HONEYCOMB SPACER CRUSH STRENGTH TEST RESULTS

(U)

by

D. R. Leader

Westinghouse Savannah River Company
Savannah River Site
Aiken, South Carolina 29808

A document prepared for:

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WSRC-TR-93-448

HONEYCOMB SPACER STRENGTH TEST RESULTS (U)

D. R. LEADER

SEPTEMBER 15, 1993

Westinghouse Savannah River Company
P. O. Box 616
Aiken, S. C. 29802

PREPARED BY THE U. S. DEPARTMENT OF ENERGY UNDER CONTRACT NO. DE-AC09-89SR18035

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WSRC-TR-93-448

**EMT
EQUIPMENT AND MATERIAL TECHNOLOGY**

KEY WORDS:

Shipping Package
Recertification
Energy Absorbent Material
Honeycomb
Crush Strength

RETENTION:

Permanent

HONEYCOMBE SPACER CRUSH STRENGTH TEST RESULTS (U)

BY

D. R. LEADER

ISSUED: SEPTEMBER 15, 1993

Authorized Derivative Classifier

Date

Westinghouse Savannah River Company
Savannah River Site
Aiken, SC 29808

DOCUMENT: **WSRC-TR-93-448**

TITLE: HONEYCOMB SPACER CRUSH STRENGTH TEST RESULTS
(U)

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9/16/93
Date

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Materials Technology Section

9/16/93
Date

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Date

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9/29/93
Date

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HONEYCOMB SPACER CRUSH STRENGTH TEST RESULTS (U)

D. R. LEADER

EXECUTIVE SUMMARY:

Aluminum honeycomb spacers, which are used as an energy absorbent material in shipping packages for off site shipment of radioactive materials. were ordered in two crush strengths, 1,000 psi and 2,000 psi for use in drop tests requested by the Packaging and Transportation group as part of the shipping container rectification process. Both the vendor and the SRTC Materials Laboratory performed crush strength measurements on test samples made from the material used to fabricate the actual spacers. The measurements of crush strength made in the SRTC Materials Laboratory are within 100 psi of the measurements made by the manufacturer for all samples tested and all test measurements are within 10% of the specified crush strength, which is acceptable to the P&T group for the planned tests.

BACKGROUND:

Sixty special "pre-crushed" aluminum honeycomb energy absorbent spacers were purchased for use in the shipping package rectification tests. There are three different spacer shapes, and ten spacers of each shape were made with two different crush strength specifications; 1,000 psi and 2,000 psi. The Still-Walter Tool and Manufacturing Company was awarded the contract to fabricate the shipping packages to be used in the recertification tests, so Still-Walter actually negotiated the purchase of the honeycomb from the Hexcel Corporation to meet WSRC specifications.

The Hexcel Corporation purchased 22 1/2 inch wide rolls of aluminum foil to make "tubes" of aluminum honeycomb. Each 22 1/2 inch long tube was then cut into short pieces to be machined to the specified shape.

Honeycomb behaves like a bundle of interconnected columns which have a very high load bearing capacity, but once the maximum load is exceeded, the compressive load bearing capacity drops off to a much lower value which is then maintained until the honeycomb structure is completely crushed. The high initial load bearing ability is what makes honeycomb attractive for applications like light weight structural members in airplanes, but it is undesirable for the energy absorbing function that is required for the shipping package application. However, the property of bearing a uniform load while being crushed is the

property that makes aluminum honeycomb attractive as an energy absorbent material for the shipping package application. All of the honeycomb spacers used in this program have been "pre-crushed" to eliminate or minimize the initial high compressive strength of the material. Pre crushing is done by "dimpling" one surface of the spacer with a ball peen hammer so one end of every aluminum column has been loaded past its maximum compressive strength and has started to deform. Although pre crushing dramatically reduces the initial peak load that can be sustained by the honeycomb, the initial maximum load on a pre crushed sample will always exceed the average load until the pre crushed honeycomb surface deforms to the shape of the surface causing it to deform.

When the honeycomb test sample is crushed between two parallel flat plates, all of the deformation takes place on the pre crushed end of the sample. Figure 1 shows the pre crushed surface of a typical test sample after it has been compressed from its initial thickness of 1-inch to about 1/2 inch thick. Figure 2 shows the other end of that same sample. Notice that there is virtually no deformation of the end of the sample that was not pre crushed. Figure 3 is a side view of the same sample. The upper side of the sample in the photograph was originally pre crushed. Notice in this picture that the failure of the honeycomb starts at the pre crushed end progresses toward the other end, but that there is no apparent deformation of the honeycomb below the area where active deformation is in progress.

Because SRS required certification that the honeycomb meets the crush strength specification, Hexcell cut one test specimen from each tube and had it crushed on a testing machine to determine its crush strength. For aluminum honeycomb, crush strength is defined as the average load after the initial peak load (in pounds per square inch) that the honeycomb will support while being crushed. The results of the manufacturers crush strength measurements are included in table I.

Hexcell also supplied a pre crushed test sample from each tube that had enough material left over after the spacers and the required certification sample were cut from the tube. Nine of the fifteen tubes had enough material left over to obtain a test sample that was one inch long.

DISCUSSION :

The nine test samples from tubes used to manufacture shipping package spacers have been tested on the Baldwin test machine in the SRTC

Materials Laboratory. Each one inch thick sample was first measured to determine its diameter and then placed between parallel surfaces in the test machine and crushed to approximately one half inch thick at a strain rate of 3 1/4 inches per minute. Discussions with Hexcell verified that this is the same technique they used in their tests to determine crush strength. A chart of machine load versus displacement was recorded for analysis. The test machine charts for both the manufacturers tests and the SRTC tests are included in the appendices of this report. The crush strength, in pounds per square inch, was calculated for both the SRTC samples and the manufacturers samples by dividing the average load after the initial peak load by the calculated sample area based on measurements of the sample. The specified dimensions of the sample were used to calculate the area of the manufacturers sample when no sample material was supplied to SRTC. The SRTC Materials Lab crush strength measurements are within 100 psi of the values determined by the manufacturer in similar tests of samples from the same honeycomb tube, and all test results are within 10% of the crush strength specifications. The results of all tests are included in table I. The samples from one tube used to manufacture five 2,000 psi spacers per drawing 13100-A had a measured crush strength 22 psi and 76 psi higher than the original specification of 2,000 psi plus or minus 100 psi. The five spacers were accepted for use in the recertification tests based on the knowledge of their actual crush strength and the small deviation from the original specification. Nonconformance Report 92-NCR-11-0159 was written to record the acceptance of these five spacers.

There were six different types of honeycomb spacers purchased from Hexcel. The first six appendices to this report contain all of material data and test results for each type of spacer. Appendix 7 contains a copy of the certificate of calibration for the Materials Lab testing machine and a copy of the chart relating the SRTC machine load to chart pen vertical position. This chart is required for interpreting the SRTC test charts because the machine load is not shown on the Y axis of the SRTC charts.

CONCLUSION:

The crush strength measurements done in the materials Laboratory confirm the results of tests done by the honeycomb manufacturer. All of the materials lab results are within 100 psi of the manufacturers test results on samples from the same tubes, and all test results are within 10% of the desired crush strength, which is acceptable for the recertification tests planned by the packaging and Transportation group.

Figure 1
Pre-Crushed Side of Spacer Sample
After Crush Strength Test

Figure 2
Undisturbed Side of Spacer Sample
After Crush Strength Test

Figure 3
Side View of Spacer Sample
After Crush Strength Test

TABLE I

SRS DRAWING NUMBER	HEXCELL TUBE NUMBER	PIECES MADE FROM TUBE	NOMINAL CRUSH STRENGTH	MFG. MEASURED CRUSH STRENGTH	SRTC MEASURED CRUSH STRENGTH
13100-A	93-1	4	1,000	1,061	989
13100-A	93-2	5	1,000	1,014	1,033
13100-A	93-3	1	1,000	1,022	1,006
13100-A	93-1 ¹	5	2,000	2,093	2,050
13100-A	93-2 ¹	5	2,000	2,176	2,122
13100-B	93-1	4	1,000	953	1,020
13100-B	93-2	3	1,000	920	997
13100-B	93-3	3	1,000	910	²
13100-B	93-1	4	2,000	2,039	²
13100-B	93-2	4	2,000	2,070	²
13100-B	93-3	2	2,000	2,039	²
13117-C	93-1	6	1,000	1,062	²
13117-C	93-2	4	1,000	1,012	²
13117-C	93-1	6	2,000	2,029	1,939
13117-C	93-2	4	2,000	1,980	1,943

¹ The two test pieces submitted by Hexcell for these two tubes were identified as " 2 " and " 93-3 ". Neither of these numbers correspond to the numbers of the tubes used to manufacture the spacers. Discussions with Hexcell did not resolve the problem. They said that the two samples were definitely from the two tubes, and speculated that the sample identified as " 2 " should have been 93-2, but they had no explanation for why the sample from tube 93-1 would be labeled 93-3.

