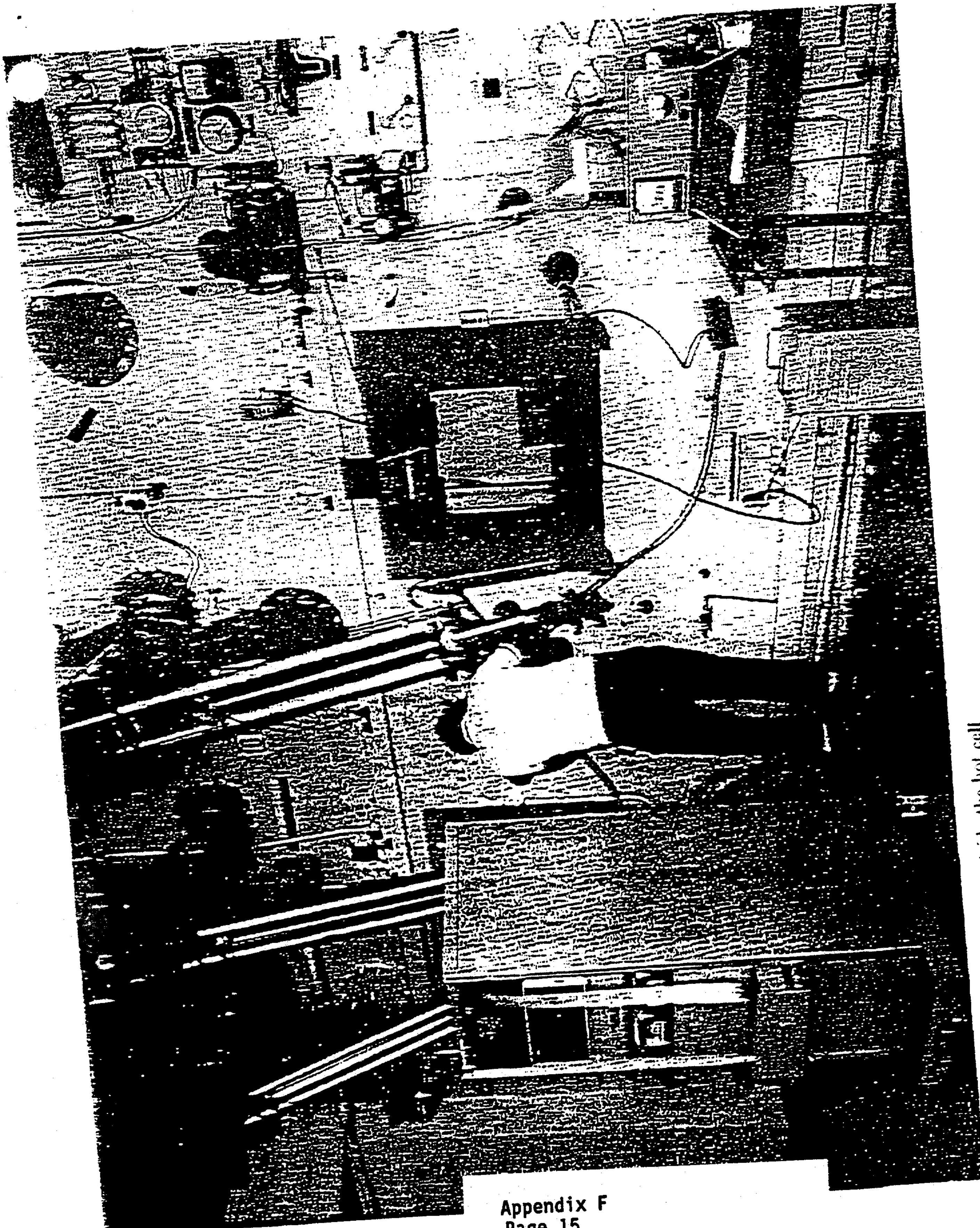


Figure 12. Data acquisition system outside the hot cell

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Figure 13. The BUSS cask loaded with 12 cesium chloride capsules

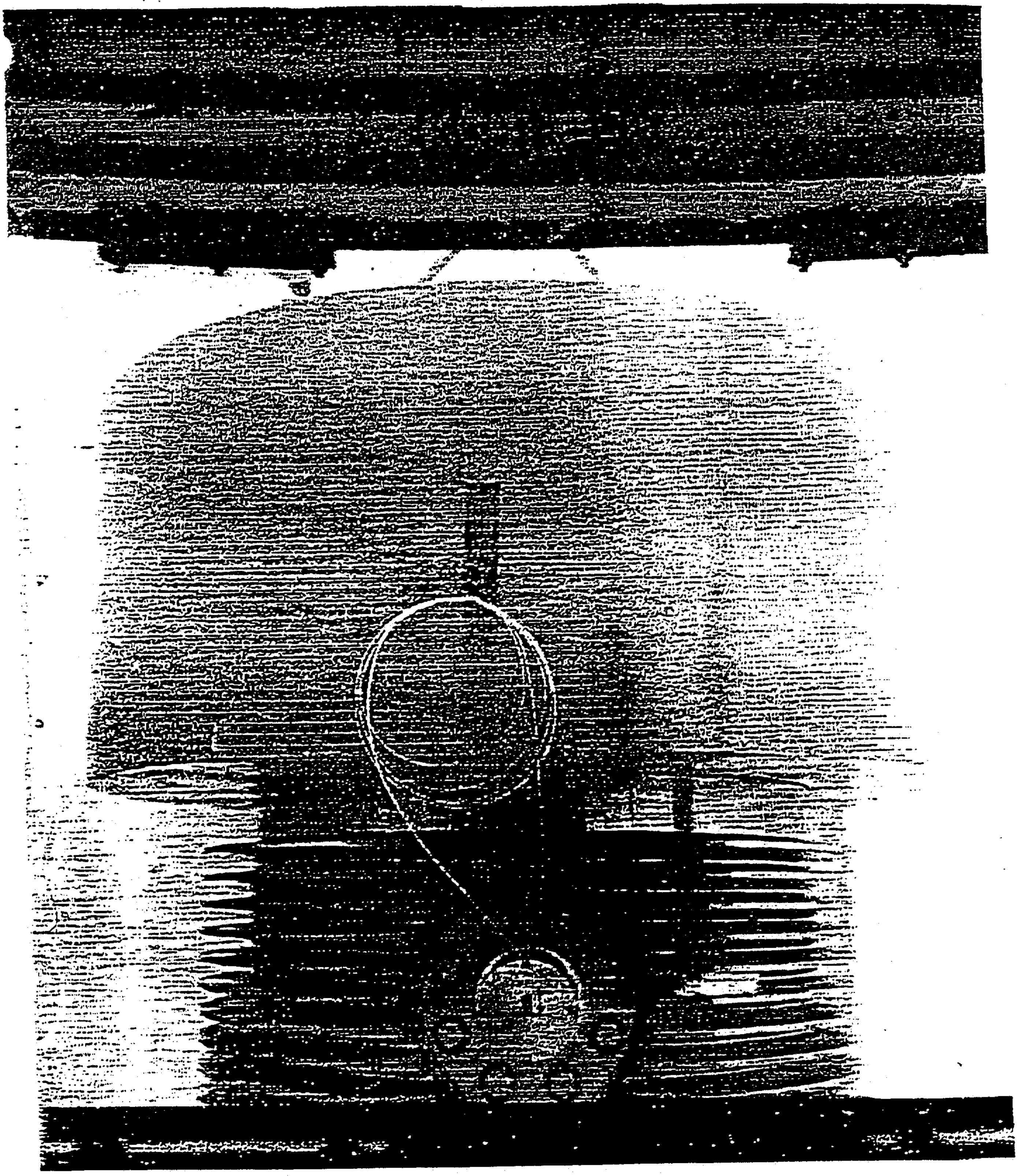

Figure 14. Thermocouple draped from the top insulating end-cap

6. Experimental Results

6.1 Calorimetry Results

Based on posttest calorimetry results,[7] the capsule heat rates averaged 265 W/capsule. Therefore, the 12 capsules produced a total thermal heat load in the cask of ~3.2 kW. The radionuclide content of the cesium chloride capsules was estimated to range from 53 to 60 kCi/capsule. Table 1 summarizes the calorimetry results.

Table 1. Calorimeter test results

Capsule Number	Radionuclide Content (kCi)	Calorimetry Decay Heat (W)	Date Tested
C48	56.09	277.09	11/01/85
C57	54.14	258.25	11/04/85
C58	58.62	279.62	10/30/85
C76	53.99	257.53	10/30/85
C77	52.93	252.48	10/31/85
C93	52.67	251.24	11/04/85
C114	54.66	260.73	11/01/85
C116	53.21	253.31	10/31/85
C118	59.74	284.96	10/31/85
C119	59.71	294.82	10/30/85
C120	52.37	252.19	11/04/85
C121	54.98	262.25	11/01/85

Figure 15 is a schematic of the location of the capsules within the instrumented basket.

6.2 Transient Temperature Results

In Figure 16, the temperatures at five locations through the midplane of the cask are plotted for the thermocouple station located at 135° (Figures 3 and 5). The recorded temperatures at the other thermocouple stations along the midplane were similar and differed by a maximum of only 22°C. Thus, the temperatures at the midplane were essentially uniform.

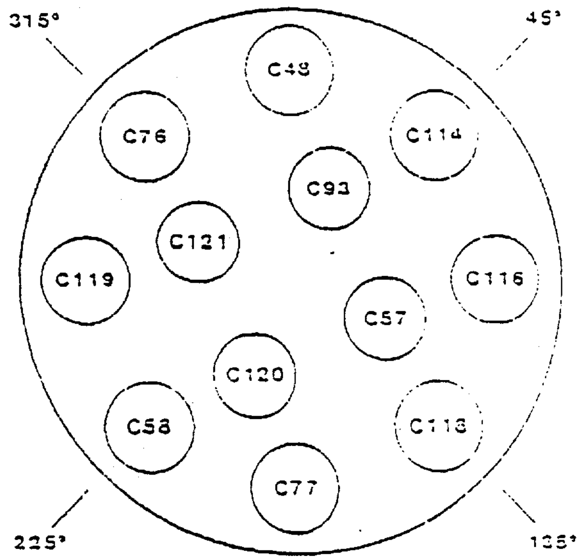

Figure 15. Location of capsules within the instrumented basket

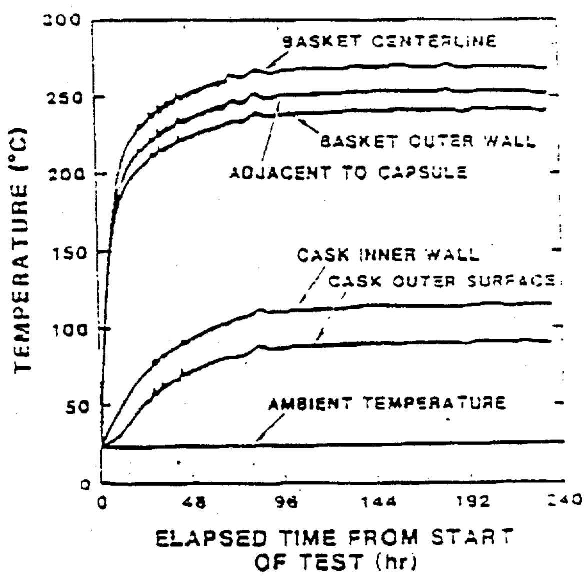

Figure 16. Transient thermocouple temperatures

The results in Figure 16 show a more rapid increase in the temperature of the basket (the top three curves) than in the cask body. The basket temperature rose to 120°C in the first few hours. In the same time period, the surface temperature of the cask had not changed. In essence, the air gaps separating the capsules from the basket and the basket from the cask body had decoupled the thermal responses of the cask body and the basket. As a result, the cask surface did not indicate internal temperatures until many hours had elapsed. The thermocouple at the centerline of the basket recorded the highest temperature. However, the maximum system temperatures occur in the cesium chloride capsules, which were not instrumented for the test.

All thermocouple data obtained during the test are included in Appendix B. The oscillations in the curves are due to extraneous noise produced by surrounding high-voltage mechanical equipment.

6.3 Steady-State Results

Steady state was reached after ~96 hr (Figure 16). The steady-state temperatures are given in Figure 17 as a function of the longitudinal distance from the bottom of the basket to the top of the cask. These temperatures are averaged values from the four circumferential thermocouple stations (Figures 3 and 5).

The results in Figure 17 show large temperature gradients from the bottom to the center of the basket. The gradients were less from the center to the top of the basket. The high-temperature gradients in the lower half of the basket result from the contact of the capsules with the surface of the basket and the contact of the lower surface of the basket with the cask body (Figure 4). The bottom of the cask body provides the path of least resistance and promotes heat conduction in the longitudinal direction. The air space between the cask lid and the basket accentuates this effect by acting as an insulator. The convective heat loss from the top of the basket is minimal compared to the conductive heat loss through the bottom of the basket. The steady-state temperatures of the cask in Figure 17 are uniform from the bottom to the top of the cask.

