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AVCO SYSTEMS DIV WILMINGTON MA F/G 16/3  
MINUTEMAN III/MARK 12A REENTRY VEHICLE CARBON-CARBON NOSETIP PRO--ETC(U)  
JUN 80 F04704-78-C-0036

UNCLASSIFIED

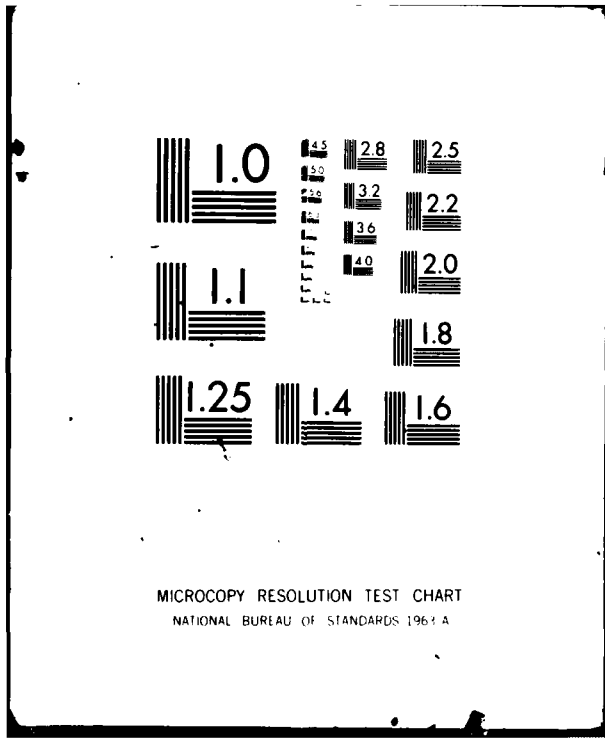
AVSD-0186-80-CR

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MICROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS 1963-A

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cy DECEMBER  
RECHAD 6/8/80



**SYSTEMS DIVISION**  
201 LOWELL STREET, WILMINGTON, MASSACHUSETTS 01887 TEL: (617) 657-2433

**LEVEL**

10 June 1980  
S300-DJM-80-123

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AD A 098594

Department of the Air Force  
Ballistic Missile Office  
Norton Air Force Base  
San Bernardino, CA 92409

Attention: Captain G. Parnell/MNNR

Gentlemen:

Subject: Transmittal of Avco Document AVSD-0186-80-CR,  
General Test Report, MMIII/MK12A Reentry Vehicle,  
Carbon/Carbon Nosetip Production, dated 10 June 1980.  
Contract F04704-78-C-0036

- Reference:
- A. Subject Contract, Attachment 1, Task 4.2.1.1
  - B. CDRL Sequence Number 081A2
  - C. CDRL Sequence Number 080A2

The subject document is transmitted herewith in accordance with Reference A and in compliance with Reference B and as formatted in Reference C.

Avco requests that BMO review and approve this document within thirty (30) days.

Very truly yours,

D. J. McQueen  
Program Manager

This document has been approved for public release and sale; its distribution is unlimited.

DTIC  
SELECTED  
MAY 7 1981  
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cc: (w/o enclosure): AVCO/SD, Attention: Mr. D. J. Sullivan, Contracts Adm. ,  
BMO/MNCA-1, Attention: Mr. C. Howard Kirk.

Enclosure: Subject Document

DTIC FILE COPY

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EXTERNAL DISTRIBUTION

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Ballistic Missile Office  
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San Bernardino, CA 92409  
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Columbus, Ohio 43201 (1)

Defense Contract Administration Services  
201 Lowell Street  
Wilmington, Mass. 01887 (1)

⑨ GENERAL TEST REPORT. 1 Mar-31 May 80.