² No sample was supplied from this tube.

APPENDIX 1
Bottom Spacer
Drawing Number S5-2-13100 A
1,000 PSI Crush Strength

Index:

Still-Walter Tool & Manufacturing Co. Certificate of Conformance	7
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Tube 93-3 crush strength test results (SRTC)	15

STILL-WALTER TOOL & MANUFACTURING CO.
375 CANNON BRIDGE RD. P.O. BOX 464
ORANGEBURG, SOUTH CAROLINA 29116-0464
PHONE: 803-534-8555 FAX: 803-534-4585

CERTIFICATE OF CONFORMANCE

DATE: June 14, 1993
STILL-WALTER ORDER: 4057 CUSTOMER: Westinghouse SRC
PURCHASE ORDER: AB10140C C/N 1 ITEM NUMBER: 6
DRAWING NUMBER: S5-2-13100-A REV. 5 QUANTITY: 10 Each
DESCRIPTION: Bottom Spacer MATERIAL: 5052 Aluminum
SPECIFICATION: Aluminum HEAT NUMBER: 168119
HEAT TREATING: Not Applicable
PROCUREMENT SPECIFICATION: None
PROCUREMENT LEVEL: 3 STORAGE LEVEL: Not Applicable
OTHER: 1000 psi Crush Strength Honeycomb
Still-Walter Part No: A1526A

This is to certify that the item fabricated and material used on the above purchase order was manufactured to and conforms with the requirements of applicable drawings and specifications.

Still-Walter Tool & Manufacturing Co.

John W. Bozard
Quality Assurance Manager

D. R. Leader
September, 1993

WSRC Purchase Order No. AB10140C C/N1
Line Item # 6
Drawing No. SS-2-13M-A, Rev. 0
Description Bottom Spacers (1000 psi)
Page 2 of 6

Q.A. ACCEPTED

INITIALS Sub DATE 5-22-93

ALCOA ALUMINUM COMPANY OF AMERICA Cust. P.O. No. / Gov't. Contract No. 74707 BUFF CERTIFICATION Code No. MA101 Alcoa No. LE 94477
180*409871
Certified Inspection Report We hereby certify that the material covered by this report has been inspected in accordance with, and has been found to meet, the applicable requirements described herein, including any specifications forming a part of the description and that certain representative of the material met the composition limits and had the mechanical properties shown on the face of this sheet. Per F. P. SWIGON
Product PLAIN COILED HONEYCOMB FOIL WOUND ON 3 IN ID FLUSH STEEL CORES, 34 IN OD MAX PER FED SPEC MIL-A 81596 & CUST SPEC 1002 REV D DTD 8/20/70 Invoice No. Invoice Date

Item No.	Alloy-Temper	Item Description	Quantity Shipped Pcs., Ft. Etc.	Pounds	Net Wt. Lbs.	Direction	Limit	Test	Test	Test	Test	Test	Test																																										
001	5052-H191	.003 IN TK X 22-1/2 IN W A/T 5052-H191 CAT 159174 QRR DA194 W/E 90-06-30 LOT PACKAGE TICKET NUMBERS 160119 700108 700109 700110 700111	4	7266				UTS	TYB	EL 5		OLSEN																																											
							MIN	53.7	50.8	4.7																																													
<p>Chemical Composition</p> <table> <tr> <td>Alloy</td> <td>5052</td> <td>SI</td> <td>FE</td> <td>CU</td> <td>MN</td> <td>MG</td> <td>CR</td> <td>ZN</td> <td>TI</td> <td>OTHR/EA</td> <td>OTHR/TOT</td> <td>ALUMINUM</td> <td>REMAINDER</td> </tr> <tr> <td></td> <td></td> <td>Max. 0.25</td> <td>0.40</td> <td>0.10</td> <td>0.10</td> <td>2.8</td> <td>0.35</td> <td>0.10</td> <td></td> <td>0.05</td> <td>0.15</td> <td></td> <td></td> </tr> <tr> <td></td> <td></td> <td>Min.</td> <td></td> <td></td> <td></td> <td>2.2</td> <td>0.15</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>														Alloy	5052	SI	FE	CU	MN	MG	CR	ZN	TI	OTHR/EA	OTHR/TOT	ALUMINUM	REMAINDER			Max. 0.25	0.40	0.10	0.10	2.8	0.35	0.10		0.05	0.15					Min.				2.2	0.15						
Alloy	5052	SI	FE	CU	MN	MG	CR	ZN	TI	OTHR/EA	OTHR/TOT	ALUMINUM	REMAINDER																																										
		Max. 0.25	0.40	0.10	0.10	2.8	0.35	0.10		0.05	0.15																																												
		Min.				2.2	0.15																																																

Date 08/27/90 92052
Gross Wgt 8105
Via X
FOB FOB DESTINATION

HEXCEL CORP
338 N PENNSYLVANIA AVE
GRAHAM, TX 76046

HEXCEL CORP
338 N PENNSYLVANIA AVE
GRAHAM, TX 76046

42-503

① When 2 or more tests per lot are made, the highest and lowest values are reported for each property determined. Single tests are reported in minimum columns.
② For test information refer to back of this sheet.

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Page 8

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Page 9

B/L 86253
REV:

5/21/93

11023

G3G008804

STILL-WALTER TOOL

ON HOBE ® SHIPMENTS HEXCEL ASSUMES NO RESPONSIBILITY FOR FAILURE OF MATERIAL TO MEET SPECIFICATIONS DUE TO IMPERFECT EXPANSION THEREOF
HEXCEL CERTIFIES THAT ALL HEXCEL MONEYCOMB OR HOBE IN THIS SHIPMENT MEETS THE REQUIREMENTS OF

10

HEXCEL HEREBY CERTIFIES THAT THE PARTS SUPPLIED
UNDER PO 11023 FULLY CONFORM TO THE DRAWINGS,
SPECIFICATIONS, AND PURCHASE ORDER REQUIREMENTS.
PART NO. A1526A REV. — SPEC(S) DS-2800.
CRUSH CHARTS IN BOX. SEE ATTACHMENT SHTS FOR SN'S

QUALITY ASSISTANT

BLOCK NUMBER	DENSITY	TEMP	DELAMINATION		COMPRESSIVE			FLEXURE		PLATE SHEAR				FLAT TENS	NODE BLOW	FOIL LOT	
			ROOM TEMP	ELEV TEMP	H2O	BARE DRY	BARE WET	STAB	L	W	STRENGTH		MODULUS				
											L	W	L				W
2800DS	.00	RT ET							0	0	0	0					
<div><div>WSRC Purchase Order No. <u>AB101402, c/w 1</u></div><div>Line Item # <u>6</u></div><div>Drawing No. <u>SS-2-13100-A</u>, Rev. <u>5</u></div><div>Description <u>Bottom Spacer (1000 psi)</u></div><div>Page <u>3</u> of <u>6</u></div></div> <div><div>** MATERIALS OR PARTS FURNISHED HAVE BEEN MANUFACTURED AND **</div><div>** TESTED IN STRICT ACCORDANCE WITH THE APPLICABLE SPECIFI- **</div><div>** CATIONS AS REFERENCED ON THE DRAWINGS AND TEST REPORTS **</div><div>** SHOWING COMPLIANCE IS ON FILE SUBJECT TO EXAMINATION. **</div><div><div>375 CANNON BRIDGE</div><div>PO BOX 464</div><div>ORANGEBURG SC 29116-0464</div></div><div><div>MATERIALS</div><div>TUBECORE</div></div></div>																	
<div><div>Q.A. ACCEPTED</div><div>INITIALS: <u>Sub</u> DATE: <u>5/28/93</u></div></div>																	