6.4 Shielding Data

Cursory gamma radiation measurements at the surface of the cask were made with a Geiger counter. The peak dose rate was 160 mrem/hr at the top port. The bottom port and the lid bolt holes (without the bolts inserted) read 75 mrem/hr and 30 mrem/hr, respectively. The dose rate along the remainder of the package surface was <25 mrem/hr.

Under normal transport conditions, the ports will be covered with a drain plug and a thermal cover. Consequently, the dose rate at the ports will be considerably less than reported above.

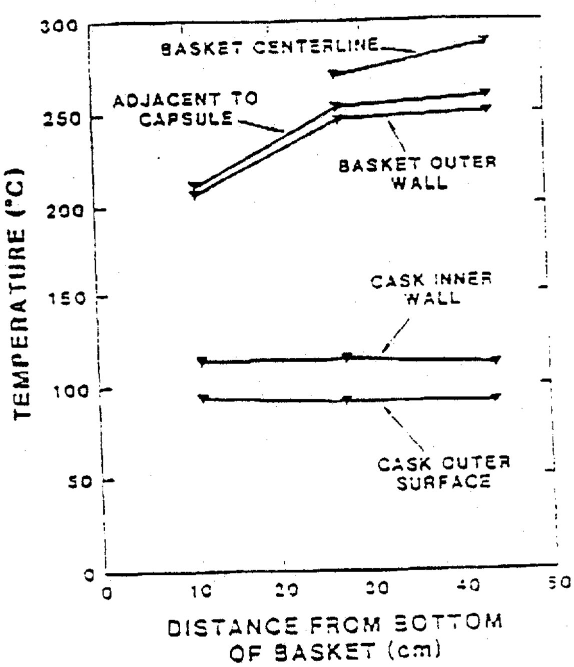

Figure 17. Average steady-state thermocouple temperatures

7. Thermal Analysis

7.1 Description of Thermal Analysis Codes

The thermal response of the BUSS cask was evaluated with state-of-the-art, finite-element modeling techniques (Q/TRAN) and with pre- and postprocessing software (PATRAN).[9] Because Q/TRAN is a fairly new code, another thermal model was developed using Systems Integrated Numerical Differencing Analyzer (SINDA). Results from SINDA and the experimental data will be used to validate the Q/TRAN code.

7.1.1 Q/TRAN-PATRAN

Q/TRAN is a new thermal analysis code developed by F. A. Rockenbach of PDA Engineering, Inc., Costa Mesa, California. The program solves heat-transfer problems using a combination of the thermal network approach and the finite-element method.

Q/TRAN was integrated into PATRAN, a finite-element modeling program. Linking capabilities between Q/TRAN and PATRAN include both pre- and postprocessing, allowing graphic display of meshing schemes and thermal results. The Q/TRAN-PATRAN link uses finite-element theory to translate the mesh data (with second-order truncation error or linear elements) into a finite-difference (resistor/capacitor) thermal analysis.[10] The link exactly maps the higher-order, finite-element difference scheme, as opposed to using a network approximation to the finite-element mesh. Therefore, Q/TRAN-PATRAN offers the capacity to increase the complexity of the model over previous computer codes, improving the ability to predict the response of nuclear shipping casks in varying thermal environments.

7.1.2 SINDA-HEATMESH

The thermal model SINDA uses the finite-difference method to solve problems governed by diffusion-type equations. These equations are modeled by a lumped-parameter representation and are solved by a general thermal analyzer using a resistor-capacitor network scheme. The finite-difference grid for SINDA was generated with the computer code HEATMESH-71.

The medium being studied is divided into parts. Each part is divided into nodal points to form the finite-difference mesh. HEATMESH-71 calculates geometric data such as element volume, nodal coordinates, and conduction paths to obtain the conductance values between nodes. The code also provides a graphics package to plot the mesh, the nodal point locations, and the conduction paths between nodal points.

7.2 Description of Thermal Model

From the geometric description of the cask, PATRAN was used to generate a two-dimensional (r,Θ) finite-element mesh. Because of symmetry, only one-eighth of the cask was modeled. Figure 18 shows the mesh used for the Q/TRAN thermal model. Table 2 gives the dimensions of the cesium chloride capsule, inner and outer cladding, and air gaps.

A similar mesh was produced for the SINDA thermal model. The Q/TRAN nodal points are located where the mesh lines in Figure 18 intersect, and the SINDA nodal points are located at the geometric center of the grid volumes.

Table 2. Basket geometry of the cesium chloride capsule

	Dimension (cm)
Capsule radius	2.62
Inner cladding wall thickness	0.24
Air gap between inner and outer cladding	0.20
Air gap between capsule and basket	0.31
Capsule length	50.10
Outer cladding wall thickness	0.28

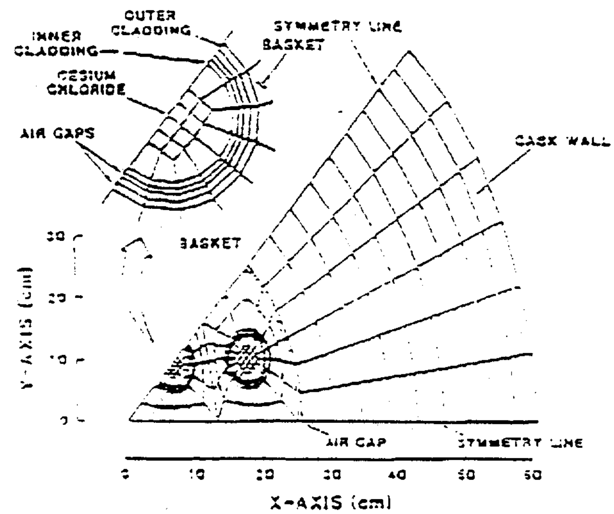

Figure 18. Q/TRAN finite-element mesh

7.2.1 Internal Model

In the model, all air gaps were modeled as annuli. The air gaps are located between the cask wall and the basket, the basket and the capsule, and the outer and inner capsule cladding. Heat transfer across the gaps was assumed to occur only by conduction and radiation.

The thermal load of cesium-137 (265 W/capsule), the radionuclide of cesium chloride, was distributed throughout the interior portions of the cask based on the energy deposition profile calculated with a three-dimensional, finite-element particle transport code (additional details in Ref. 2). About 50% of the decay energy is transported to and absorbed by the capsule cladding, the basket, and the cask wall. The rest of the heat released during the radioactive decay of cesium-137 is deposited within the cesium chloride.

7.2.2 Boundary Conditions of the urface of the Cask

Energy is dissipated from the external surface of the cask by free convection and thermal radiation. Convection heat transfer is enhanced by 11 annular fins. They are 10.2 cm long, evenly spaced on 5.1-cm centers, and are of non-uniform cross section. They taper 5° from the base to a 1.3-cm flat edge at their tip.

The fins were modeled as annular, with a rectangular profile. Fin thickness was assumed to be 1.3 cm, conservative because less surface area is available for heat dissipation.

With the fins in place, the convective heat-transfer rate from the cask surface is

$$q_c = q_f - q_o \, . \tag{1}$$

The heat-transfer rate from the fins is given by

$$q_f = N\eta q_{max} \, , \tag{2}$$

where q_{max} is the heat-transfer rate if the entire fin was maintained at the base temperature, and is defined as

$$q_{max} = 2\pi h(r_c^2 - r_o^2)(T_1 - T_\infty) \, .$$

The heat transfer from the unfinned surface, q_o, is

$$q_o = hA_o(T_1 - T_\infty) \, . \tag{3}$$

Hence, substitution of Eqs (2) and (3) into Eq (1) yields

$$q_c = 2\pi h(T_1 - T_\infty)\,[N\eta(r_c^2 - r_o^2) + (H - Nt)\,r_o] \, . \tag{4}$$

Fin efficiency η[12] was calculated using

$$\eta = \left[\frac{2r_o}{m(r_c^2 - r_o^2)}\right] \times \left[\frac{I_1(mr_c)K_1(mr_o) - K_1(mr_c)I_1(mr_o)}{I_0(mr_o)K_1(mr_c) - I_1(mr_c)K_0(mr_o)}\right] \tag{5}$$

Using conservative values for the thermal conductivity of steel (14.3 W/m °C), the convective heat-transfer coefficient (5 W/m^2 °C), and the appropriate physical dimensions of the fin, we calculated the fin efficiency as defined in Eq (5) to be 0.80.

All values needed to determine the convective portion of total heat transfer are known; thus, Eq (4) is applied as a convection boundary condition to the two-dimensional thermal model.

The cavity formed by two adjacent fins (Figure 19) was modeled as a diffuse gray enclosure with a nonparticipating medium. The fins were assumed to be rectangular, 10.2 cm long, 1.3 cm thick, and spaced 3.8 cm apart. The total energy dissipated by thermal radiation is given by

$$q_R = q_{enclosure} - q_{fin-tip} \, , \tag{6}$$

where the energy leaving the enclosure was expressed as

$$q_{enclosure} = \frac{\sigma(T_1^4 - T_\infty^4)}{R_{1-\infty}} + \frac{\sigma(T_2^4 - T_\infty^4)}{R_{2-\infty}} \tag{7}$$

where

$$R_{m-n} = (1 - \epsilon_m)/(\epsilon_m A_m) - 1/A_m F_{m-n}$$
$$- (1 - \epsilon_n)/(\epsilon_n A_n) \, , \text{ for } m = 1,2 \text{ and } n = \infty \, .$$

The energy leaving the fin tip is given by

$$q_{fin-tip} = A_3\sigma(T_3^4 - T_\infty^4)/(1/\epsilon_3 + 1/\epsilon_\infty - 1) \, . \tag{8}$$

All values of emissivities ($\epsilon_1, \epsilon_2, \epsilon_3$, and ϵ_∞) were assumed to be 0.5.

Because the fins are long and slender, and steel has a high thermal conductivity, it is assumed the fins are at uniform temperature equal to the temperature of the cask surface:

$$T_1 = T_2 = T_3 \, .$$

Thus, Eqs (7) and (8) can be combined into Eq (6) to approximate the thermal radiation dissipated by the cask surface.

The fins were not explicitly modeled. An effective outer radius was calculated and used in the thermal model to account for the added thermal mass of the fins.

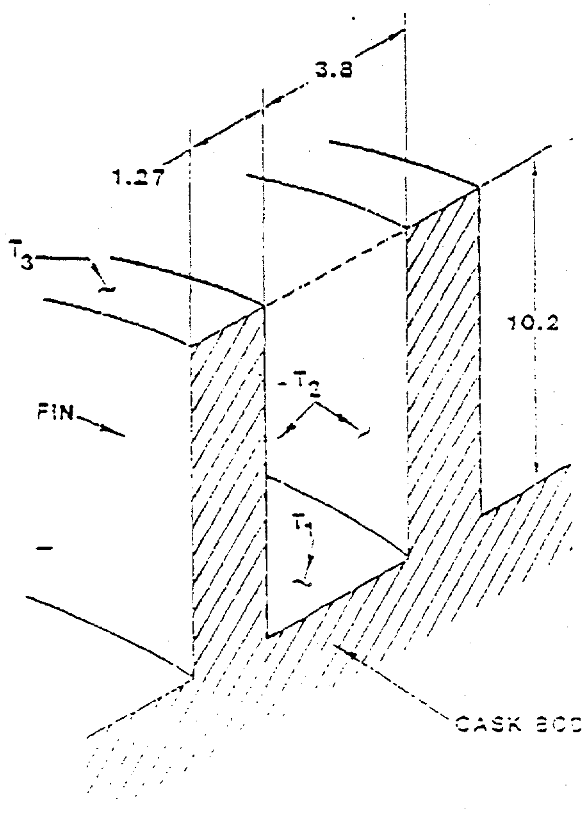

Figure 19. Geometry of the BUSS cask model's fin

8. Comparison of Experimenal and Analytical Results

8.1 Steady-State Results

Figure 20 shows a comparison of the radial steady-state temperature distributions for the experimental results and the calculated values from Q/TRAN and SINDA. The predicted values were higher in the basket than the measured values; however, the results compared well in the cask region. The discrepancy was due to the thermal models' conservative assumptions of uniform annular air gaps between cask components, and to the omission of axial heat flow.

During the experiment, the air gaps were not annular and the capsules were in contact with the basket. To account for the contact resistance between the capsule and the basket, an effective thermal conductance was specified for the air gaps. The best agreement between the experimental and calculated values was found when the air-gap conductance was increased by a factor of 2. Increasing the air-gap conductance also improved the comparison between the Q/TRAN and SINDA results (Figure 21).