PRODUCTION LOT SAMPLING

⑭ AVSD-0186-80-CR ✓

⑥ MINUTEMAN III/MARK 12A REENTRY VEHICLE  
CARBON-CARBON NOSETIP PRODUCTION.  
CONTRACT F04704-78-C-0036  
CDRL SEQUENCE NUMBER 081A2

(REPORT PERIOD 1 MARCH 1980 - 31 MAY 1980)

⑫ 331

⑪ 10 JUN 1980

⑮ F04704-78-C-0036

Prepared By

AVCO SYSTEMS DIVISION  
201 Lowell Street  
Wilmington, Massachusetts 01887

Prepared For

DEPARTMENT OF THE AIR FORCE  
BALLISTIC MISSILE OFFICE  
Norton Air Force Base  
San Bernardino, California 92409

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FOREWORD

As required one (1) densified billet out of each ~~thirty-six (36)~~ processed is randomly selected and subjected to the Production Lot Sampling Tests specified in paragraph 5.2.3 of the Equipment Test Plan, AVSD-0325-78-CR dated 14 March 1979. During this report several PLS billets were tested. These are as follows: PLS #5 from densification Lot 6, PLS #6 from densification Lot 8, PLS #7 from densification Lot 9, PLS #8 from densification Lot 10 and PLS #9 from densification Lot 11. All data has been compiled on previously presented Figures 7, 8, and 9 from the Equipment Test Plan, and included herein as the General Test Report, Production Lot Sampling, in accordance with CDRL Sequence Number 081A2.

✓

*Ritter on file*

Availability	Special
lot	Special
A	

SUMMARY OF TEST RESULTS

During this reporting period a change in the requirements for Thermal Conductivity and Torsional Shear were incorporated by Change Order P00009 to Contract F04704-78-C-0036.

All of the PLS test results obtained were within specification requirements, no changes were made in the test procedures and there are no anomalies to be reported.

DATA SUMMARY

PLS #5.

DENSIFICATION LOT 6

PLS SUMMARY DATA SHEET  
TYPE II CARBON/CARBON BILLET

BILLET S/N K900046 (P1.S #5)

PREFORM S/N (P1441A)F900852

DENSIFICATION LOT(S) 6

BILLET SIZE 8.059 x 3.237 x 3.237

BILLET WEIGHT 2728.1 grams

BULK DENSITY 1.971 gms/cc

RADIOMETRIC DENSITY

EDGE TO CORE RATIO 0.9978

END TO END GRADIENT 0.0008

SIDE TO SIDE GRADIENT 0.015

OPEN POROSITY 4.41%

FRACTURES (X) None

& INCLUSIONS (Y) None

VISUAL INSPECTION Accept

PREFORM DATA SUMMARY

MISSING/DISPLACED YARN  
BUNDLES (Z) None

FIBER ORIENTATION 1 W/In 2°

Z AXIS BENDING None

Z ELEMENT SPACING W/In ± .005

XY LAYER SPACING W/In ± .002

BULK DENSITY 1.081 gms/cc

DENSITY GRADIENT 0.064 gm/cc

PLS SUMMARY DATA SHEET (FOR PLS BILLETS ONLY)  
 TYPE II CARBON/CARBON BILLET

BILLET S/N K900046 (PLS #5)

PREFORY S/N (P1441A) F900786

FABRIC ACCEPTANCE DATA

WEAVER Textile Products

LOT NUMBER 232

DEFECTS Accept

CONTAMINATION Accept

WEAVE CONSTRUCTION 8 Harness Satin

VOLATILE CONTENT 4.67

YARN COUNT 29 Warp 29 Fill

WEIGHT 5.188 oz./sq. yd.

THICKNESS .013

BREAKING STRENGTH 220.0 Warp 220.8 Fill

YARN ACCEPTANCE DATA

TYPE	LOT NO.	TENSILE STRENGTH (PSI)	MODULUS X 10 <sup>6</sup> PSI	DENIER $\frac{\text{gms}}{\text{9000M}}$	DENSITY $\frac{\text{gms}}{\text{cc}}$
HM-1000 PAN (For Fabric)	118-2	405 x 10 <sup>3</sup>	57.0	13469	1.842
HM-3000 PAN (For Rods)	97-3	320 x 10 <sup>3</sup>	54.0	4518	1.832