D. R. Leader
September, 1993

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Page 10

D. R. Leader
September, 1993

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Page 12

PRELOAD
40 + 190

16 JULY 1993
DIAMETER 5.85" - 5.9"
THICKNESS 1.00"
WSRC PURCHASE ORDER NO. AB10TH C Q/W 1
LINE ITEM #6
DRAWING NO. 55-B-13100-A REV 5
DESCRIPTION BOTTOM SPACER
PAGE 2 OF 3
BOTTOM SPACER, 1,010 PSI
CRUSH STRENGTH
TEST PIECE 93-2

Shedd & Brown
O.B. Antonucci
10.33 7.51

5

PRE LOAD

DIAMETER 5.85" 5.95" 10 JULY 1993

THICKNESS .95"

WSRC PURCHASE ORDER NO. AB101400 C/N1

LINE ITEM #6

DRAWING NO. 55-2-13100-A, REV. 5

DESCRIPTION BOTTOM SPACER

PAGE 3 OF 3

BOTTOM SPACER, 1,000 PSI

CRUSH STRENGTH

* TEST PIECE - 93-3

Handwritten signature: D. R. Leader

1,000 PSI

610+190

APPENDIX 2
Bottom Spacer
Drawing Number S5-2-13100 A
2,000 PSI Crush Strength

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Still-Water Tool & manufacturing Co. Certification of Conformance	17
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Tube 93-2 crush strength test results (Hexel)	22
Tube 93-3 crush strength test results (SRTC)	23
Tube 2 crush strength test results (SRTC)	24

STILL-WALTER TOOL & MANUFACTURING CO.

375 CANNON BRIDGE RD. P.O. BOX 464
ORANGEBURG, SOUTH CAROLINA 29116-0464
PHONE: 803-534-8555 FAX: 803-534-4585

CERTIFICATE OF CONFORMANCE

DATE: June 14, 1993

STILL-WALTER ORDER: 4057 CUSTOMER: Westinghouse SRC

PURCHASE ORDER: AB10140C C/N 1 ITEM NUMBER: 7

DRAWING NUMBER: S5-2-13100-A REV. 5 QUANTITY: 10 Each

DESCRIPTION: Bottom Spacer MATERIAL: 5052 Aluminum

SPECIFICATION: Aluminum HEAT NUMBER: 168119 & 102598

HEAT TREATING: Not Applicable

PROCUREMENT SPECIFICATION: None

PROCUREMENT LEVEL: 3 STORAGE LEVEL: Not Applicable

OTHER: 2000 psi Crush Strength Honeycomb

Still-Walter Part No: A1526B

This is to certify that the item fabricated and material used on the above purchase order was manufactured to and conforms with the requirements of applicable drawings and specifications.

Still-Walter Tool & Manufacturing Co.

John W. Bozard
Quality Assurance Manager

ALUMINUM COMPANY OF AMERICA

Cust. P.O. No. / Gov't. Contract No.
74707

BUFF CERTIFICATION

Code No. MA101
180*409871

LE 94477

Certified
Inspection
Report

We hereby certify that the material covered by this report has been inspected in accordance with, and has been found to meet, the applicable requirements described herein, including any specifications forming a part of the description and that same are representative of the material met the composition limits and had the mechanical properties shown on the face of this sheet. Per

Invoice
No.

Invoice
Date

duct

PLAIN COILED HONEYCOMB FOIL WOUND ON 3 IN ID FLUSH STEEL CORES, 34 IN OD MAX PER FED SPEC MIL-A-81596 & CUST SPEC 1002 REV D DTD 8/20/70

Report	Sheet Per	PLAIN COILED HONEYCOMB FOIL WOUND ON 3 IN ID FLUSH STEEL TOWER										
duct		81596 & CUBT SPEC 1002 REV D DTD 8/20/70										
Item No.	Alloy-Temper	Item Description	Quantity Shipped Pcs., Ft. Etc.	Pounds	Direction	Limit	Test	Test	Test	Test	Test	Test
001	5052-H191	003 IN TR X 22-1/2 IN W A/T 5052-H191 CAT 159174 QRR DA194 W/E 90-06-30 LOT PACKAGE TICKET NUMBERS 188119 700108 700109 700110 700111	4	7266			UTS	TYB	EL 5		OLSEN	
					1		MIN 53.7	50.8	4.7			
			Frank P Swigon Quality Assurance Manager									
Chemical Composition												
Alloy	5052	SI	FE	CU	MN	HC	CR	ZN	TI	OTHR/EA	OTHR/TOT	ALUMINUM
		0.25	0.40	0.10	0.10	2.8	0.35	0.10		0.05	0.15	REMAINDER
		Max.				2.2	0.15					
		Min.										
						HEXCEL CORP						

Frank P. Swigon
Quality Assurance Manager

HEXCEL CORP
338 N PENNSYLVANIA AVE
GRAHAM, TX 76046

42-503

① When 2 or more tests per lot are made, the highest and lowest values are reported for each property determined. Single tests are reported in minimum columns.
② See test abbreviation explanation on back of this sheet.

Date 08/27/90^{RA} 92052
Gross Wgt. 8105
Via
FOB X
FOB DESTINATION
From LEBANON, PA.

PAGE 1 IN SET OF 3

Q.A. ACCEPTED

INITIALS Sub DATE 5-28-93

WSRC Purchase Order No.	AB10140C clu1
Line Item #	7
Drawing No.	552-13100-A No. 5
Description	Bottom Spacer (2000 psi)
Page	2 of 6

D. R. Leader
September, 1993

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Bottom Spine (2000 per.)	
Drawing No. SS-2-13100-A	Rev. 5
Line Item # 7	
WSRC Purchase Order No. AB101400 C/N1	

INITIALS: *gub* DATE: 5-28-93

OA-ACCEPTED

Certified Inspection Report		Product	
<p>Aluminum Company of America</p> <p>27307</p> <p>Contract No. / Govt. Contract No.</p> <p>Code No. 0401</p> <p>Alcoa No. 11-17-10</p>		<p>PLAIN COILED HONEYCOMB FOIL WOUND ON 3 IN ID EXTENDED SHEET COILS. MAT. 54 10 00 100 100 100</p>	
<p>Product</p> <p>Inspection Report</p> <p>Sheet For</p> <p>We hereby certify that the material covered by this report has been inspected in accordance with, and has been found to meet, the applicable requirements described herein, including any specifications forming a part of the description and that samples representative of the material met the composition limits and had the mechanical properties shown on the face of this report.</p> <p>E. F. SWIGON</p>		<p>Item No.</p> <p>Item Description</p> <p>Quantity Shipped</p> <p>Net Weight</p> <p>Direction</p> <p>Limit</p> <p>UTS</p> <p>TYS</p> <p>EL</p> <p>DLSEN</p> <p>DATE</p>	
<p>5052-H191</p> <p>0047 IN TX 39 IN W</p> <p>5052-H191 QRR DA194</p> <p>W/E 92-02-01</p> <p>PACKAGE TICKET NUMBERS</p> <p>102598 784486 784487</p>		<p>1</p> <p>6730</p> <p>1</p> <p>MIN 47.5</p> <p>45.5</p> <p>3.6</p>	
<p>Alloy</p> <p>Chemical Composition</p> <p>Max</p> <p>Min</p> <p>5052</p>		<p>Aluminum</p> <p>Remainder</p>	
<p>From</p> <p>LEBANON, TN</p> <p>FOB</p> <p>CUST PICKUP</p> <p>TOB DESTINATION</p> <p>Via</p> <p>Gross Wgt</p> <p>01/30/92</p> <p>02876</p> <p>1230</p>		<p>HEXCEL CORP</p> <p>330 N PENNSYLVANIA AVE</p> <p>TX 75046</p> <p>GRAHAM</p> <p>TX 75046</p> <p>HEXCEL CORP</p> <p>330 N PENNSYLVANIA AVE</p> <p>TX 75046</p> <p>GRAHAM</p> <p>TX 75046</p>	

WSRC-TR-93-448
Page 20

B/L 8625-2
REV:

11023

G3G008805

CERTIFICATION

ON HOBE • SHIPMENTS, HEXCEL ASSUMES NO RESPONSIBILITY FOR FAILURE OF MATERIAL TO MEET SPECIFICATIONS DUE TO IMPERFECT EXPANSION THEREOF. HEXCEL CERTIFIES THAT ALL HEXCEL HONEYCOMB OR HOBE IN THIS SHIPMENT MEETS THE REQUIREMENTS OF