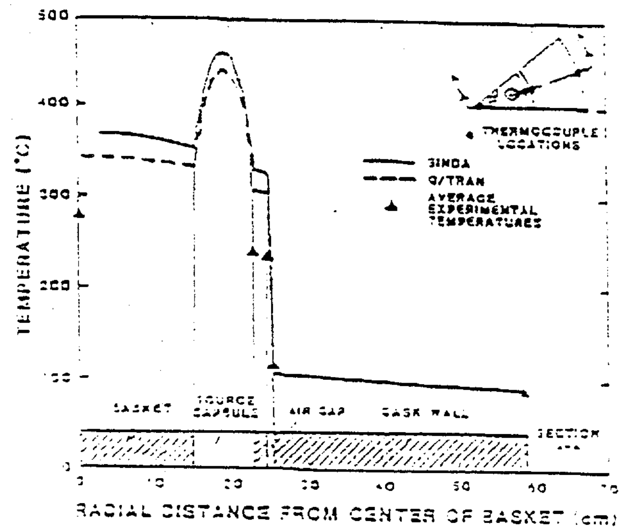

Figure 20. Comparison of experimental and calculated steady-state results

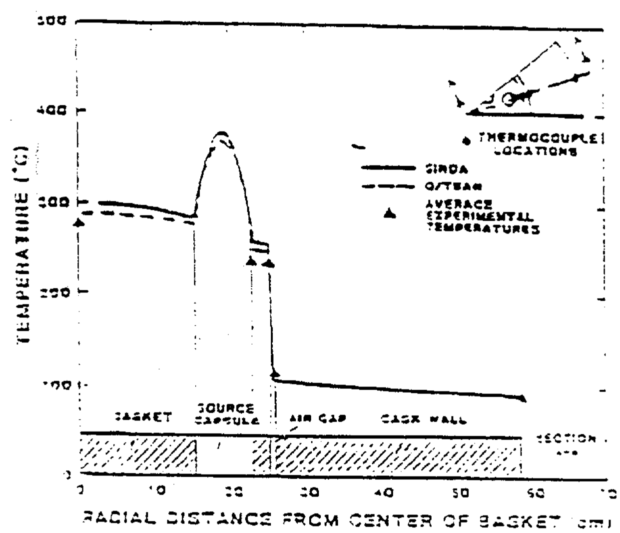

Figure 21. Comparison of experimental and calculated steady-state results, doubling air-gap conductance

The results in Figures 20 and 21 show that SINDA predicts higher basket and capsule temperatures than Q/TRAN. However, both SINDA and Q/TRAN agree well in the cask region, and the two models follow the same temperature behavior. The SINDA thermal model did not include the fins at the surface of the cask body. Instead, a boundary temperature condition was specified that was equal to the experimental value.

8.2 Transient Results

For the transient analysis, the air-gap conductance was increased by a factor of 2 to account for the contact resistance and the nonannular air gaps between the capsules and the basket. Because the initial temperatures of the capsules were not known, it was assumed that initial capsule temperatures were those predicted by the steady-state analysis (Section 8.1) with annular air gaps. The initial temperature of the rest of the BUSS Cask system was the ambient level of 20°C. Figure 22 shows good correlation between the transient results predicted by both models. The results also show that the temperature of the source capsule drops immediately within the first few hours because of the large temperature gradients between the capsule and the surrounding basket and cask. As the basket and cask begin to heat up, the temperature gradients begin to decrease, which causes the capsule to heat up once again.

Figure 23 shows a comparison of the experimental results and the calculated values from Q/TRAN. In the earlier part of the analysis, Q/TRAN predicts slightly higher temperatures than the experimental temperatures. However, both the experimental and calculated values follow the same temperature behavior and agree extremely well during the latter part of the analysis. The discrepancy between the calculated and measured values during the early part of the solution is most likely due to the discretization error and the uncertainty in the initial conditions for the source capsules. The discretization error in the solution is due to replacement of continuous domain by the discrete model with finite capacitance. As the solution approaches the steady-state values, the error associated with the use of finite capacitance and uncertainty in the initial conditions is reduced. Thus, the discrepancy between the calculated and the measured values decreases.

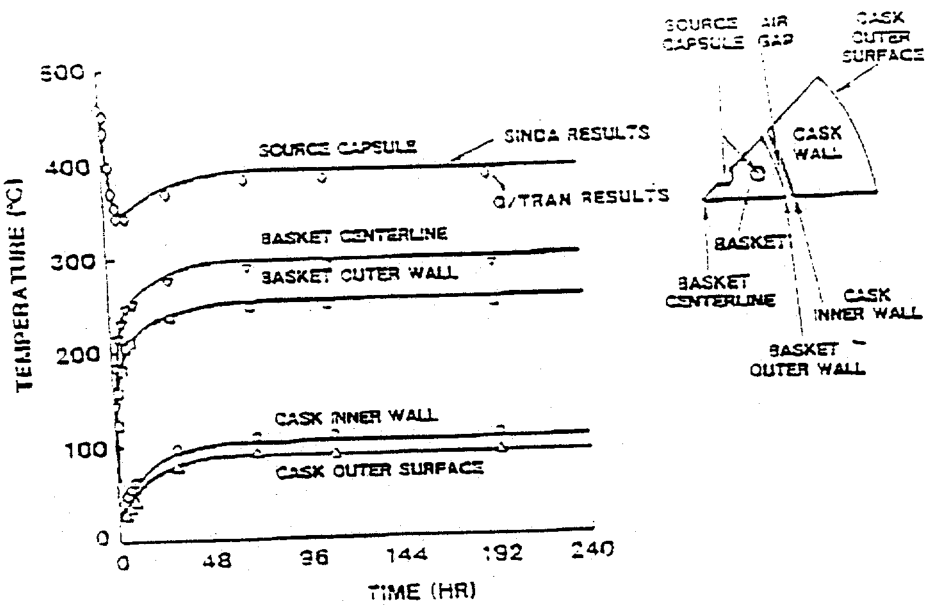

Figure 22. Comparison of transient results from SINDA and Q/TRAN

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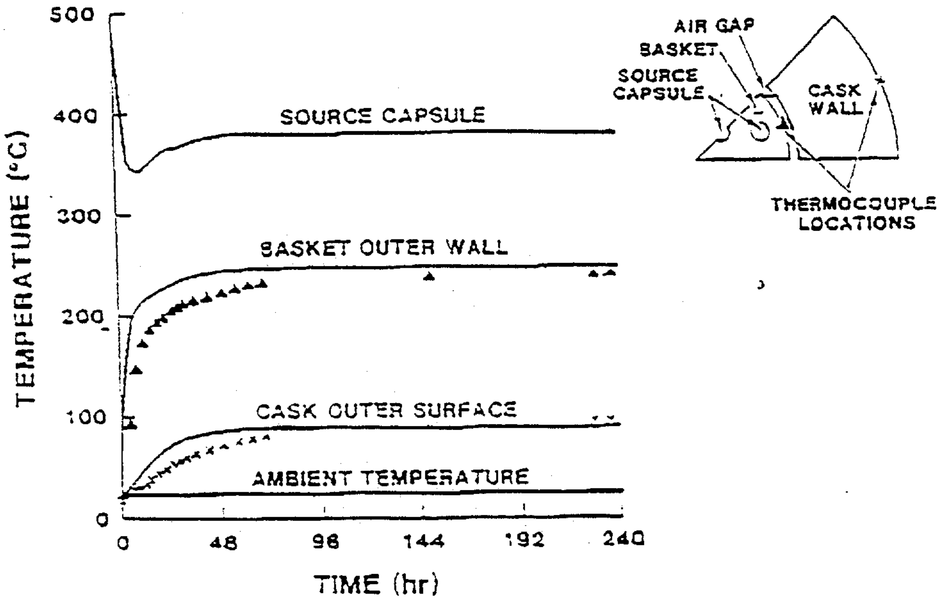

Figure 23. Comparison of experimental and calculated transient results, doubling air-gap conductance

8.3 Operational Start-Up Curve

The calculated and measured transient thermal responses will be used to assist in verifying proper loading of the capsules in the BUSS cask. Before shipping radioactive material, the shipper must ensure that the package and its contents satisfy the requirements of the Certificate of Compliance and the Safety Analysis Report. Typically, steady-state thermal measurements are taken to verify proper thermal loading of the cask. However, the thermally massive BUSS cask requires many hours to reach steady-state conditions. The BUSS cask thermal test and analysis show that if the ambient environment conditions are well-defined, the transient surface temperature of the cask can be predicted with confidence. Thus, an equation was developed, using the thermal test data, to predict the cask thermal load, given the surface temperature at a particular time.

To derive the mathematical equation, we considered the cask body to be of infinite conductivity, and initially at a uniform temperature of T_∞. Performing an energy balance on the cask body yields

$$q - q_{stored} = q_{conv} - q_{rad} \tag{9}$$

The term q is the heat produced by the capsules and transferred to the inner surface of the cask, and q_{stored} is the energy stored by the cask body. The right side of Eq (9) is the heat loss from the external surface of the cask by free convection and thermal radiation. Equation (9), for a small time interval, can be rewritten as

$$q - MC_p(dT/d\tau) = h_T A_0(T - T_\infty) \,. \tag{10}$$

In Eq (10), the radiation term has been linearized and combined with the convection term. Thus, the parameter h_T represents a global heat-transfer coefficient. If all the parameters in Eq (10), except T and τ, are constant, then Eq (10) can be transformed into a first-order differential equation whose solution is of the form

$$T(\tau) - T_\infty = C_1 \exp(-\tau/\omega) - q \cdot R \,, \tag{11}$$

where C_1 is an integration constant, ω is the system characteristic time defined as

$$\omega = \frac{MC_p}{h_T A_0} \,. \tag{12}$$

and R is the lumped cask surface thermal resistance defined as

$$R = \frac{1}{h_e A_o}. \qquad (13)$$

The constant C_1 is solved from the initial condition

$$T = T_o \text{ at } \tau = 0. \qquad (14)$$

If it is assumed that the initial temperature of the cask is at the ambient temperature ($T_o = T_\infty$), then the constant C_1 from Eq (11) is

$$C_1 = -q \cdot R \qquad (15)$$

Substituting C_1 into Eq (11) gives the result

$$T(\tau) = qR\,[\,1 - \exp(-\tau/\omega)] + T_\infty. \qquad (16)$$

The numerical values of R and ω were determined by performing a least-square fit of the thermal test data to Eq (16). Figure 24 shows the results of Eq (16), with ω = 41.7 hr and 1/R = 48.2 W/°C. Therefore, if the measured surface temperature of the cask is significantly less than that predicted from Eq (16) when q is equal to the maximum allowed heat load (4 kW), the cask is ready to ship.

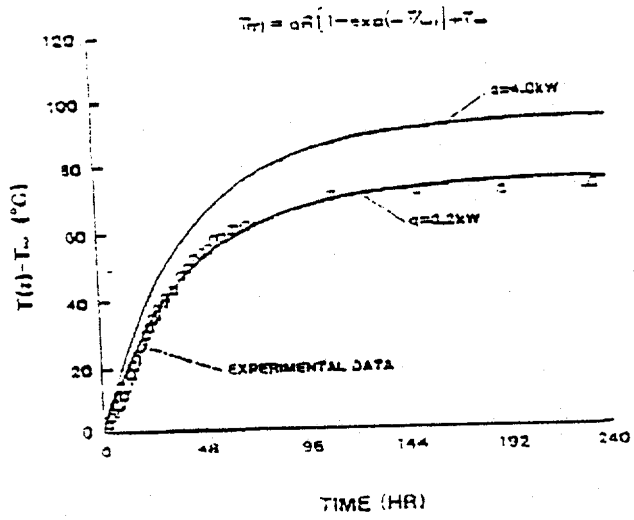

Figure 24. Cask surface temperature as a function of elapsed time

9. Summary and Conclusions

A full-scale thermal test was successfully conducted on the BUSS cask. The thermal test was designed to verify a two-dimensional axisymmetric Q/TRAN thermal model developed for the SARP.[2] Because Q/TRAN is a fairly new thermal code, another thermal model using SINDA was also developed and the results were compared with Q/TRAN results and experimental data.

The predicted steady-state values from both thermal codes were higher in the basket than the measured values; however, the results compared well in the cask region and thus validated the boundary conditions used to approximate the heat transfer from a finned surface. When the effective conductance in the air gap was increased to account for the contact resistance between the capsules and the basket, and the omission of axial heat transfer, comparison of the basket's experimental and calculated steady-state results showed good agreement. We therefore conclude that, as a result of the conservative assumptions of the thermal analysis, the actual system temperatures will be considerably lower than the reported values in the SARP.

The BUSS cask thermal test and analysis show that if the ambient environment conditions are well-defined, the transient surface temperature of the cask can be predicted with confidence. Typically, steady-state thermal measurements are taken to verify proper thermal loading of the cask during normal operation. However, the thermally massive BUSS cask requires many hours to reach steady state. Thus, an equation was developed using the thermal test data to predict the cask thermal load, given the surface temperature at a particular time. That equation, coupled with normal administrative controls, provides a simplistic, cost-effective, and redundant method to verify the cask thermal load.

References

[1]W. M. Rohsenow et al., eds., *Handbook of Heat Transfer Fundamentals*, 2nd Ed., pp 14-39 (New York, NY: McGraw-Hill, 1973).

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[12]D. Q. Kern and A. D. Kraus, *Extended Surfaces Heat Transfer*, pp 103 (New York, NY: McGraw-Hill, 1972).