PLS SUMMARY DATA SHEET  
MECHANICAL PROPERTIES - TYPE II CARBON/CARBON BILLETS

BILLET S/N K900046 (P1441A) PLS #5

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
<b>ULTIMATE TENSILE STRENGTH</b>			
X	TX-1	<u>27600</u>	$18.2 \times 10^3$ PSI
	TX-2	<u>33800</u>	
	TX-3	<u>30200</u>	
	TX-4	<u>32500</u>	
Z	TZ-1	<u>27200</u>	$16.5 \times 10^3$ PSI
	TZ-2	<u>26800</u>	
	TZ-3	<u>28500</u>	
<b>TENSILE MODULUS</b>			
X	TX-1	<u>15.0</u>	$8.5 \times 10^6$ PSI
	TX-2	<u>13.6</u>	
	TX-3	<u>15.1</u>	
	TX-4	<u>14.5</u>	
Z	TZ-1	<u>12.3</u>	$9.4 \times 10^6$ PSI
	TZ-2	<u>11.8</u>	
	TZ-3	<u>11.8</u>	
<b>COMPRESSIVE YIELD STRENGTH</b>			
X	CX-1	<u>19100</u>	$15.2 \times 10^3$ PSI
	CX-2	<u>18900</u>	
	CX-3	<u>18400</u>	
Z	CZ-1	<u>16900</u>	$11.0 \times 10^3$ PSI
	CZ-2	<u>18400</u>	
	CZ-3	<u>16900</u>	

PLS SUMMARY DATA SHEET  
MECHANICAL PROPERTIES - TYPE II CARBON/CARBON BILLETS

BILLET S/N K900046 (P1441A) PLS#5

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
COMPRESSIVE MODULUS			
X	CX-1	<u>13.8</u>	11.2 x 10 <sup>6</sup> PSI
	CX-2	<u>13.0</u>	
	CX-3	<u>12.4</u>	
Z	CZ-1	<u>10.6</u>	8.4 x 10 <sup>6</sup> PSI
	CZ-2	<u>10.9</u>	
	CZ-3	<u>9.7</u>	
45° XY TENSION, .1% OFFSET YIELD			
	TXY-1	<u>4170</u>	3500 PSI
	TXY-2	<u>3830</u>	
TORSIONAL SHEAR, .2% OFFSET YIELD			
	TS-1	<u>1000</u>	950 PSI
	TS-2	<u>1030</u>	

PLS SUMMARY DATA SHEET  
TYPE II CARBON/CARBON BILLET

THERMAL PROPERTIES

BILLET S/NK900046(P1441A)PLS#5

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT</u>
THERMAL EXPANSION			$\Delta L/L \times 10^3$ IN/IN @ 4000°F
X @ 4000°F	TEX-1	<u>3.59</u>	3.2 TO 4.1
	TEX-2	<u>3.62</u>	
Z @ 4000°F	TEZ-1	<u>3.50</u>	3.1 TO 4.1
	TEZ-2	<u>3.59</u>	
THERMAL CONDUCTIVITY			BTU IN/HR FT <sup>2</sup> °F
Z @ 500°F	TCZ-1	<u>627</u>	580 - 740
Z @ 1500°F	TCZ-1	<u>460</u>	410 - 520
X @ 500°F	TCX-1	<u>901</u>	770 - 1010
X @ 1500°F	TCX-1	<u>585</u>	500 - 655

DATA SUMMARY

PLS #6

DENSIFICATION LOT 8

PLS SUMMARY DATA SHEET  
TYPE II CARBON/CARBON BILLET

BILLET S/N A000453 (PLS #6)