STILL-WALTER TOOL

10

DS - 2260

HEXCEL HEREBY CERTIFIES THAT THE PARTS SUPPLIED
UNDER PO 11023 FULLY CONFORM TO THE DRAWINGS,
SPECIFICATIONS, AND PURCHASE ORDER REQUIREMENTS.
PART NO. A1526B REV. — SPEC(S) D5-2800.
CRUSH CHARTS IN BOX. SEE ATTACHMENT SHTS FOR SN'S

W. Baughman
QUALITY ASSISTANT

BLOCK NUMBER	DENSITY	TEMP	DELAMINATION			COMPRESSIVE			FLEXURE		PLATE SHEAR				FLAT TENS	NODE BLOW	FOIL LOT
			ROOM TEMP	ELEV TEMP	H2O	BARE DRY	BARE WET	STAB	L	W	STRENGTH		MODULUS				
											L	W	L	W			
2800DS	.00	RT ET							0	0	0	0					
<p>Q.A. ACCEPTED</p> <p>INITIALS: <u>Sub</u> DATE: <u>5-28-93</u></p>																	
<div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: 80%;"> VSRC Purchase Order No. <u>AB10440C c/w</u> Line Item # <u>7</u> Drawing No. <u>S52-B100-A</u>, Rev. <u>5</u> Description <u>Bottom Spacer (2000 psi)</u> Page <u>4</u> of <u>6</u> </div>																	
<p> ** MATERIALS OR PARTS FURNISHED HAVE BEEN MANUFACTURED AND ** ** TESTED IN STRICT ACCORDANCE WITH THE APPLICABLE SPECIFI- ** ** CATIONS AS REFERENCED ON THE DRAWINGS AND TEST REPORTS ** ** SHOWING COMPLIANCE IS ON FILE SUBJECT TO EXAMINATION. ** </p>																	
<div style="display: flex; justify-content: space-between;"> <div> 375 CANNON BRIDGE PO BOX 464 ORANGER, NC 29116-0464 </div> <div> MATERIALS TUBECORE </div> </div>

17.0 11.750 + 180

10.5 JULY 1993

DIMETER 5.9"-6.0"

THICKNESS 1.0"

USED PURCHASE ORDER NO. H8141402 Q111

LINE ITEM #7

DRAWING NO. 55-2-13.10-11, REV 5

DESCRIPTION RATCH SPACER

PHYS 2 OF 2

"RATCH SPACER, 3.140 KSI

DEBUSH STRENGTH "

*TEST PIECE - Q313

Q13 OUTSIDE

Charles J. Rouch

2.050

62.390

Avg Load 27.000

Avg Area: 27.9015

Avg Crush Strength =

2.050

16 JULY 1993

DIAMETER 5.9" 6.0"

THICKNESS 1.0"

WSRC PURCHASE ORDER NO AB101406 C/NL

LINE ITEM #1

DRAWING NO S5-2-13100-A REV 5

DESCRIPTION BOTTOM SPACER

PAGE 1 OF 2

"BOTTOM SPACER, 2000 PSI CRUSH STRENGTH"

* TEST PIECE - 2

Thickness RECON

Brinell Antennae

2,122 PSI

527,070

= AVG Load = 57,000
= AVG Area = 27.805
Avg Crush Strength 2,2

APPENDIX 3
Bottom Spacer
Drawing Number S5-2-13100 B
1,000 PSI Crush Strength

Index:

Still-Water Tool & Manufacturing Co. Certificate of Conformance	26
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Hexcel honeycomb spacer certificate of conformance	28
Tube 93-1 crush strength test results (Hexcel)	29
Tube 93-1 crush strength test results (SRTC)	30
Tube 93-2 crush strength test results (Hexcel)	31
Tube 93-2 crush strength test results (SRTC)	32
Tube 93-3 crush strength test results (Hexcel)	33

STILL-WALTER TOOL & MANUFACTURING CO.

375 CANNON BRIDGE RD. P.O. BOX 464
ORANGEBURG, SOUTH CAROLINA 29116-0464
PHONE: 803-534-8555 FAX: 803-534-4585

CERTIFICATE OF CONFORMANCE

DATE: June 14, 1993

STILL-WALTER ORDER: 4057 CUSTOMER: Westinghouse SRC

PURCHASE ORDER: AB10140C C/N 1 ITEM NUMBER: 4

DRAWING NUMBER: S5-2-13100-B REV. 5 QUANTITY: 10 Each

DESCRIPTION: Top Spacer MATERIAL: 5052 Aluminum

SPECIFICATION: Aluminum HEAT NUMBER: 297909

HEAT TREATING: Not Applicable

PROCUREMENT SPECIFICATION: None

PROCUREMENT LEVEL: 3 STORAGE LEVEL: Not Applicable

OTHER: 1000 psi Crush Strength Honeycomb.

Still-Walter Part No: A1525A Rev. 1.

This is to certify that the item fabricated and material used on the above purchase order was manufactured to and conforms with the requirements of applicable drawings and specifications.

Still-Walter Tool & Manufacturing Co.

A handwritten signature in dark ink, appearing to read "John W. Bozard". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

John W. Bozard
Quality Assurance Manager

2475 Trenton Avenue • Williamsport, Pennsylvania 17701
717-323-4430 • FAX 717-323-6866

CERTIFIED TEST REPORT

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O

Hexcel Corp.
338 N. Pennsylvania Ave.
Graham, TX 76046

ORDER NUMBER 10110		CUSTOMER PURCHASE ORDER NUMBER 31172		CERTIFIED BY Keith DeHaas <i>Keith DeHaas</i>	
ALLOY 5052	TEMPER H191	GAUGE 0.0037"	WIDTH 23"	TITLE Lab. Technician	DATE 2/9/93
FINISH mill		PART NUMBER		APPLICABLE SPECIFICATION(S) M11-A-81596A Hexcel 1002 Rev.E	
CHEMICAL COMPOSITION FOR ALLOY					
ELEMENT	% MINIMUM	% MAXIMUM			
SILICON		0.25			
IRON		0.40			
COPPER		0.10			
MANGANESE		0.10			
MAGNESIUM	2.20	2.80			
CHROMIUM	0.15	0.35			
ZINC		0.10			
OTHERS EACH		0.05			
OTHERS TOTAL		0.15			
ALUMINUM DIFFERENCE		remainder			
<p>CERTIFICATION</p> <p>Coastal Aluminum Rolling Mills hereby certifies that metal shipped under this order has been inspected and tested and found in conformance with the requirements of the applicable specifications as indicated herein. Any warranty is limited to that shown on Coastal's standard General Terms and Conditions of Sales. Test reports are on file, subject to examination.</p> <p>COASTAL ALUMINUM ROLLING MILLS WILLIAMSPORT, PA</p>					

Q.A. ACCEPTED

LOT NO	297909			
ULTIMATE TENSILE, KSI, MAXIMUM	46.4			
ULTIMATE TENSILE, KSI, MINIMUM	46.4			
YIELD STRENGTH, KSI, MAXIMUM	44.7			
YIELD STRENGTH, KSI, MINIMUM	44.5			
ELONGATION, MAXIMUM				
ELONGATION, MINIMUM				
ROLL NUMBER(S)	C-6219A, B			
	C-6220A, B			
	C-6221A, B			

LOT NO		WSRC Purchase Order No.	AB10406 CMI
ULTIMATE TENSILE, KSI, MAXIMUM		Line Item #	4
ULTIMATE TENSILE, KSI, MINIMUM		Drawing No.	55-213100-B, Rev. 5
YIELD STRENGTH, KSI, MAXIMUM		Description	Top Spaces (1000 PAL)
YIELD STRENGTH, KSI, MINIMUM		Page	2 of 6
ELONGATION, MAXIMUM			
ELONGATION, MINIMUM			
ROLL NUMBER(S)

PART :

REV :

B/L 85943

5, 6, 93

11023

G3G008801

CERTIFICATION:

CERTIFICATION: **STILL-WALTER TOOL**
 ON HOBE • SHIPMENTS HEXCEL ASSUMES NO RESPONSIBILITY FOR FAILURE OF MATERIAL TO MEET SPECIFICATIONS DUE TO IMPERFECT EXPANSION THEREOF
 HEXCEL CERTIFIES THAT ALL HEXCEL MONEYCOMB OR HOBE IN THIS SHIPMENT MEETS THE REQUIREMENTS OF