Appendix G: Lid Closure Bolt Torque Tests

Sandia National Laboratories

P. O. Box 5800
Albuquerque, New Mexico 87185-0718

Managed by Martin Mariettta Corporation
for the U. S. Department of Energy

H. Richard Yoshimura
Transportation Systems Analysis

May 18, 1994

Dewey Robbins
Westinghouse Hanford Company
P. O. Box 1970
MS S6-65
Richland, WA 99352

Subject: Revised Lid Bolt Torque Value for Beneficial Uses Shipping System (BUSS) Cask

Dear Mr. Robbins:

As stated in Section 8.1.7 Lid Closure Bolt Torque Tests in the BUSS Cask Safety Analysis Report for Packaging (SARP), we have performed torque tests to validate the relationship between torque and preload on the 1 1/2 inch diameter A-286 lid closure bolts. This relationship is based upon a simplified formula described in Section 4.1.3 in Chapter 4, Containment.

Based upon our tests, (DBID:8E381 and 8E377), it is required that a torque value of 1250 ft-lbs be used for the lid closure bolts when using nuclear grade Neolube lubricant. This torque value replaces the value of 1125 ft-lbs specified in Chapter 7 of the SARP. EH33.2 (Robert Towell and Peter Turula) has been informed of our test results and the revised torque value and has concurred with the requirement. We have agreed to update the lid bolt torque value in the next revision of the SARP.

Please call me if you have any questions (505) 845-8181.

Sincerely,

H. R. Yoshimura

H. R. Yoshimura, Acting Manager
Transportation Systems Analysis
Department 6641

HRY:6641:kas

Copy to:
6631 C. Olson (Quality Assurance)
6643 D. R. Bronowski
BUSS Cask File
6641 H. R. Yoshimura

date: July 14, 1993

to: BUSS Cask File

D.R. Bronowski

from: D. R. Bronowski, 6643

subject: Test Results: BUSS Cask Lid Bolt Torque Versus Preload

Results of torque versus preload tests performed indicate that a torque value of 1250 foot-pounds be used for cask assembly operations. The BUSS cask safety analysis report for packaging (SARP) requires a lid bolt load of 45,000 per bolt to obtain and maintain an acceptable seal. Tests were performed in July of 1987 to establish the correlation between applied torque and resulting load for the operational BUSS cask lid bolts.

Results of this testing indicate that a torque of 1250 foot-pounds be applied to the lid bolts for normal operations as this is the value required to achieve average bolt loads of 45,000 pounds. This value is based on bolts lubricated with Neolube No. 1, dry film lubricant.

Test results yield a calculated coefficient of friction of approximately .22 versus to assumed value of .20 stated in Chapter 4 of the BUSS SARP.

Tests were performed following a formal procedure, Test Plan; BUSS Bolt Torque Versus Tension Tests. This tests series 1) established a torque required to produce the desired 45,000 pounds, and 2) performed multiple runs to observe repeatability. Four different sequences were performed, three with various types of lubricant and one without lubricant. Attached is the working/lab copy of the test plan including data printouts, calibration data, and test fixture drawings. It should be noted that while the test program was abbreviated for selected lubricants, sufficient data was acquired regarding Neolube lubricant to make a reliable determination.

enclosures: Working copy of test procedure, BUSS-BTT.

DBID: 0E3 / / ( )

TEST PLAN:
BUSS BOLT TORQUE VERSUS TENSION TESTS
SANDIA NATIONAL LABORATORIES

March 30, 1987

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Prepared by: D. R. Bronowski — Date: 3/31/87
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Test Coordinator

Approved by: George C. Allen Jr. — Date: 4/3/87
G. C. Allen Jr., 6323
Division Supervisor

H. R. Yoshimura — Date: 3/31/87
H. R. Yoshimura, 6323
Task Leader

J. L. Moya — Date: 4/01/87
J. L. Moya, 6323
Test Engineer

J. M. F. Sena — Date: 4/02/87
J. M. F. Sena, 6323
Quality Assurance

Reviewed by: William L Uncapher — Date: 4/3/87
W. L. Uncapher, 6323

Robert E Glass — Date: 4/3/87
R. E. Glass, 6322

SUPPLEMENTARY DOCUMENTATION:
RAW DATA: DBID 8E380
LOAD CELL CALS: DBID 8E378, 8E379
LETTER REPORT: DBID 8E381

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

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Issue Summary and Distribution

Issue	Date	Prepared by	Purpose of Issue
A	3-30-87	D. R. Bronowski	Original Issue

- -

Copy	Rev.	Name	Org.	Project
1	A	H. R. Yoshimura	6323	BUSS
2	A	J. L. Moya	6323	BUSS
3	A	D. R. Bronowski	6323	BUSS
4	A	G. C. Allen, Jr.	6323	BUSS
5	A	A. Gonzales	6323	BUSS
6	A	R. G. Eakes	6322	BUSS
7	A	J. M. F. Sena	6323	Q. A.
8	A	W. L. Uncapher	6323	Review
9	A	R. E. Glass	6322	Review
10	A	L. R. Dorrell	7544	Facility
11	A	BUSS File	6323	Q A File

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

1.0 Introduction

1.1 Purpose

The purpose of this document is to define a series of torque versus tension tests for the closure bolts of the Beneficial Uses Shipping System (BUSS) cask. The objective is to obtain a reliable correlation between bolt torquing forces and the resulting tension on the bolt. In addition, the changes in bolt tension for a given torque will be measured resulting from the use of various lubricants (or a lack of lubricant) on the bolt threads. Also the effect of the various lubricants on bolt thread wear or damage after numerous torquing cycles will be investigated.

A tension, or preload, of 45,000 pounds per bolt is required to obtain the design clamping force. The precise torque to which the lid bolts must be tightened to obtain the desired tension is difficult to calculate due to the unknown friction coefficients in the various contact areas of the bolts. The results of these tests should yield a reliable torque value in order to consistently obtain the desired bolt tensions. The test will also give an indication as to the durability of the bolts and inserts in operation using various types of lubrication.

1.2 Scope

The test plan for the BUSS bolt torque versus tension tests will serve the following functions:

- Define the Quality Assurance level and documentation requirements for the tests.
- Identify responsibilities of the individuals involved in the test.
- Detail the fixture configuration to be tested.
- Define the instrumentation used in the tests.
- Detail test set-up, general requirements, and test procedure.

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

2.0 Responsibilities

Task Leader - H. R. Yoshimura, 6323

The Task Leader shall have overall responsibility for all aspects of the testing. He shall establish the testing requirements and general procedures. He shall be responsible for approving test feasibility and for approving the Test Plan. He is also responsible for approving any changes to the Test Plan.

Test Engineer - J. L. Moya, 6323

The Test Engineer will work with the Task Leader to establish test requirements and general procedures. He shall have the responsibility for approving the Test Plan for technical content and for assuring proper implementation of the Test Plan for the tests. He shall be responsible for reviewing the test data.

Test Coordinator - D. R. Bronowski, 6323

The Test Coordinator will work with the Task Leader and the Test Engineer to establish the test requirements and general procedures. He shall be responsible for preparing the test procedure, for the design, fabrication, calibration, and assembly of test hardware. He shall be responsible for scheduling and conducting the tests, and collecting the test data.

Quality Assurance Coordinator -J. M. F. Sena, 6323

The 6320 Quality Assurance Coordinator shall verify that the Test Plan is in accordance with the requirements of the 6000 QAPP and approve it for use. He is responsible for verifying calibration and assembly of test hardware. He will provide independent assurance that the Test Plan is implemented and the required documentation is obtained and recorded. He shall be responsible for maintaining the test data in the program file. In the event of a nonconformance, he has the authority to stop the testing activity until the nonconformance is corrected.

Test Facility Coordinator - L. R. Dorrell, 7544

The Test Facility Coordinator of the Modal and Structural Mechanics Division will calibrate the bolt force sensors for use in the tests. He will also operate the equipment to record the data during the bolt torque versus tension tests.

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

3.0 Quality Assurance

Activities described in this procedure will follow quality assurance policies outlined in the Organization 6000 Energy Programs Vice Presidency Quality Assurance Program Plan (QAPP). The QAPP states the policies governing the activities affecting the quality of products and services performed by SNL Organization 6000.

The BUSS bolt torque versus tension tests are designated as Major, Level II. Two independent peer reviews will be performed for the Test Plan. Test log books and data will be controlled. The Test Plan will be controlled and documented in accordance with EPI-XI-I, "Test Procedure Content and Control".

Any changes to the Test Plan are to be explained in writing and signed by the Task Leader and/or the Test Engineer and approved by the Quality Assurance Coordinator. Changes will be documented per EPI-V-1 on an Interactive Procedure Generation Form and attached to this procedure.

4.0 Documentation Requirements

Still 35 mm photographs shall be taken to visually record the testing events. The completed copy of this procedure shall be filed in the Q. A. Records Storage Facility along with the calibration records, inspection reports, and the data from the acquisition system.

5.0 Test Fixture Description

The test fixture to be used for all tests is illustrated in Figure 1. The fixture bottom is a representation of the stainless steel BUSS cask body. Installed in the bottom are two threaded inserts identical to those used in the BUSS cask. The material used is 304 stainless steel, and the finishes of the mating surfaces match those of the BUSS cask.

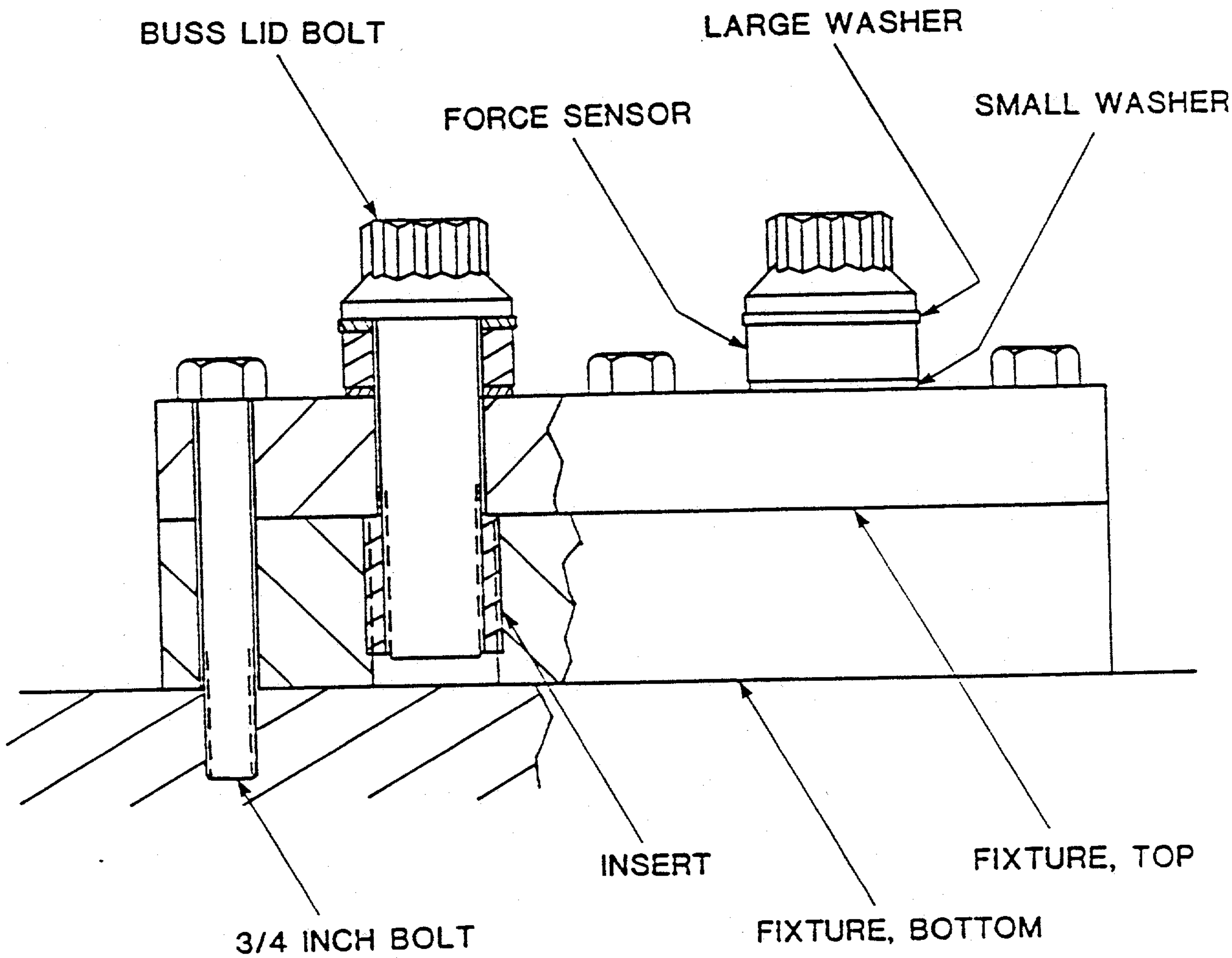
The fixture top models the lid of the BUSS cask. It is also made of 304 stainlees steel, and the mating surfaces have been finished the same as those on the BUSS lid. The thickness of the fixture top has been decreased to offset the thickness of the force sensors. This assures the same amount of bolt threaded into the inserts.