PREFORM S/N (P1466A) F900952

DENSIFICATION LOT(S) 8

BILLET SIZE 8.063 x 3.211 x 3.237

BILLET WEIGHT 2697.8 grams

BULK DENSITY 1.964 gms/cc

RADIOMETRIC DENSITY

EDGE TO CORE RATIO 0.9959

END TO END GRADIENT 0.0004

SIDE TO SIDE GRADIENT 0.017

OPEN POROSITY 4.85%

FRACTURES (X) None

& INCLUSIONS (Y) None

VISUAL INSPECTION Accept

PREFORM DATA SUMMARY

MISSING/DISPLACED YARN  
BUNDLES (Z) None

FIBER ORIENTATION ⊥ W/In 2°

Z AXIS BENDING None

Z ELEMENT SPACING W/In + .005

XY LAYER SPACING W/In + .002

BULK DENSITY 1.115 gms/cc

DENSITY GRADIENT (MAX) 0.037 gm/cc

PLS SUMMARY DATA SHEET (FOR PLS BILLETS ONLY)  
TYPE II CARBON/CARBON BILLET

BILLET S/N A000453 (PLS#6)

PREFORM S/N (P1466A) F900811

FABRIC ACCEPTANCE DATA

WEAVER Textile Products

LOT NUMBER 247

DEFECTS Accept

CONTAMINATION Accept

WEAVE CONSTRUCTION 8 Harness Satin

VOLATILE CONTENT 3.4 - 4.3

YARN COUNT 29 Warp 29 Fill

WEIGHT 5.188 oz./sq. yd.

THICKNESS .012 - .013

BREAKING STRENGTH 246-258 Warp 221-224 Fill

YARN ACCEPTANCE DATA

<u>TYPE</u>	<u>LOT NO.</u>	<u>TENSILE STRENGTH (PSI)</u>	<u>MODULUS X 10<sup>6</sup> PSI</u>	<u>Length/Unit Wt. (M/KG)</u>	<u>DENSITY lb/cc</u>
HM-1000 PAN (For Fabric)	137 - 2,3	353-385 x 10 <sup>3</sup>	55.1-60.4	13331-13757	1.82-1.85
HM-3000 PAN (For Rods)	97-3	387 x 10 <sup>3</sup>	54.7	4408	1.82

**PLS SUMMARY DATA SHEET**  
**MECHANICAL PROPERTIES - TYPE II CARBON/CARBON BILLETS**

BILLET S/N A000453 (P1466A) PLS #6

DATE 4-15-80

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
<b>ULTIMATE TENSILE STRENGTH</b>			
X	TX-1	<u>21.1</u>	$18.2 \times 10^3$ PSI
	TX-2	<u>21.4</u>	
	TX-3	<u>23.7</u>	
	TX-4	<u>24.3</u>	
Z	TZ-1	<u>25.1</u>	$16.5 \times 10^3$ PSI
	TZ-2	<u>22.4</u>	
	TZ-3	<u>21.1</u>	
<b>TENSILE MODULUS</b>			
X	TX-1	<u>12.5</u>	$8.5 \times 10^6$ PSI
	TX-2	<u>12.2</u>	
	TX-3	<u>13.4</u>	
	TX-4	<u>13.0</u>	
Z	TZ-1	<u>11.9</u>	$9.4 \times 10^6$ PSI
	TZ-2	<u>12.9</u>	
	TZ-3	<u>12.8</u>	
<b>COMPRESSIVE YIELD STRENGTH</b>			
X	CX-1	<u>19.2</u>	$15.2 \times 10^3$ PSI
	CX-2	<u>16.3</u>	
	CX-3	<u>17.6</u>	
Z	CZ-1	<u>15.3</u>	$11.0 \times 10^3$ PSI
	CZ-2	<u>15.1</u>	
	CZ-3	<u>13.5</u>	

PLS SUMMARY DATA SHEET  
MECHANICAL PROPERTIES - TYPE II CARBON/CARBON BILLETS

BILLET S/NA 000453 (P1466A) PLS#6

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
COMPRESSIVE MODULUS			
X	CX-1	<u>13.9</u>	11.2 x 10 <sup>6</sup> PSI
	CX-2	<u>13.8</u>	
	CX-3	<u>14.4</u>	
Z	CZ-1	<u>10.1</u>	8.4 x 10 <sup>6</sup> PSI
	CZ-2	<u>10.9</u>	
	CZ-3	<u>11.1</u>	
45° XY TENSION, .1% OFFSET YIELD			
	TXY-1	<u>4100</u>	3500 PSI
	TXY-2	<u>3700</u>	
TORSIONAL SHEAR, .2% OFFSET YIELD			
	TS-1	<u>1430</u>	950 PSI
	TS-2	<u>1390</u>	