DS-2800

HEXCEL HEREBY CERTIFIES THAT THE PARTS SUPPLIED
UNDER PO 11023 FULLY CONFORM TO THE DRAWINGS,
SPECIFICATIONS, AND PURCHASE ORDER REQUIREMENTS.
PART NO. A1525A REV. U/A SPEC(S) DS-2500.
CRUSH CHARTS IN BOX. SEE ATTACHMENT SHTS FOR SN'S

Dace Trachin
QUALITY ASSISTANT

BLOCK NUMBER	DENSITY	TEMP	DELAMINATION			COMPRESSIVE			FLEXURE		PLATE SHEAR				FLAT TENS	NODE BLOW	FOIL LOT
			ROOM TEMP	ELEV TEMP	H2O	BARE DRY	BARE WET	STAB	L	W	STRENGTH		MODULUS				
											L	W	L	W			
2800DS	.00	RT ET								0	0	0	0				
<div><div>Q.A. ACCEPTED</div><div>INITIALS: <u>QUB</u> DATE: <u>5/14/93</u></div></div>																	
<div><div>WSRC Purchase Order No. <u>PR10400 CBU</u></div><div>Line Item # <u>4</u></div><div>Drawing No. <u>SS-2-13100-B</u> Rev. <u>5</u></div><div>Description <u>Top Spacer (1000 psi)</u></div><div>Page <u>3</u> of <u>6</u></div></div>																	
<div><div><div>** MATERIALS OR PARTS FURNISHED HAVE BEEN MANUFACTURED AND **</div><div>** TESTED IN STRICT ACCORDANCE WITH THE APPLICABLE SPECIFI **</div><div>** CATIONS AS REFERENCED ON THE DRAWINGS AND TEST REPORTS **</div><div>** SHOWING COMPLIANCE IS ON FILE SUBJECT TO EXAMINATION. **</div></div><div><div>375 CANNON BRIDGE</div><div>PO BOX 464</div><div>ORANGEBURG SC 29115-0464</div></div><div><div>MATERIALS</div><div>TUBECORE</div></div></div>																	

D. R. Leader
September, 1993

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Page 29

16 JULY 1993 4 4
DIAMETER 8.5" - 8.6"
THICKNESS 1.0"
WSRC PURCHASE ORDER NO AB10142C C/M
LINE ITEM #12
DRAWING NO. SS-2-13100-C, REV 51 (SS-2-13117-C ON SAMPLE)
DESCRIPTION: BOTTOM SPACER
PAGE 1 OF 24
"BOTTOM SPACER 1000 PSI CRUSH STRENGTH"
TEST PIECE - 93-1

Charles J. Leoni
O.B. Antonicelli

1,020 PSI

D. R. Leader
September, 1993

WSRC-TR-93-448
Page 31

Pulver 110 + 190
+ 190

12 JULY 1993
DIAMETER 4.5" - 4.55"
THICKNESS 1"
WSRC PURCHASE ORDER NO. 78101440 Q/MY
LINE ITEM #12
DRAWING NO. 55-2-13100-0, REV. 5/1
DESCRIPTION BITUM SPREAD
PAGE FOUR
* BOTTOM SPREAD, 1,000 PSI
CRUSH STRENGTH 1"
* TEST PLACE - 93-R
O.B. Antomelli
David D. Leader
997 751

APPENDIX 4
Bottom Spacer
Drawing Number S5-2-13100 B
2,000 PSI Crush Strength

Index:

Still-Water Tool & Manufacturing Co. Certificate of Conformance	35
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Hexcel honeycomb spacer certificate of conformance	37
Tube 93-1 crush strength test results (Hexcel)	38
Tube 93-2 crush strength test results (Hexcel)	39
Tube 93-3 crush strength test results (Hexcel)	40

STILL-WALTER TOOL & MANUFACTURING CO.

375 CANNON BRIDGE RD. P.O. BOX 464
ORANGEBURG, SOUTH CAROLINA 29116-0464
PHONE: 803-534-8555 FAX: 803-534-4585

CERTIFICATE OF CONFORMANCE

DATE: June 14, 1993

STILL-WALTER ORDER: 4057 CUSTOMER: Westinghouse SRC

PURCHASE ORDER: AB10140C C/N 1 ITEM NUMBER: 5

DRAWING NUMBER: S5-2-13100-B REV. 5 QUANTITY: 10 Each

DESCRIPTION: Top Spacer MATERIAL: 5052 Aluminum

SPECIFICATION: Aluminum HEAT NUMBER: 297909

HEAT TREATING: Not Applicable

PROCUREMENT SPECIFICATION: None

PROCUREMENT LEVEL: 3 STORAGE LEVEL: Not Applicable

OTHER: 2000 psi Crush Strength Honeycomb.

Still-Walter Part No: A1525B Rev. 1.

This is to certify that the item fabricated and material used on the above purchase order was manufactured to and conforms with the requirements of applicable drawings and specifications.

Still-Walter Tool & Manufacturing Co.

John W. Bozard
Quality Assurance Manager

D. R. Leader
September, 1993

WSRC-TR-93-448
Page 36

2475 Trenton Avenue • Williamsport, Pennsylvania 17701
717-323-4430 • FAX 717-323-6866

CERTIFIED TEST REPORT

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Hexcel Corp.
338 N. Pennsylvania Ave.
Graham, TX 76046

ORDER NUMBER 10110		CUSTOMER PURCHASE ORDER NUMBER 31172		CERTIFIED BY Keith DeHaas <i>Keith DeHaas</i>	
ALLOY 5052	TEMPER H191	GUAGE 0.0037"	WIDTH 23"	TITLE Lab. Technician	DATE 2/9/93
FINISH mill		PART NUMBER		APPLICABLE SPECIFICATION(S) Mil-A-81596A Hexcel 1002 Rev.E	
CHEMICAL COMPOSITION FOR ALLOY					
ELEMENT	% MINIMUM	% MAXIMUM			
SILICON		0.25			
IRON		0.40			
COPPER		0.10			
MANGANESE		0.10			
MAGNESIUM	2.20	2.80			
CHROMIUM	0.15	0.35			
ZINC		0.10			
OTHERS, EACH		0.05			
OTHERS, TOTAL		0.15			
ALUMINUM, DIFFERENCE		remainder			
<p align="center">CERTIFICATION</p> <p>Coastal Aluminum Rolling Mills hereby certifies that metal shipped under this order has been inspected and tested and found in conformance with the requirements of the applicable specifications as indicated herein. Any warranty is limited to that shown on Coastal's standard General Terms and Conditions of Sales. Test reports are on file, subject to examination.</p> <p align="center">COASTAL ALUMINUM ROLLING MILLS WILLIAMSPORT, PA</p>					

LOT NO	297909	<p align="center">Q.A. ACCEPTED</p> <p>INITIALS: <i>Sub</i> DATE: 5/4/93</p>
ULTIMATE TENSILE, KSI, MAXIMUM	46.4	
ULTIMATE TENSILE, KSI, MINIMUM	46.4	
YIELD STRENGTH, KSI, MAXIMUM	44.7	
YIELD STRENGTH, KSI, MINIMUM	44.5	
ELONGATION, MAXIMUM		
ELONGATION, MINIMUM		
ROLL NUMBER(S)	C-6219A, B	
	C-6220A, B	
	C-6221A, B	

LOT NO		WSRC Purchase Order No. <u>AB10140C CWT</u>
ULTIMATE TENSILE, KSI, MAXIMUM		Line Item # <u>5</u>
ULTIMATE TENSILE, KSI, MINIMUM		Drawing No. <u>SS-2-13100-B</u> , Rev. <u>5</u>
YIELD STRENGTH, KSI, MAXIMUM		Description <u>Top Specimen (2000 psi)</u>
YIELD STRENGTH, KSI, MINIMUM		Page <u>2</u> of <u>6</u>
ELONGATION, MAXIMUM		
ELONGATION, MINIMUM		
ROLL NUMBER(S)		

WSRC-TR-93-448
Page 37

B/L 8 5943
REV:

DATE 5-16-93

11023

G3G008803

CERTIFICATION:

ON HOBE: * SHIPMENTS: HEXCEL ASSUMES NO RESPONSIBILITY FOR FAILURE OF MATERIAL TO MEET SPECIFICATIONS DUE TO IMPERFECT EXPANSION THEREOF. HEXCEL CERTIFIES THAT ALL HEXCEL MONEYCOMB OR HOBE IN THIS SHIPMENT MEETS THE REQUIREMENTS OF

STILL-WALTER TOOL

DS - 2800

HEXCEL HEREBY CERTIFIES THAT THE PARTS SUPPLIED
UNDER PO 11023 FULLY CONFORM TO THE DRAWINGS,
SPECIFICATIONS, AND PURCHASE ORDER REQUIREMENTS.
PART NO. A1525B REV. N/A SPEC(S) DS-2500.
CRUSH CHARTS IN BOX. SEE ATTACHMENT SHTS FOR SN'S

10

Dale Frachin
QUALITY ASSISTANT

BLOCK NUMBER	DENSITY	TEMP	DELAMINATION			COMPRESSIVE			FLEXURE		PLATE SHEAR				FLAT TENS	NODE BLOW	FOIL LOT
			ROOM TEMP	ELEV TEMP	H2O	BARE DRY	BARE WET	STAB	L	W	STRENGTH		MODULUS				
											L	W	L	W			
2800DS	.00	RT ET									0	0	0	0			
<p>Q.A. ACCEPTED</p> <p>INITIALS: <u>Sub</u> DATE: <u>5-14-93</u></p>																	
<div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: 80%;"> <p>WSRC Purchase Order No. <u>AB101400 C/W 1</u></p> <p>Line Item # <u>5</u></p> <p>Drawing No. <u>S5-2-13100-B</u>, Rev. <u>5</u></p> <p>Description <u>Top Spacer (200 psi)</u></p> <p>Page <u>3</u> of <u>6</u></p> </div>																	
<p>** MATERIALS OR PARTS FURNISHED HAVE BEEN MANUFACTURED AND **</p> <p>** TESTED IN STRICT ACCORDANCE WITH THE APPLICABLE SPECIFI **</p> <p>** CATIONS AS REFERENCED ON THE DRAWINGS AND TEST REPORTS **</p> <p>** SHOWING COMPLIANCE IS ON FILE SUBJECT TO EXAMINATION. **</p>																	
<div style="display: flex; justify-content: space-between;"> <div> <p>375 CANNON BRIDGE</p> <p>PO BOX 464</p> <p>ORANGEBURG SC 29116-0464</p> </div> <div style="text-align: center;"> <p>MATERIALS TUBECORE</p> </div> </div>

APPENDIX 5
Bottom Spacer
Drawing Number S5-2-13117 C
1,000 PSI Crush Strength

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STILL-WALTER TOOL & MANUFACTURING CO.

375 CANNON BRIDGE RD. P.O. BOX 464
ORANGEBURG, SOUTH CAROLINA 29116-0464
PHONE: 803-534-8555 FAX: 803-534-4585

CERTIFICATE OF CONFORMANCE

DATE: June 14, 1993

STILL-WALTER ORDER: 4057 CUSTOMER: Westinghouse SRC

PURCHASE ORDER: AB10140C C/N 1 ITEM NUMBER: 12

DRAWING NUMBER: S5-2-13117-C REV. 51 QUANTITY: 10 Each

DESCRIPTION: "13117 Spacer, 1000 psi" MATERIAL: 5052 Aluminum

SPECIFICATION: Aluminum HEAT NUMBER: 168119

HEAT TREATING: Not Applicable

PROCUREMENT SPECIFICATION: None

PROCUREMENT LEVEL: 3 STORAGE LEVEL: Not Applicable

OTHER: "13117 Spacer, 1000 psi Crush Strength"

Still-Walter Part No: A1527A

This is to certify that the item fabricated and material used on the above purchase order was manufactured to and conforms with the requirements of applicable drawings and specifications.

Still-Walter Tool & Manufacturing Co.

A handwritten signature in cursive script, reading "John W. Bozard", is positioned above the printed name and title.

John W. Bozard
Quality Assurance Manager

ALCOA Certified Inspection Report Product <u>PLAIN COILED HONEYCOMB FOIL WOUND ON 3 IN ID FLUSH STEEL CORES, 34 IN OD MAX PER FED SPEC MIL-A-81596 & CUST SPEC 1002 REV D DTD 8/20/70</u>		ALUMINUM COMPANY OF AMERICA Cust. P.O. No. / Gov't. Contract No. 74707 BUFF CERTIFICATION Code No. MA101 Altus No. LE 94477 1804409871		Invoice No. _____ Invoice Date _____																																		
We hereby certify that the material covered by this report has been inspected in accordance with, and has been found to meet, the applicable requirements described herein, including any specifications forming a part of the description and that samples representative of the material met the composition limits and had the mechanical properties shown on the face of this sheet. For F. P. SWIGON		Quantity Shipped 4 Pcs., Ft. Etc. 7266																																				
Alloy-Temper 5052-H191 003 IN TK X 22-1/2 IN W A/T 5052-H191 CAT 159174 QRR DA194 W/E 90-06-30 LOT 168119 700108 700109 700110 700111 PACKAGE TICKET NUMBERS		Direction 1 Limit MIN		Test UTS 53.7 Test TYB 50.8 Test EL 4.7 Test DLSEN																																		
Chemical Composition Alloy 5052		<table border="1"> <tr> <th>Si</th> <th>Fe</th> <th>Cu</th> <th>Mn</th> <th>Mg</th> <th>Cr</th> <th>Zn</th> <th>Ti</th> <th>Other/EA</th> <th>Other/TOT</th> <th>ALUMINUM</th> </tr> <tr> <td>0.25</td> <td>0.40</td> <td>0.10</td> <td>0.10</td> <td>2.8</td> <td>0.35</td> <td>0.10</td> <td></td> <td>0.05</td> <td>0.15</td> <td>REMAINDER</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>2.2</td> <td>0.15</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>				Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Other/EA	Other/TOT	ALUMINUM	0.25	0.40	0.10	0.10	2.8	0.35	0.10		0.05	0.15	REMAINDER					2.2	0.15					
Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Other/EA	Other/TOT	ALUMINUM																												
0.25	0.40	0.10	0.10	2.8	0.35	0.10		0.05	0.15	REMAINDER																												
				2.2	0.15																																	
Date 08/27/90 Gross Wgt 8105 Via X FOB FOB DESTINATION From LEBANON, PA.		HEXCEL CORP 338 N PENNSYLVANIA AVE GRAHAM, TX 76046		HEXCEL CORP 338 N PENNSYLVANIA AVE GRAHAM, TX 76046																																		

WSRC Purchase Order No. AB10140C CH1 Line Item # 12 Drawing No. "1317 Spec" , Rev 51 Description S5-2-1317C (1000 psi) Page 2 of 5

Q.A. ACCEPTED

INITIALS Sub DATE 6-7-93

① When 2 or more tests per lot are made, the highest and lowest values are reported for each property determined. Single tests are reported in minimum columns.
 ② See test observation explanation on back of this sheet.

WSRC-TR-93-448
Page 44

REV:

5/27/93

B/L 864.30

11028

G 3 G 0 1 4 4 0 1

CERTIFICATION

ON MOBE • SHIPMENTS HEXCEL ASSUMES NO RESPONSIBILITY FOR FAILURE OF MATERIAL TO MEET SPECIFICATIONS DUE TO IMPERFECT EXPANSION THEREOF
HEXCEL CERTIFIES THAT ALL HEXCEL HONEYCOMB OR MOBE IN THIS SHIPMENT MEETS THE REQUIREMENTS OF

DS - 2800

STILL-WALTER TOOL

HEXCEL HEREBY CERTIFIES THAT THE PARTS SUPPLIED
UNDER PO 11028 FULLY CONFORM TO THE DRAWINGS,
SPECIFICATIONS, AND PURCHASE ORDER REQUIREMENTS.
PART NO. 6TC93A174 REV. I SPEC(S) DS2000
CRUSH CHARTS IN BOX. SEE ATTACHMENT SHTS FOR SN'S
(A1527A)