The bolts used are operational type A-286 BUSS cask lid bolts.

The bolt force sensors are the bolt tension measuring devices. They are essentially hollow, compression load cells that operate by use of internal strain gages. The force sensors will be calibrated using a load/tension machine which has a current NBS traceable calibration.

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

Figure 1. Test Fixture Configuration



FIXTURE DOCUMENTATION: SNLA DWG FILE.
FIXTURE TOP: S83605
FIXTURE BOTTOM: S83606

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

The fixture assembly will be bolted to an immovable base for the test. The bolts will be tightened using a torque wrench which has been calibrated.

The output signal from the force sensors will be recorded on a data acquisition system whose electronic signal measuring equipment has been calibrated with equipment whose calibration is NBS traceable.

6.0 Test Program Description

The test program will consist of a series of four tests, each composed of two parts.

The first test will use nuclear grade Neverseez brand lubricant on the threads of the two bolts. The first part of the test (Part A) requires incrementally tightening the bolts to obtain a torque value which produces the desired 45,000 pounds of tension in each bolt. The bolts will be loosened and then retightened in the same sequence a second time. Based on data from this part of the test, a specific torque value will be chosen which should consistently produce 45,000 pounds of tension.

The second part of the test (Part B) will consist of numerous tightening trials to the torque value selected from Part A of the test, with the maximum tension being recorded for each trial.

The test fixture will then be disassembled, cleaned, and inspected.

The second test in the series will be conducted using nuclear grade Neolube brand lubricant on the bolt threads. The processes for Parts A and B of the test are the same as for the first test, with the exception that the torque values selected to obtain the 45,000 pound tension may differ.

The third test in the series will be conducted using a spray on, dry molybdenum disulfide (moly) lubricant on the bolt threads. The processes for Parts A and B of the test are the same as for the first test, with the exception that the torque values selected to obtain the 45,000 pound tension may differ.

The fourth test in the series will be conducted without the use of any lubricant on the threads of the bolts. Once again, the processes for Parts A and B of the test are the same as for the other tests, with the exception that the torque values selected to obtain the 45,000 pound tension may differ.

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

7.0 Mechanical Inspections

A pre-test inspection of the bolts will be made by the Mechanical Measurements and Calibration Section, 7485-3. This inspection will consist of measuring the width of the thread tooth at the pitch diameter. Specifically, these measurements will be made on the tenth and fifteenth tooth of the thread at a radial location marked for repeatability. The inspection reports and any polaroid type photos taken by the optical comparator are to be attached to the working copy of this procedure.

A mid-test inspection will be made if the tensions produced in Part B, trial 8, of the test are more than 30 percent lower than the original target tension. These same bolts (and inserts) are to be used to complete the Part B of the test regardless of the result of the inspection.

A post test inspection of the bolts will be made after the completion of Part B of every test.

Any bolt whose post test inspection which shows measurable wear of the threads will be replaced prior to any subsequent tests. Since the inserts cannot be easily inspected, the assumption will be made that they have worn an amount approximately equal to the bolts, and will be replaced at the same times.

8.0 Bolt Force Sensor Calibration Procedure

The force sensors must be calibrated before use in the tests. Figure 2 illustrates the fixture configuration to be used for calibration. The calibration will be performed by the Test Facility Coordinator of the Modal and Structural Mechanics Division 7544 using a load/tension machine which has a NBS traceable calibration. This calibration information is amaintained by organization 7544.

Each force sensor will be calibrated by using a BUSS lid bolt in tension to put the force sensor in compression. The calibration is to be performed in increments of 5,000 pounds to a final load of 50,000 pounds. This calibration is to determine the sensitivity per unit load for each sensor to obtain a readout in pounds. Copies of the calibration sheets are to be attached to this procedure.

9.0 Bolt Torque Versus Tension Test Procedure

9.1 Materials and Equipment

BUSS bolt torque fixture, top; Drawing No. S83605 Issue A
BUSS bolt torque fixture, bottom; Drawing No. S83606 Issue A

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

BUSS lid bolt; Drawing No. S66574 Issue A (2)
BUSS insert; Drawing No. S66575 Issue B (for replacements)
Bolt force sensor; Lebow Model No. 3711-1500 (2)
Torque wrench, calibrated, 2000 lb-ft capacity
Bolt, 3/4 in. x 6 in. long (6)
Neverseez lubricant, nuclear grade, No. NGBT-16
Neolube lubricant, nuclear grade, No. 1
Molybdenum disulfide lubricant (dry moly), spray type
Alcohol base solvent
Freon and chlorothene degreaser
Kimwipes

9.2 Test Fixture Assembly

Clean the mating surfaces of the top and bottom with solvent and Kimwipes. Bolt the top and bottom to an immovable base as shown in Figure 1 using the six 3/4 inch bolts. Tighten these bolts to a minimum of 50 lb-ft.

Clean the top surface of the fixture using solvent. Locate the small washers of the bolt force sensors over the 1-1/2 inch holes in the fixture. Place the force sensors on the small washers. Record the serial number of each force sensor (as it relates to the locations marked on the fixture) on Part B of the data sheet for the test. Place the large washers on top of the force sensors with the bevel feature facing up. Note: Figure 1 details the proper locations of these washers. Lubricate the threads of the bolts with the proper lubricant for the particular test as listed below.

Use a small amount of lubricant to obtain a thin, even layer on the threaded section of the bolt only; do not get lubricant under the head of the bolt as this could change the friction at this location and thus change tension readings.

Test No. 1: Nuclear grade Neverseez

Test No. 2: Nuclear grade Neolube

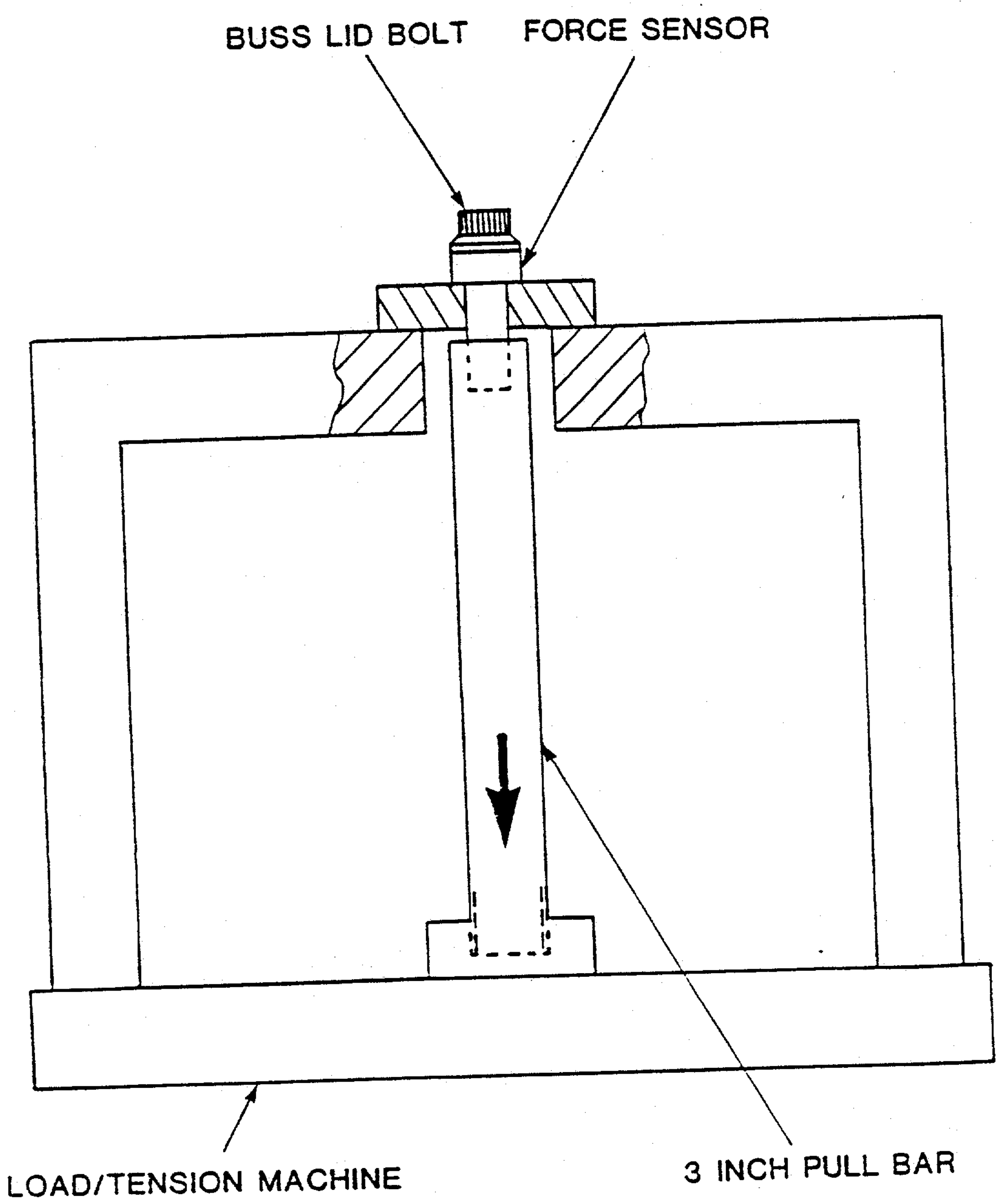
Test No. 3: Dry molybdenum disulfide

Test No. 4: No lubricant

Record the serial number of each BUSS lid bolt (as it relates to the locations marked on the fixture) on part B of the data sheet for the test. Insert the bolts though the force sensors and fixture top, and thread into the inserts in the fixture bottom. Leave the bolts loose.

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

Figure 2. Force Sensor Calibration Set-Up



TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

Attach the signal wires of the force sensors to the data acquisition system. Set the proper excitation voltage and sensitivity per unit load obtained from the calibration of the sensors and balance the system.

9.3 Test Procedure - Part A

While the bolts are still loose, record the output readings from the force sensors. Record the readings on Part A of the data sheet for the test. (These data will also be recorded by the acquisition system.) Using the calibrated torque wrench, tighten each bolt to a torque of 100 lb-ft. Record the readings on the data sheet and with the acquisition system. Torque the bolts to 200, 300, and 400 lb-ft, continuing to record the readings at each step. Use engineering judgement to determine further torque values based on results obtained thus far. If the last tension value is substantially below the required tension of 45,000 pounds, continue increasing the value in 100 lb-ft increments; if it appears that an increase of 100 lb-ft would substantially surpass 45,000 pounds tension, increase the torque value by only 50 lb-ft. The objective is to obtain the the lowest torque value within a 50 lb-ft increment which surpasses the required 45,000 pounds.

After reaching the desired tension, completely loosen the bolts. Perform the entire sequence a second time using the same torque value increments if possible. Again, the results of each increment must be closely observed to obtain the lowest torque value within a 50 lb-ft increment which surpasses the required 45,000 pounds.

Carefully examine the results of both trials of the two bolts to obtain a torque value common to both trials which meets the 45,000 pound tension criteria. This value will be used for Part B of the test.

9.4 Test Procedure - Part B

Loosen and remove the bolts from the fixture. Using the same type of lubricant as in Part A of the test, reapply as necessary to obtain a thin, even layer on the bolt threads. If no lubricant was used, (Test No. 4) clean the threads with solvent. Loosely reinstall the bolts into the fixture, using care to locate each bolt into the same hole it was removed from. Rebalance the force sensors for the start of the test.

Using the torque wrench, tighten each of the bolts first to 100 lb-ft, and then to one-half of the final torque value established by Part A of the test. No readings are to be taken at these steps. Tighten the bolts to the established final torque value.

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

Record the tension measurement on the Part B data sheet for the test (trial 3) and with the data acquisition system. Completely loosen the bolts and record the readings with the data acquisition system only. (These zero readings are a check of the force sensors.)

Repeat the process of tightening and recording, and then loosening and recording twice more (trials 4 and 5).

Remove the bolts from the fixture and relubricate (or reclean) as before.

Continue the test by re-installing the bolts and repeating the process of tightening and recording, and then loosening and recording. Pause after trial 8 to relubricate (or reclean) the bolt threads. Check the last tension value obtained and compare it to the 45,000 pound target value: if it is less than 35,000 pounds (approximately 78 percent of original), clean the bolt threads thoroughly and perform a mechanical inspection as detailed in Section 7.0. After this inspection, lubricate the threads with the appropriate type of lubricant for the test, assemble and continue the torquing cycles.

Pause after cycle 11 to relubricate (or reclean) the bolt threads.

After completing trial 14, remove the bolts for cleaning and inspection.

10.0 Post Test Cleaning and Inspection

Thoroughly clean the threads of the bolts and inserts with solvents and spray type freon and chlorothene degreasers. This is extremely important after Test No. 3, in preparation for Test No. 4 where no lubricant is used; even a slight residue of lubricant from the previous test could adversely affect the results of the unlubricated test. If there is any doubt of the cleanliness of the threads for Test No. 4, replace both the bolts and the inserts prior to conducting the test.

Visually inspect the threads of the bolts and inserts for damage. Record any galling, scratches, or abnormal wear on the Post Test Observation Sheet for the test. Also inspect for and record damage to the underside of the head.

Inspect the bolt threads as detailed in Section 7.0.

If any damage or wear exists, the damaged bolt and its respective insert are to be replaced prior to any subsequent tests.

If any inserts are replaced, mark the used inserts with identifiers as to location and test(s)

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

TEST 1 - PART A   Lubrication: Neverseez

LOCATION 1		LOCATION 2	
Trial 1		Trial 1	
TORQUE lb-ft	TENSION lb	TORQUE lb-ft	TENSION lb
100	3689	100	4155
200	7564	200	8181
300	11049	300	11123
400	15011	400	14973
500	18644	500	18315
600	22196	600	22495
700	26191	700	25951
800	29935	800	29595
900	33936	900	33992
1000	38196	1000	37791
1100	39937	1100	40168
1200	42378	1200	43875
1300	47292	1300	47692
Trial 2		Trial 2	
TORQUE lb-ft	TENSION lb	TORQUE lb-ft	TENSION lb
100	3795	100	3983
200	7391	200	7614
300	11457	300	10856
400	15245	400	14258
500	19347	500	17876
600	23133	600	21401
700	27383	700	25362
800	31158	800	29085
900	35764	900	32909
1000	39092	1000	36145
1100	42254	1100	38844
1200	46496	1200	44049
1250	47041	1250	45719

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS
TEST 1 - PART B   Lubrication: Neverseez

Torque determined from Test 1 - Part A: 1300 lb-ft

LOCATION A

TRIAL NO.	TENSION lb
3	48206
4	49877
5	48465
6	50120
7	45937
8	49352
9	44502
10	44094
11	45998
12	46706
13	41351
14	44756

Bolt Serial No. T01

Force Sensor No. 5139

LOCATION B

TRIAL NO.	TENSION lb
3	45933
4	46574
5	45022
6	49026
7	45158
8	46037
9	45320
10	48138
11	43736
12	47041
13	45682
14	44760

Bolt Serial No. T02

Force Sensor No. 5140

Resistance Check

Location A Pre-Test Input	Location A Pre-Test Output	Location A Post Test Input	Location A Post Test Output	Location B Pre-Test Input	Location B Pre-Test Output	Location B Post Test Input	Location B Post Test Output
120.8	120.7	121.5	120.6	120.5	120.5	120.2	120.2

Digital Multimeter

Manufacturer KEITHLEY   Model No. 177

Expiration Date 8-13-87   Serial No. 15453

Torque Wrench

Manufacturer SNAP-ON ~~Blue Point~~   Model No. TE 100? ~~QCR 4600~~

Cal. Exp. Date ~~1-6-88~~ 9-8-88   Serial No. SNLA-420 ~~SNLA-459~~ 1371

PROTO MODEL # 6025 (2000 FT-lb CAP USED FOR TORQUES OVER 900 FT-lb

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

Post Test Observation Sheet

Test 1 - Neverseez Lubricant

Record any visible damage to the bolts:

Record any visible damage to the inserts:

Record any operational problems:
BLUE POINT TORQUE WRENCH SEEMED TO BE INACCURATE AT LOW (100-200) POUND SETTINGS. VERIFIED BY COMPARISON TO 3 OTHER CALIBRATED WRENCHES. TEST RESTARTED USING THE SNAP-ON 1003 WRENCH FOR TORQUE 100 TO 600. TORQUES 900-1300 WERE MADE USING A PROTO MODEL NO. 6025 TORQUE WRENCH, SER. NO. 1397

Test performed and inspections made by: D R Bremond 7-2-87
Test Coordinator Date

Test performance verified by: [signature] 9544 7-2-87
Q.A. Coordinator Date

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

TEST 2 - PART A   Lubrication: Neolube

LOCATION 1		LOCATION 2	
Trial 1		Trial 1	
TORQUE lb-ft	TENSION lb	TORQUE lb-ft	TENSION lb
100	3102	100	4519
200	6128	200	8055
300	9175	300	11698
400	12066	400	14750
500	14722	500	18134
600	19114	600	21490
700	22277	700	26148
800	24891	800	28321
900	28483	900	32224
1000	31409	1000	36108
1100	33401	1100	39375
1200	35595	1200	43153
1300	38802	1300	47262
1400	42331	1400	50499
Trial 2		Trial 2	
TORQUE lb-ft	TENSION lb	TORQUE lb-ft	TENSION lb
RELUBRICATE 100	3078	100	4112
200	6047	200	7727
300	9223	300	11433
400	11925	400	15024
500	14673	500	18607
600	19172	600	22689
700	22411	700	26309
800	26412	800	30673
900	29856	900	34240
1000	30911	1000	37301
1100	35070	1100	40303
1200	36328	1200	43862
1300	40657	1300	47643
1400	43305	1400	49916
1450	44891	1450	51857

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS
TEST 2 - PART B   Lubrication: Neolube

Torque determined from Test 1 - Part A: 1300 lb-ft

LOCATION A TRIAL NO.	LOCATION A TENSION lb	LOCATION B TRIAL NO.	LOCATION B TENSION lb
3	41393	3	46131
4	40329	4	44954
5	40205	5	47177
6	40503	6	42653
7	41444	7	45527
8	42305	8	45436
9	40939	9	43567
10	41483	10	45294
11	42543	11	44558
12	44442	12	45721
13	42238	13	46089
14	45893	14	44940

Bolt Serial No. B03   Bolt Serial No. B04

Force Sensor No. 5139   Force Sensor No. 5140

Insert No. BT03   Insert No. BT04

Resistance Check

Pre-Test Input	Pre-Test Output	Post Test Input	Post Test Output	Pre-Test Input	Pre-Test Output	Post Test Input	Post Test Output
121.5	120.6	120.7	120.5	120.2	120.2	120.2	120.3

Digital Multimeter

Manufacturer Keithley   Model No. 177

Expiration Date 8-13-87   Serial No. 15453

Torque Wrench

Manufacturer Snap-on   Model No. TE-1003

Cal. Exp. Date 9-8-88   Serial No. SNLA-420

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

Post Test Observation Sheet

Test 2 - Neolube Lubricant

Record any visible damage to the bolts:

Record any visible damage to the inserts:

Record any operational problems:
WIDE DIFFERENCE IN TRIAL #1 READINGS. BOLTS REMOVED AND RELUBRICATED WITH A HEAVY COAT OF NEOLUBE FOR TRIAL #2.
TRIALS #1 #2 LOCATION A WAS BUMPY/GRABBED WHEN TURNED

Test performed and inspections made by: D.R. Barnard 7-2-87
Test Coordinator Date

1544

Test performance verified by: [signature] 7-2-87
Q.A. Coordinator Date

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

TEST 3 - PART A Lubrication: Molybdenum

LOCATION 1

Trial 1

TORQUE lb-ft	TENSION lb
100	3363
200	6723
300	10184
400	13199
500	15576
600	19632
700	22869
800	26308
900	27524
1000	29187
1100	34582
1200	37460
1300	40842
1400	41346
1500	43978
1550	47819

Trial 2

TORQUE lb-ft	TENSION lb
100	3950
200	6835
300	9874
400	12696
500	15513
600	18280
700	20451
800	22781
900	25271
1000	30035
1100	33148
1200	34555
1300	36642
1400	42152
1500	44915
1550	45590
1600	46421

LOCATION 2

Trial 1

TORQUE lb-ft	TENSION lb
100	3068
200	6111
300	9118
400	12140
500	15284
600	17667
700	21165
800	24951
900	27092
1000	30374
1100	32028
1200	36971
1300	39243
1400	42440
1500	43371
1550	46103

Trial 2

TORQUE lb-ft	TENSION lb
100	3287
200	5934
300	9153
400	12086
500	15148
600	17283
700	21252
800	23534
900	26079
1000	29175
1100	31991
1200	35311
1300	37310
1400	40434
1500	42016
1550	42077
1600	43322

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

TEST 3 - PART B Lubrication: Molybdenum

Torque determined from Test 2 - Part A: 1600 lb-ft

LOCATION A TRIAL NO.	TENSION lb	LOCATION B TRIAL NO.	TENSION lb
3	48366	3	45918
4	* TORQUE WRENCH FAILURE	4	
5	TEST DISCONTINUED	5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		1	
12		1	
13		1	
14		14	

Appendix G
Page 23
WHC-SD-WM-TI-654
REV O

Bolt Serial No. 805 Bolt Serial No. 806

Force Sensor No. 5139 Force Sensor No. 5140

Insert No. BT05 Insert No. BT06

Resistance Check

Location A Pre-Test Input	Pre-Test Output	Post Test Input	Post Test Output	Location B Pre-Test Input	Pre-Test Output	Post Test Input	Post Test Output
120.7	120.5			120.2	120.3		

Digital Multimeter

Manufacturer KEITHLEY Model No. 177

Expiration Date 8-13-87 Serial No. 15453

Torque Wrench

Manufacturer SNAP-ON Model No. TE 1003

Cal. Exp. Date 9-8-88 Serial No. SNLA-420

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

Post Test Observation Sheet

Test 3 - Molybdenum Lubricant

Record any visible damage to the bolts:

Record any visible damage to the inserts:

Record any operational problems:
2000# TORQUE WRENCH FAILED/BROKE.
ADD'L 'TRIALS' TESTS NOT PERFORMED.

Test performed and ~~inspections~~ made by: D.R. Bronowski 7-2-87
Test Coordinator Date

Test performance verified by: ____________ ______
Q.A. Coordinator Date

TESTING CONTINUED W/QUESTIONABLE TORQUE WRENCH: INFORMAL, PROOF-OF PRINCIPAL TESTS ONLY - NOT CERTIFIED. TEST 3B + 4A + 4B RUN ON 1 BOLT/INSERT ONLY. DRB 7-3-87

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

TEST 3 - PART B Lubrication: Molybdenum

Torque determined from Test 3 - Part A: . 1600 lb-ft

LOCATION A		LOCATION B	
TRIAL NO.	TENSION lb	TRIAL NO.	TENSION lb
3	46840	3	
4	47180	4	
5	41400	5	
6	48700	6	
7	48780	7	
8	47140	8	
9	47640	9	
10	45860	10	
11	45240	11	
12	46720	12	
13	46600	13	
14	44740	14	

Bolt Serial No. ~~F~~-10 / INSERT NO DESIG.

Force Sensor No. 5140

Bolt Serial No. ______

Force Sensor No. ______

Resistance Check

Pre-Test		Post Test		Pre-Test		Post Test	
Input	Output	Input	Output	Input	Output	Input	Output

Digital Multimeter

Manufacturer ______ Model No. ______

Expiration Date ______ Serial No. ______

Torque Wrench TORQUE WRENCH REPAIRED: CALIBRATION NOT VERIFIED.

Manufacturer ______ Model No. ______

Cal. Exp. Date ______ Serial No. ___

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

Post Test Observation Sheet

Test 3 - Molybdenum Lubricant

Record any visible damage to the bolts:

Record any visible damage to the inserts:

Record any operational problems:

NON - CALIBRATED WRENCH USED. WRENCH APPEARS TO BE ACCURATE: WRENCH COMPAIRED TO 2 OTHER WRENCHES AT 500 AND AT ~900 FT/POUNDS.