10

Dale Frachising
QUALITY ASSISTANT

BLOCK NUMBER	DENSITY	TEMP	DELAMINATION			COMPRESSIVE			FLEXURE		PLATE SHEAR				FLAT TENS	NODE BLOW	FOIL LOT
			ROOM TEMP	ELEV TEMP	H2O	BARE DRY	BARE WET	STAB	L	W	STRENGTH		MODULUS				
											L	W	L	W			
2800DS	.00	RT ET							0	0	0	0					
<p>Q.A. ACCEPTED</p> <p>INITIALS: <u>gab</u> DATE: <u>6-7-83</u></p>																	
<div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: 80%;"> <p>WSRC Purchase Order No. <u>AR 10140C C/AM</u></p> <p>Line Item # <u>12</u></p> <p>Drawing No. <u>SS-2-1317-C</u>, Rev. <u>SI</u></p> <p>Description <u>"3117 Spec." 1000 psi</u></p> <p>Page <u>3</u> of <u>5</u></p> </div>																	
<p>.. MATERIALS OR PARTS FURNISHED HAVE BEEN MANUFACTURED AND ..</p> <p>.. TESTED IN STRICT ACCORDANCE WITH THE APPLICABLE SPECIFI- ..</p> <p>.. CATIONS AS REFERENCED ON THE DRAWINGS AND TEST REPORTS ..</p> <p>.. SHOWING COMPLIANCE IS ON FILE SUBJECT TO EXAMINATION. ..</p>																	
<p>375 CANNON BRIDGE MATERIALS PO BOX 464 TUBECORE ORANGEBURG SC 29116-0464</p>

APPENDIX 6
Bottom Spacer
Drawing Number S5-2-13117 C
2,000 PSI Crush Strength

Index:

Still-Water Tool & Manufacturing Co. Certificate of Conformance	48
ALCOA aluminum foil certificate of conformance	49
ALCOA aluminum foil certificate of conformance	50
Hexcel honeycomb spacer certificate of conformance	51
Tube 93-1 crush strength test results (Hexcel)	52
Tube 93-1 crush strength test results (SRTC)	53
Tube 93-2 crush strength test results (Hexcel)	54
Tube 93-2 crush strength test results (SRTC)	55

STILL-WALTER TOOL & MANUFACTURING CO.

375 CANNON BRIDGE RD. P.O. BOX 464
ORANGEBURG, SOUTH CAROLINA 29116-0464
PHONE: 803-534-8555 FAX: 803-534-4585

CERTIFICATE OF CONFORMANCE

DATE: June 14, 1993

STILL-WALTER ORDER: 4057 CUSTOMER: Westinghouse SRC

PURCHASE ORDER: AB10140C C/N 1 ITEM NUMBER: 13

DRAWING NUMBER: S5-2-13117-C REV. 51 QUANTITY: 10 Each

DESCRIPTION: "13117 Spacer, 2000 psi" MATERIAL: 5052 Aluminum

SPECIFICATION: Aluminum HEAT NUMBER: 168119 & 102598

HEAT TREATING: Not Applicable

PROCUREMENT SPECIFICATION: None

PROCUREMENT LEVEL: 3 STORAGE LEVEL: Not Applicable

OTHER: "13117 Spacer, 2000 psi Crush Strength"

Still-Walter Part No: A1527B

This is to certify that the item fabricated and material used on the above purchase order was manufactured to and conforms with the requirements of applicable drawings and specifications.

Still-Walter Tool & Manufacturing Co.

A handwritten signature in cursive script, reading "John W. Bozard", is written over a horizontal line.

John W. Bozard
Quality Assurance Manager

ALUMINUM COMPANY OF AMERICA

Cust. P.O. No. / Govt. Contract No.
74707

BUFF CERTIFICATION

Code No. MA101
180*409871

Alcoa No.
LE 94477

Certified
Inspection
Report

We hereby certify that the material covered by this report has been inspected in accordance with, and has been found to meet, the applicable requirements described herein, including any specifications forming a part of the description and that samples representative of the material met the composition limits and had the mechanical properties shown on the face of this report.

F. P. SWIGON

Invoice
No.

Invoice
Date

Product

PLAIN COILED HONEYCOMB FOIL WOUND ON 3 IN ID FLUSH STEEL CORES, 34 IN OD MAX PER FED SPEC MIL-A-81596 & CUST SPEC 1002 REV D DTD 8/20/78

Item No.	Alloy-Temper	Item Description	Quantity Shipped Pcs. Fl. Ets. Pounds	Net Wt. Lbs.	Direction	Limit	Test	Test	Test	Test	Test	Test																																							
001	5052-H191	.003 IN TR X 22-1/2 IN W A/T 5052-H191 CAT 159174 QRR DA194 W/E 90-06-30 LOT PACKAGE TICKET NUMBERS 180119 700108 700109 700110 700111	7266				UTS	TYB	EL		OLSEN																																								
							MIN 53.7	50.8	4.7																																										
<p>Chemical Composition</p> <table> <tr> <td>Alloy</td><td>5052</td><td>SI</td><td>FE</td><td>CU</td><td>MN</td><td>HG</td><td>CR</td><td>ZN</td><td>TI</td><td>OTHR/EA</td><td>OTHR/TOT</td><td>ALUMINUM</td></tr> <tr> <td></td><td></td><td>Max. 0.25</td><td>0.40</td><td>0.10</td><td>0.10</td><td>2.8</td><td>0.35</td><td>0.10</td><td></td><td>0.05</td><td>0.15</td><td>REMAINDER</td></tr> <tr> <td></td><td></td><td>Min.</td><td></td><td></td><td></td><td>2.2</td><td>0.15</td><td></td><td></td><td></td><td></td><td></td></tr> </table>													Alloy	5052	SI	FE	CU	MN	HG	CR	ZN	TI	OTHR/EA	OTHR/TOT	ALUMINUM			Max. 0.25	0.40	0.10	0.10	2.8	0.35	0.10		0.05	0.15	REMAINDER			Min.				2.2	0.15					
Alloy	5052	SI	FE	CU	MN	HG	CR	ZN	TI	OTHR/EA	OTHR/TOT	ALUMINUM																																							
		Max. 0.25	0.40	0.10	0.10	2.8	0.35	0.10		0.05	0.15	REMAINDER																																							
		Min.				2.2	0.15																																												

Date 08/27/90 R 92052
Gross Wgt 8105

HEXCEL CORP
338 N PENNSYLVANIA AVE
GRAHAM, TX 76046

HEXCEL CORP
338 N PENNSYLVANIA AVE
GRAHAM, TX 76046

FOB DESTINATION

From LEBANON, PA.

42-503

① When 2 or more tests per lot are made, the highest and lowest values are reported for each property determined. Single tests are reported in minimum columns.
② See test abbreviation explanation on back of this sheet.

WSRC Purchase Order No. AB10140C CNI
Line Item # 13
Drawing No. SS-2-13117-C, Rev. 51
Description "13117 spec" (200 psi)
Page 2 of 6

Q.A. ACCEPTED

DATE 6-7-93

WSRC-TR-93-448
Page 51

REV :

DATE: 5/27/93

B/L 86430
CUSTOMER P.O. NO. 11028

SEARCHED INDEXED
SERIALS SECTION
G 3 G 0 1 4 4 0 2

STILL - WALTER TOOL

DS - 2800

HEXCEL HEREBY CERTIFIES THAT THE PARTS SUPPLIED
UNDER PO 11028 FULLY CONFORM TO THE DRAWINGS,
SPECIFICATIONS, AND PURCHASE ORDER REQUIREMENTS.
PART NO. 6TC93405 REV. I SPEC(S) DS 2800
CRUSH CHARTS IN BOX. SEE ATTACHMENT SHTS FOR SN'S
(A15278)