Test performed and inspections made by: DLB (signature) 7-3-87
Test Coordinator Date

Test performance verified by: ______________ ______
Q.A. Coordinator Date

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

TEST 4 - PART A   Lubrication: None

LOCATION 1

Trial 1

TORQUE lb-ft	TENSION lb
100	3560
200	6880
300	10160
400	13180
500	16220
600	19300
700	21740
800	24480
900	27140
1000	30700
1100	32800
1200	35320
1300	37860
1400	40780
1500	43020
1600	47080

Trial 2

TORQUE lb-ft	TENSION lb
100	2720
200	5720
300	8500
400	11220
500	13760
600	16120
700	18440
800	20840
900	24820
1000	29240
1100	32720
1200	35440
1300	39260
1400	42640
1500	46220

LOCATION 2

Trial 1

TORQUE lb-ft	TENSION lb
100	
200	
300	
400	

Trial 2

TORQUE lb-ft	TENSION lb
100	
200	
300	
400	

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

TEST 4 - PART B   Lubrication: None

Torque determined from Test 4 - Part A: .1550 lb-ft

LOCATION A TRIAL NO.	LOCATION A TENSION lb	LOCATION B TRIAL NO.	LOCATION B TENSION lb
3	47720	3	
4	42300	4	
5	40240	5	
6	41280	6	
7	38860	7	
8	37060	8	
9	38400	9	
10	35620	10	
11	35120	11	
12	38140	12	
13	35920	13	
14	34860	14	

Bolt Serial No. ~~B~~-09 BT-08   Bolt Serial No. ______

Force Sensor No. 5140   Force Sensor No. ______

Resistance Check

Location A Pre-Test Input	Location A Pre-Test Output	Location A Post Test Input	Location A Post Test Output	Location B Pre-Test Input	Location B Pre-Test Output	Location B Post Test Input	Location B Post Test Output

Digital Multimeter

Manufacturer ______   Model No. ______

Expiration Date ______   Serial No. ______

Torque Wrench

Manufacturer ______   Model No. ______

Cal. Exp. Date ______   Serial No. ______

TEST PLAN: BUSS BOLT TORQUE VERSUS TENSION TESTS

Post Test Observation Sheet

Test 4 - No Lubricant

Record any visible damage to the bolts:

Record any visible damage to the inserts:

Record any operational problems:
STEADY DROP-OFF OF LOADS WITH EACH TRIAL INDICATE WEARING OR GALLING OF TREADS

Test performed and inspections made by: DRB 7-3-87
Test Coordinator Date

Test performance verified by: ____________ ______
Q.A. Coordinator Date

DBID: 8E378 (1) of 2

LOAD CELL CALIBRATION RECORD
CALIBRATED BY DIV. 7541

DATE: 04-09-87
EXPIRES: 04-09-88

MFG. LEBOW MODEL: 3711-1500 SERIAL NO. [illegible]

LOAD CELL CAPACITY: 50000 LBS
LOAD CELL RESISTANCE: [illegible] OHMS
BRIDGE EXCITATION: 4.99 VOLTS
[illegible]: [illegible] MILLIVOLTS/VOLT [illegible]
NOMINAL SENSITIVITY: .0224 MICROVOLTS/VOLT/[illegible]

CALIBRATED IN TENSION ON THE 300000 POUND RANGE OF [illegible]
USING THE HP9836A DATA ACQUISITION SYSTEM (DASY II)

TENSION (+) LOADING SHOULD PRODUCE INCREASING (+) OUTPUTS.
COMPRESSION (-) LOADING SHOULD PRODUCE DECREASING (-) OUTPUTS.

****

SENSITIVITY USED TO CALCULATE INDICATED LOAD:

APPLIED LOAD POUNDS	BRIDGE OUTPUT VOLTS	OUTPUT CHANGE VOLTS	MEASURED OUTPUT mV/V	MEASURED SENS uV/V/lb	INDICATED LOAD POUNDS	DEVIATION FROM APPLIED LOAD POUNDS	PERCENT
0	0.000343	00.000000	000.0000	00.0000	0	0	0000.00
5000	0.001000	00.000657	000.1316	00.0263	5171	171	0003.42
10000	0.001632	00.001289	000.2581	00.0258	10140	140	0001.40
15000	0.002254	00.001921	000.3847	00.0256	15[illegible]	[illegible]	0000.56
20000	0.002887	00.002544	000.5096	00.0255	20020	[illegible]	0000.[illegible]
[illegible]	0.003523	00.003180	000.6370	00.0254	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]03805	000.7622	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]04428	000.8870	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

	CALIBRATION DATA	[illegible] DATA
SERIAL NO.	5129	5129
CAPACITY, POUNDS..........	50000	50000
BRIDGE RESISTANCE, OHMS..	120	120
FULL SCALE OUTPUT, MV/V..	1.2762	1.2756
[illegible] LB.....	.0255	.0255
[illegible] LB....	1.021	1.020

LOAD CELL CALIBRATION RECORD

CALIBRATED BY DIV. 7541

DATE: 04-09-87
EXPIRES: 04-09-89

MFG. LEBOW MODEL: 3711-1500 SERIAL NO. 5140

LOAD CELL CAPACITY: 50000 LBS
LOAD CELL RESISTANCE: 120 OHMS
BRIDGE EXCITATION: 4.99 VOLTS
NOMINAL OUTPUT: 1.2700 MILLIVOLTS/VOLT @ FULL SCALE
NOMINAL SENSITIVITY: .0254 MICROVOLTS/VOLT/POUND

CALIBRATED IN TENSION ON THE 100000 POUND RANGE OF UTM3
USING THE HP9836A DATA ACQUISITION SYSTEM (DASY II).

TENSION (+) LOADING SHOULD PRODUCE INCREASING (+) OUTPUTS.
COMPRESSION (-) LOADING SHOULD PRODUCE DECREASING (-) OUTPUTS.

****

SENSITIVITY USED TO CALCULATE INDICATED LOAD: .0248

APPLIED LOAD POUNDS	BRIDGE OUTPUT VOLTS	OUTPUT CHANGE VOLTS	MEASURED OUTPUT mV/V	MEASURED SENS uV/V/lb	INDICATED LOAD POUNDS	DEVIATION FROM APPLIED LOAD POUNDS	PERCENT
0	0.000533	00.000000	000.0000	00.0000	0	0	0000.00
5000	0.001148	00.000615	000.1232	00.0246	4963	-37	-0000.74
10000	0.001762	00.001229	000.2462	00.0246	9923	-77	-0000.77
15030	0.002388	00.001855	000.3716	00.0247	14977	-53	-0000.35
20070	0.003020	00.002487	000.4982	00.0248	20077	7	0000.[illegible]
25040	0.003648	00.003115	000.624[illegible]	00.0249	25149	109	[illegible]
30000	0.004268	00.003735	000.748[illegible]	00.0249	30154	154	0000.5[illegible]
35000	[illegible]004902	00.004369	000.875[illegible]	[illegible]	[illegible]	[illegible]	0000.[illegible]
[illegible]	[illegible]005531	[illegible]004999	[illegible]	[illegible]0250	[illegible]	349	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]6795	00.006263	[illegible]2548	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]00538	[illegible]000005	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

DBID: 8E379 (2) of 2

	CALIBRATION DATA	BEST FIT DATA
SERIAL NO.	5140	5140
CAPACITY, POUNDS..........	50000	50000
BRIDGE RESISTANCE, OHMS..	120	120
FULL SCALE OUTPUT, MV/V..	1.2443	1.2368
SENSITIVITY, UV/V/LB.....	.0249	.0247
S.F. FOR [illegible] = 10 [illegible] LB....	.995	.989

DBID: 8E380(1) of 31

ATE: 07-01-87 16:19:58
PERATOR: DORRELL

TEST NO.-UNIT NO. TEST1
CONDITION NO. 1 (PART A)
TRIAL 1

LUBRICANT: NEVERSEEZ

TABLE

SHEET 1 OF 1

INDICATED UNITS, LBS

SCAN TIME H:MN:SC	TEST LEVEL FT-LBS	LOCATION 1 X-DUCER 1	LOCATION 2 X-DUCER 2
5:36:34	0	-4	-3
5:57:28	100	+3688	+4155
5:58:50	200	+7564	+8181
5:59:54	300	+11049	+11122
6:00:58	400	+15011	+14973
6:02:34	500	+18644	+18316
6:05:48	600	+22196	+22495
6:07:10	700	+26191	+25951
6:08:32	800	+29925	+29595
6:09:59	900	+33936	+33992
6:11:58	1000	+38196	+37791
6:13:19	1100	+39937	+40168
6:14:50	1200	+42378	+43875
6:16:27	1300	+47792	+47693
~~6:18:56~~	~~0~~	~~-56~~	~~-86~~

8E380(2)

ATE 07-01-87 16:39:02

PE JR: DORRELL

TEST NO.-UNIT NO. TEST1

CONDITION NO. 2

TABLE

TEST PART A

SHEET 1 OF 1

TRIAL 2

INDICATED UNITS, LBS

NEVERSEEZ

TIME R:MN:SC	TEST LEVEL FT-LBS	LOCATION/ X-DUCER 1	LOCATION/ X-DUCER 2
6:21:48	0	-7	+1
6:22:35	100	+3795	+3983
6:23:28	200	+7391	+7614
6:24:14	300	+11457	+10856
6:24:58	400	+15245	+14258
6:25:08	500	+19347	+17876
6:27:10	600	+23133	+21401
6:28:11	700	+27383	+25362
[illegible]	800	+31158	+29085
6:30:24	900	+35764	+32909
6:31:50	1000	+39092	+36145
6:33:10	1100	+42254	+38844
6:34:46	1200	+46496	+44049
6:36:28	1250	+47041	+45719
6:38:16	0	-57	-60

8E380(3)

TE: 07-02-87 08:57:01
ERATOR: DORRELL

TEST NO.-UNIT NO. TEST1
CONDITION NO. 3

TABLE

SHEET OF

INDICATED UNITS LBS

TEST 1 - PART B

TRIAL 3

NEVERLSGEZ

SCAN TIME :MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
:51:29	0	-2	-9
:52:36	100	+3439	+3530
:53:30	600	+21992	+20120
:54:58	1300	+48206	+45933
:56:24	0	-56	-116

8E380(4)

[illegible]ATE: 07-02-87 09:02:33
[illegible]TOR: DORRELL

TEST NO.-UNIT NO. TEST[illegible]
CONDITION NO. 4

TABLE

SHEET 1 OF 1

TEST 1 - PART B
TRIAL 4

INDICATED UNITS, LBS

[illegible] TIME [illegible]	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
[illegible]:58:03	0	-5	-4
[illegible]:58:45	100	+3577	+3493
[illegible]:59:40	600	+21570	+20153
[illegible]:00:40	1300	+49877	+46574
[illegible]:01:59	0	-60	-80

8E380(5)

ATE: 07-02-87 09:08:54
PERATOR: DORRELL

TEST NO.-UNIT NO. TEST1
CONDITION NO. 5

TABLE

SHEET 1 OF 1

TEST 1 - PART B

INDICATED UNITS, LBS

TRIAL 5

SCAN TIME H:MM:SC	TEST LEVEL FT-LBS	X-DUCER	X-DUCER
9:03:50	0	-1	-5
9:04:52	100	+3824	+3607
9:05:48	600	+20590	-20317
9:06:49	1300	+48465	+45022
9:08:13	0	-55	-44

8E380(6)

ATE: 07-02-87 09:16:10
PERATOR: DORRELL

TEST NO.-UNIT NO.-TEST1
CONDITION NO. 6

TABLE

SHEET 1 OF 1

INDICATED UNITS: LBS

TEST 1 - PART B
TRIAL 6

SCAN TIME R:MN:SC	TEST LEVEL FT-LBS	X-DUCER	X-DUCER 2
9:10:17	0	+9	-8
9:11:16	100	+3242	+3630
9:12:56	600	+19980	+20767
9:14:13	1300	+50119	+49025
9:15:38	0	-39	-71

8E380(7)

ATE: 07-02-87 09:22:24
PER OR: DORRELL

TEST NO.-UNIT NO. TEST1
CONDITION NO. 7

TABLE

SHEET 1 OF 1

TEST 1- PART 8

INDICATED UNITS, LBS

TRIAL 7

..AR TIME H:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
[illegible]:17:12	0	+2	+6
[illegible]:17:53	100	+3545	+3650
[illegible]:18:42	600	+19215	+21010
[illegible]:19:56	1300	+45937	+45158
[illegible]:21:12	0	-72	-55

8E380(8)

ATE: 07-02-87   09:28:59
PERATOR: DORRELL

TEST NO.-UNIT NO. TEST1
CONDITION NO. 8

TABLE

SHEET 1 OF 1

TEST 1 - PART B
TRIAL 8

INDICATED UNITS, LBS

TIAL TIME HH:MM:SS	TEST LEVEL FR-LBS	X-DUCER 1	X-DUCER 2
9:23:43	0	-1	-2
9:24:43	100	+3561	+3739
9:25:49	600	+20743	+20251
9:26:52	1300	+49352	+46037
9:28:32	0	-51	-73

8E380(9)

DATE: 07-02-87 09:37:08
OPERATOR: DORRELL

TEST NO.-UNIT NO. TEST1
CONDITION NO. 9

TABLE

SHEET 1 OF

TEST 1 - PART B

TRIAL 9

INDICATED UNITS, LBS

SCAN TIME HR:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
09:30:55	0	-5	+2
09:32:06	100	+3277	+3313
09:32:59	600	+19315	+20048
09:34:03	1300	+44502	+45320
09:35:59	0	-68	-75

8E380(10)

ATE: 07-02-87 09:48:29
REF OR: DORRELL

TEST NO.-UNIT NO. TEST1
CONDITION NO. 10

TABLE

SHEET 1 OF 1

TEST 1 - PART 8

INDICATED UNITS. LBS

TRIAL 10

[illegible]	TEST	X-DUCER 1	X-DUCER 2
TIME H:MN:SC	LEVEL FT-LBS		
[illegible]	0	+19	+26
[illegible]	100	+3443	+3419
9:42:50	500	+20237	+20044
9:44:05	1000	+44094	+48138
9:47:35	0	-21	+1[illegible]

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8E380(11)

ATE: 07-02-87 09:54:3?
PERATOR: DORRELL

TEST NO.-UNIT NO. TEST1
CONDITION NO. 11

TABLE

TEST 1 - PART 8
TRIAL 11

SHEET 1 OF 1

INDICATED UNITS, LBS

SCAN TIME R:MN:SC	TEST LEVEL FT-LBS	X-DUCER	X-DUCER
9:49:41	0	-3	-1
9:50:28	100	+3558	-3307
9:51:21	600	+20963	+2040?
9:52:14	1300	+45998	+43736
9:53:37	0	-67	-92

8E380 (12)

ATE: 07-02-97 10:03:55
PER^TOR: DORRELL

TEST NO.-UNIT NO. TEST
CONDITION NO. 12

TABLE

SHEET 1 OF 1

TEST 1 - PART B

INDICATED UNITS, LBS

TRIAL 12

SCAN TIME HR:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
9:58:31	0	-2	+0
9:59:34	100	+3295	+3300
:00:32	600	+20624	+20251
:01:41	1300	+46706	+47041
:03:05	0	-57	-112

8E380(13)

-TE: 07-02-87 10:10:25
ERATOR: DORRELL

TEST NO.-UNIT NO. TEST1
CONDITION NO. 13

TABLE

SHEET 1 OF 1

TEST 1-PART 8
TRIAL 13

INDICATED UNITS, LBS

SCAN TIME :MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
:05:33	0	-3	-1
:06:28	100	+3654	+3428
:07:08	600	+20479	+20964
:08:02	1300	+41351	+45682
:09:25	0	-50	-84

-TE: 07-02-87 10:16:39
-ERATOR: DORRELL

TEST NO.-UNIT NO. TEST
CONDITION NO. 14

TABLE

SHEET 1 OF 1

TEST 1- PART 8
TRIAL 14

INDICATED UNITS, LBS

[illegible] TIME [illegible]	TEST LEVEL [illegible] LBS	X-DUCER	X-DUCER 2
[illegible]:19	0	+2	+8
[illegible]	100	+3257	+3733
[illegible]:53	600	+20366	+20641
[illegible]4:59	1300	+44756	+44760
[illegible]	0	-76	-72

8E380(15)

DATE: 07-02-87 11:30:47
OPERATOR: DORRELL

TEST NO.-UNIT NO. TEST2
CONDITION NO. 1

TABLE

SHEET 1 OF 1

INDICATED UNITS, LBS

TEST 2-PART A
NEOLUBE LUBRICANT
TRIAL 1

SCAN TIME HR:MN:SC	TEST LEVEL FT-LBS	LOCATION/ X-DUCER	LOCATION/ X-DUCER 2
0:44:03	0	-12	-1
1:13:10	100	+3102	+4519
1:14:04	200	+6128	+9055
1:14:59	300	[illegible]	+11698
1:15:53	400	[illegible]	+14750
1:16:53	500	+14722	+18134
1:18:39	600	+19114	+21490
1:19:58	700	[illegible]	[illegible]
1:21:06	800	[illegible]	[illegible]
1:22:20	900	[illegible]	[illegible]
1:23:25	1000	+31409	[illegible]
1:24:41	1100	+33401	+39375
1:25:59	1200	+35595	+43453
1:27:37	1300	+38801	+47262
~~1:29:01~~	1400	+42331	+50499
1:30:18	0	-33	-71

8E380(16)

DATE: 07-02-87 12:38:38
OPERATOR: DORRELL

TEST NO.-UNIT NO.-TEST2
CONDITION NO. 2

TABLE

SHEET 1 OF 1

INDICATED UNITS. LBS

TEST 2 - PART A
NEOLUBE
TRIAL 2

SCAN TIME HR:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
12:13:11	0	+2	-2
12:15:08	100	+3078	+4112
12:16:14	200	+6047	+7727
12:17:08	300	+9222	+11433
12:18:14	400	+11925	+15024
12:19:15	500	+14673	+18607
12:21:41	600	+19172	+22689
12:22:54	700	+22411	+26309
12:24:06	800	+26442	+30673
12:25:26	900	+29856	+34240
12:26:49	1000	+30911	+37301
12:27:57	1100	+35070	+40303
12:29:16	1200	+36328	+43862
12:30:25	1300	+40657	+47643
12:32:08	1400	+43305	+49916
12:34:44	1450	+44891	+51857
12: :11	0	-67	-98

8E380(17)

DATE: 07-02-87 12:45:02
OPERATOR: DORRELL

TEST NO.-UNIT NO. TEST2
CONDITION NO. 3

TABLE

SHEET 1 OF 1

INDICATED UNITS, LBS

TEST 2 - PART B
NEOLURE
TRIAL 3

SCAN TIME HR:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
2:40:06	0	-7	-10
2:40:57	100	+2890	+4050
2:41:58	600	+15960	+21117
2:43:15	1300	+41393	+46131
2:44:27	0	-68	-42

8E380(18)

ATE: 07-02-87 12:50:31
PERATOR: DORRELL

TEST NO.-UNIT NO.-TEST2
CONDITION NO. 4

TABLE

SHEET 1 OF 1

INDICATED UNITS, LBS

Test 2-Part B
Neolube
Trial 4

SCAN TIME R:MN:SC	TEST LEVEL FT-LBS	X-DUCER	X-DUCER
2:45:57	0	-2	-10
2:47:06	100	+3133	+4158
2:47:47	600	+17715	+20925
2:48:32	1300	+40329	+44954
2:49:59	0	-34	-42

8E380(19)

ATE: 07-02-87 12:56:02
PERATOR: DORRELL

TEST NO.-UNIT NO. TEST2
CONDITION NO. 5

TABLE

SHEET 1 OF 1

TEST 2 - PART B
NSOLUBE
TRIAL 5

INDICATED UNITS. LBS

SCAN TIME	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
[illegible]:51:14	0	-5	+0
[illegible]:52:38	100	+3591	+4088
[illegible]:53:23	500	+18314	+21217
[illegible]:54:19	1300	+40205	+47177
[illegible]:55:32	0	-45	-43

8E380(20)

ATE: 07-02-87 13:03:29
PEF JR: DORRELL

TEST NO.-UNIT NO. TEST2
CONDITION NO. 6

TABLE

SHEET 1 OF 1

INDICATED UNITS. LBS

TEST 2 - PART 8
NEOLUBE
TRIAL 6

SCAN TIME R:MN:SC	TEST LEVEL FT-LBS	X-DUCER	X-DUCER 2
2:58:30	0	-7	-2
2:59:16	100	+3246	+4408
3:00:02	600	+18780	+22810
3:01:09	1300	+40503	+42653
3:02:41	0	-48	-64

8E380 (21)

DATE: 07-02-87 13:08:27
OPERATOR: DORRELL

TEST NO.-UNIT NO. TEST2
CONDITION NO. 7

TABLE

SHEET 1 OF 1

INDICATED UNITS, LBS

TEST 2 - PART B
NEOLUBE
TRIAL 7

SCAN TIME HR:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
13:04:10	0	-4	+1
13:05:06	100	+3537	+3667
13:05:44	600	+20872	+20568
13:06:41	1300	+41444	+45527
13:07:57	0	-38	-89

8E380(22)

ATE: 07-02-87 13:16:59
PEF JR: DORRELL

TEST NO.-UNIT NO.: TEST2
CONDITION NO.: 8

TABLE

SHEET 1 OF 1

INDICATED UNITS, LBS

TEST 2 - PART B
NEOLUBE
TRIAL 8

SCAN TIME R:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
3:09:40	0	-5	-2
3:13:42	100	+3493	+4254
3:14:21	600	+20345	+21366
3:15:12	1300	+42305	+45436
3:16:19	0	-48	-56

8E380(23)

ATE: 07-02-87 13:24:40
PER OR: DORRELL

TEST NO.-UNIT NO. TEST2
CONDITION NO. 9

TABLE

SHEET 1 OF 1

INDICATED UNITS, LBS

TEST 2- PART B
NEOLUBE
TRIAL 9

SCAN TIME HR:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
3:17:49	0	-7	-8
3:20:30	100	+3695	+4087
3:21:09	600	+20185	+22243
3:22:00	0	+40939	+43567
3:23:49	0	-23	-32

8E380(24)

ATE 07-02-87 13:29:59
PEF JR: DORRELL

TEST NO.-UNIT NO TEST2
CONDITION NO. 10

TABLE

SHEET 1 OF 1

INDICATED UNITS, LBS

TEST 2 - PART B
NEOLUBE
TRIAL 10

SCAN TIME R:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
3:25:26	0	-8	-2
3:25:10	100	+2726	+3311
3:26:58	600	+18669	+19725
3:28:06	1300	+41483	+45294
3:29:22	0	-73	-92

8E380(25)

'ATE: 07-02-87 13:35:19
'PERATOR: DORRELL

TEST NO.-UNIT NO.-TEST2
CONDITION NO. 11

TABLE

SHEET 1 OF 1

TEST 2 - PART 8
NEOLUBE
TRIAL 11

INDICATED UNITS, LBS

SCAN TIME R:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
3:30:50	0	+0	-1
3:31:43	100	+3454	+3628
3:32:24	600	+20516	+20824
3:33:14	1300	+42543	+44558
3:34:49	0	-23	-41

8E380(26)

ATE: 07-02-87 13:42:29
PEF 'R: DORRELL

TEST NO.-UNIT NO.-TEST2
CONDITION NO. 12

TABLE

SHEET 1 OF 1

INDICATED UNITS, LBS

TEST 2-PART 8
NEOLUBE
TRIAL 12

SCAN TIME R:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
3:36:27	0	-2	+4
3:38:30	100	+3080	+3913
3:39:10	600	+19016	+21339
3:40:33	1300	+44442	+45721
3:41:51	0	-42	-67

8E380(27)

TE: 07-02-87 13:47:56
ER OR: DORRELL

TEST NO.-UNIT NO. TEST2
CONDITION NO. 13

TABLE

SHEET 1 OF 1

INDICATED UNITS, LBS

TEST 2 - PART B
NEOLUBE
TRIAL 13

SCAN TIME :MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
:43:25	0	+5	+5
:44:24	100	+3114	+3754
:45:05	600	+20300	+20280
:45:46	1300	+42238	+46090
:47:00	0	-32	-45

8E380(28)

ATE: 07-0[illegible]-87 13:52:57
PERATOR: DORRELL

TEST NO.-UNIT NO. TEST2
CONDITION NO. 14

TABLE

SHEET 1 OF 1

INDICATED UNITS. LBS

TEST 2 - PART B
NEOLUBE
TRIAL 14

SCAN TIME H:MN:SS	TEST [illegible]	X-DUCER 1	X-DUCER 2
3:48:54	0	+4	+6
3:49:47	100	-2797	+3804
3:50:31	600	+19928	+20462
3:51:15	1300	+45893	+44940
3:52:28	0	-62	-14

8E380(29)

ATE: 07-02-87 15:45:05
PER( )R: DORRELL

TEST NO.-UNIT NO. TESTS
CONDITION NO. 1

SHEET 1 OF 1

INDICATED [illegible] LBS

TEST 3 - PART A
TRIAL 1

SCAN TIME R:MN:SC	TEST LEVEL FT-LBS	X-DUCER	X-DUCER
5:09:25	0	-4	-[illegible]
5:15:41	100	+3363	+3066
5:23:13	200	+6723	+6110
5:24:48	300	+10184	+9[illegible]
5:25:37	400	+13198	+12140
5:26:28	500	+15576	+15284
5:27:24	600	+19632	+[illegible]
5:28:49	700	+22869	+21155
5:29:48	800	+25308	+2495[illegible]
5:30:54	900	+27524	+2709[illegible]
5:31:55	1000	+29187	+30374
5:33:11	1100	+34582	+32023
5:34:25	1200	+37460	+36971
5:36:01	1300	+40842	+39243
5:39:54	1400	+41346	+42440
5:4[illegible]:13	1500	+43977	+43371
5:4[illegible]:47	1550	+47819	+46403
5:44:18	0	+56	+127

8E380(30)

ATE: 07-02-87 16:19:10
PERATOR: DORRELL

TEST NO.-UNIT NO. TESTS
CONDITION NO. 2

TABLE

SHEET OF

TEST 3 - PART A
TRIAL 2

INDICATED UNITS: LBS

SCAN TIME H:MN:SC	TEST LEVEL FT-LBS	X-DUCER 1	X-DUCER 2
5:46:11	0	-10	-8
5:47:38	100	+3950	+3297
5:48:40	200	+6835	+5934
5:49:52	300	+9873	+9152
5:50:43	400	+12696	+12086
5:52:26	500	+15513	+15148
5:53:30	600	+18280	+17283
5:54:53	700	+20451	+21252
5:55:53	800	-22781	+23534
5:56:54	900	+25271	+26079
5:57:50	1000	+30035	+29175
5:58:55	1100	+33148	+31991
5:59:51	1200	+34555	+35311
6:00:54	1300	+36643	+37310
6:02:04	1400	+42152	+40434
6:03:11	1500	+44915	+42016
6:1[illegible]27	1550	+45590	+42077
6:[illegible]0	1600	+46444	+43285
[illegible].16	1600	+46420	+43322
6:18:42	0	-55	-65

8E380(31)

[illegible] OPERATOR: SORRELL

TEST NO.-UNIT NO. TEST: [illegible]
CONDITION NO. 3

TEST 3 - PART B
TRIAL 3

[illegible]