10

Dale Trachsel
QUALITY ASSISTANT

BLOCK NUMBER	DENSITY	TEMP	DELAMINATION			COMPRESSIVE			FLEXURE		PLATE SHEAR				FLAT TENS	NODE BLOW	FOIL LOT
			ROOM TEMP	ELEV TEMP	H2O	BARE DRY	BARE WET	STAB	L	W	STRENGTH		MODULUS				
											L	W	L	W			
2800DS	.00	RT ET							0	0	0	0					
<div style="text-align: right; font-weight: bold; font-size: 1.2em;">Q.A. ACCEPTED</div> <div style="text-align: right; margin-top: 10px;"> INITIALS <u>Sub</u> DATE <u>6-7-93</u> </div> <div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: 80%;"> V3SRC Purchase Order No. <u>AB10140C C/N1</u> Line Item # <u>13</u> Drawing No. <u>SS-2-13117-C</u>, Rev. <u>51</u> Description <u>"3117 Specimen" (2000 psi)</u> Page <u>4</u> of <u>6</u> </div> <div style="margin-top: 20px;"> <div style="float: left; width: 45%;"> <p>** MATERIALS OR PARTS FURNISHED HAVE BEEN MANUFACTURED AND</p> <p>** TESTED IN STRICT ACCORDANCE WITH THE APPLICABLE SPECIFI-</p> <p>** CATIONS AS REFERENCED ON THE DRAWINGS AND TEST REPORTS</p> <p>** SHOWING COMPLIANCE IS ON FILE SUBJECT TO EXAMINATION.</p> </div> <div style="float: right; width: 45%; text-align: right;"> <p>**</p> <p>**</p> <p>**</p> <p>**</p> </div> <div style="clear: both;"></div> </div> <div style="margin-top: 20px;"> <div style="float: left; width: 45%;"> <p>375 CANNON BRIDGE</p> <p>PO BOX 464</p> <p>ORANGEBURG SC 29116 0464</p> </div> <div style="float: right; width: 45%; text-align: right;"> <p>MATERIALS</p> <p>TUBECORE</p> </div> <div style="clear: both;"></div> </div>

7

DIAMETER 4.6" - 4.65" 10 JULY 1993
THICKNESS 1.0"
WSRC PURCHASE ORDER NO. AB101400 C/M
LINE ITEM #13
DRAWING NO. SS-2-13117-C, REV. 51
DESCRIPTION BOTTOM SPACER
PAGE 1 OF 2
BOTTOM SPACER, 2,000 PSI
CRUSH STRENGTH
TEST PIECE # 93-7

Harold A. Reagin
O.B. Antonietti

1939 PSI

PRELOAD 370+
190

D. R. Leader
September, 1993

WSRC-TR-93-448
Page 54

Reload = 150 + 70

16 JULY 1993
DIAMETER 4.6" - 4.7"
THICKNESS 1.0"
WSRC PURCHASE ORDER NO AB161400 C/N1
LINE ITEM #13
DRAWING NO. S5-2-1317-C REV 5/1
DESCRIPTION BOTTOM SPACER
PAGE 2 OF 4
BOTTOM SPACER, 2000 PSI
CRUSH STRENGTH
TEST PIECE - 93-4

Hold 2 Run
O.B. Antonacci
1943 PSI

35,220

Avg Load = 33,000

Avg Area = 16.98

Avg Crush Strength = 1,943

**APPENDIX 7
MATERIALS LABORATORY TEST
MACHINE DATA**

Index:

Certificate of Calibration	57
Certificate of Calibration (continued)	58
Pen position vs. machine load	59

Certificate of Calibration SOUTHERN CALIBRATION AND SERVICE

P.O. BOX 13308
ATLANTA, GA 30324-0308
(404) 873-4431 FAX: (404) 876-4539

CERTIFICATE NUMBER: 930849

This is to certify that the following described machine has been calibrated in accordance with ASTM E4-89 and found to be within a tolerance of 1.0%.
Tester certified to be accurate.

401241
WESTINGHOUSE SAVANNAH RIVER COMPANY
Building 773-A

Aiken, SC 29801
MACHINE SATEC
(MODEL) 4008TE
(SER. NO.) 372134
COMPRESSION TEST

AS CALIBRATED

MACHINE RANGE 40,000.0000 thru 400,000.0000 lbs.

MACHINE READING	RING READING	MACHINE ERROR lbs.	%	RING CODE
40,000.0000	39,933.0000	67.0000	0.17	2
80,000.0000	79,859.0000	141.0000	0.18	1
160,000.0000	159,655.0000	345.0000	0.22	1
240,000.0000	239,695.0000	305.0000	0.13	1
320,000.0000	319,258.0000	742.0000	0.23	1
400,000.0000	398,923.0000	1,077.0000	0.27	1

MACHINE RANGE 16,000.0000 thru 160,000.0000 lbs.

MACHINE READING	RING READING	MACHINE ERROR lbs.	%	RING CODE
16,000.0000	15,953.0000	47.0000	0.30	2
32,000.0000	31,934.0000	66.0000	0.21	2
60,000.0000	59,921.0000	79.0000	0.13	2
96,000.0000	96,082.0000	-82.0000	0.09	1
128,000.0000	127,944.0000	56.0000	0.04	1
160,000.0000	160,234.0000	-234.0000	0.15	1

MACHINE RANGE 8,000.0000 thru 80,000.0000 lbs.

MACHINE READING	RING READING	MACHINE ERROR lbs.	%	RING CODE
8,000.0000	7,976.0000	24.0000	0.30	2
16,000.0000	15,941.0000	59.0000	0.37	2
32,000.0000	31,940.0000	60.0000	0.19	2
48,000.0000	47,918.0000	82.0000	0.17	2
60,000.0000	59,878.0000	122.0000	0.20	2
80,000.0000	79,859.0000	141.0000	0.18	1

(continued)

Certificate of Calibration
SOUTHERN CALIBRATION AND SERVICE

460 PLASHOUR DRIVE
P.O. BOX 13308
ATLANTA, GA 30324-0308
(404) 873-4431 FAX: (404) 876-4539

CERTIFICATE NUMBER: 930849 (continued)

This is to certify that the following described machine has been calibrated in accordance with ASTM E4-89 and found to be within a tolerance of 1.0%.
Tester certified to be accurate.

401241
WESTINGHOUSE SAVANNAH RIVER COMPANY
Building 773-A

MACHINE SATEC
(MODEL) 4008TE
(SER. NO.) 372134
COMPRESSION TEST

Aiken, SC 29801

=====

AS CALIBRATED

MACHINE RANGE 1,600.0000 thru 16,000.0000 lbs.

MACHINE READING	RING READING	MACHINE ERROR lbs.	%	RING CODE
1,600.0000	1,598.3000	1.7000	0.11	3
3,200.0000	3,206.1000	-6.1000	0.19	3
6,400.0000	6,413.0000	-13.0000	0.20	2
9,600.0000	9,574.0000	26.0000	0.27	2
12,800.0000	12,837.0000	-37.0000	0.29	2
16,000.0000	16,047.0000	-47.0000	0.29	2

CALIBRATION APPARATUS

PR/SER.#

CAPACITY CALIBRATION LAB AND LAB NUMBER

CLASS 'A' VERIF. CAL. DATE MANUFACTURER

1 5-4960	600,000 lbs. MOREHOUSE 732.07/243758	73300 LB. Force	08/03/92 MOREHOUSE INSTRUMENT CO.
2 2802	60,000 lbs. NIST LAB NO. 737.229759	3596 LB. Force	03/24/93 MOREHOUSE INSTRUMENT CO.
3 3039	10,000 lbs. MOREHOUSE INST. 737.229759	700 LB. Force	09/09/92 MOREHOUSE INSTRUMENT CO.

VERIFICATION METHOD USED: ELASTIC CALIBRATION DEVICE

LOAD VALUES CORRECTED FOR TEMP OF 74 DEGREES FAHRENHEIT
RING TEMP 74 DEGREES FAHRENHEIT

Environmental Condition: Ambient (not applicable)
Method of verification and pertinent data is in accordance with ASTM specification E4-89. The testing device(s) used for this calibration have been verified per ASTM specification E74-83 and are directly traceable to the National Institute of Standards and Technology (NIST).
Meets requirements of MIL-STD-45662A.

DATE OF CALIBRATION: 05/05/1993 BY: VICTOR A. NAPOLILLO

SERVICE REPRESENTATIVE

SCS Procedure U.P. 30, Rev. #3

Machine Load VS Vertical Pen Position
for the
SRTC Testing Machine

Distribution:

J. D. Cohen,	773-A	
T. L. Capaletti,	773-41A	
N. C. Iyer,	773-A	
E. K. Opperman,	305-2A	
M. A. Whiney,	305-2A	
G. Cacellie,	305-2A	
R. W. Emmett,	305-2A	
A G. Eggers,	305-2A	
J. Pardo,	992-1W	
SRTC Records,	773-53A	(4)
MTS Files,	773-41A	Rm. 140
Job Folder 22306	730-A	Rm. 128
Project File	PTG-PF-93-001	305-2A

END

DATE

FILMED

12/16/93