PLS SUMMARY DATA SHEET  
TYPE II CARBON/CARBON BILLET

THERMAL PROPERTIES

BILLET S/N A000453 (P1466A)PLS#6

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT</u>
<u>THERMAL EXPANSION</u>			$\Delta L/L \times 10^3$ IN/IN @ 4000°F
X @ 4000°F	TEX-1	<u>3.44</u>	3.2 TO 4.1
	TEX-2	<u>3.36</u>	
Z @ 4000°F	TEZ-1	<u>3.44</u>	3.1 TO 4.1
	TEZ-2	<u>3.33</u>	
<u>THERMAL CONDUCTIVITY</u>			BTU IN/HR FT <sup>2</sup> °F
X @ 500°F	TCX-1	<u>883</u>	770 to 1010
X @ 1500°F	TCX-1	<u>610</u>	500 to 655
Z @ 500°F	TCZ-1	<u>650</u>	580 to 740
Z @ 1500°F	TCZ-1	<u>465</u>	410 to 520

DATA SUMMARY

PLS #7

DENSIFICATION LOT 9

PLS SUMMARY DATA SHEET  
TYPE II CARBON/CARBON BILLET

BILLET S/N B000287 (PLS #7)

PREFORM S/N (P1-476B) F900993

DENSIFICATION LOT(S) 9

BILLET SIZE 8.127 x 3.240 x 3.240

BILLET WEIGHT 2754.6 grams

BULK DENSITY 1.970 gms/cc

RADIOMETRIC DENSITY

EDGE TO CORE RATIO 0.9993

END TO END GRADIENT 0.0046

SIDE TO SIDE GRADIENT 0.020

OPEN POROSITY 4.73%

FRACTURES (X) None

& INCLUSIONS (Y) None

VISUAL INSPECTION Accept

PREFORM DATA SUMMARY

MISSING/DISPLACED YARN

BUNDLES (Z) None

FIBER ORIENTATION  $\perp$  W/In  $2^0$

Z AXIS BENDING None

Z ELEMENT SPACING W/In  $\pm .005$

XY LAYER SPACING W/In  $\pm .002$

BULK DENSITY 1.110 gms/cc

DENSITY GRADIENT (MAX) 0.070 gm/cc

PLS SUMMARY DATA SHEET (FOR PLS BILLETS ONLY)  
TYPE II CARBON/CARBON BILLET

BILLET S/N B000287 (PLS #7)

PREFORM S/N (P1476B) F900821

FABRIC ACCEPTANCE DATA

WEAVER Textile Products

LOT NUMBER 247 & 249

DEFECTS Accept

CONTAMINATION Accept

WEAVE CONSTRUCTION 8 Harness Satin

VOLATILE CONTENT 3.41 - 3.18

YARN COUNT 29 Warp 29 Fill

WEIGHT 5.27-5.26 oz./sq. yd.

THICKNESS .013 - .0125

BREAKING STRENGTH 251-246 Warp 256-228 Fill

YARN ACCEPTANCE DATA

TYPE	LOT NO.	TENSILE STRENGTH (PSI)	MODULUS X 10 <sup>6</sup> PSI	Length/unit wt. (M/Kg)	DENSITY gm/cc
HM-1000 PAN (For Fabric)	137-3, 4	385 x 10 <sup>3</sup>	55.1	13331	1.82
HM-3000 PAN (For Rods)	97-3	387 x 10 <sup>3</sup>	54.7	13098	1.82

PLS SUMMARY DATA SHEET  
MECHANICAL PROPERTIES - TYPE 11 CARBON/CARBON BILLETS

BILLET S/K B000287 (P1476B) PLS #7

DATE 5/06/80

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
<b>ULTIMATE TENSILE STRENGTH</b>			
X	TX-1	<u>18.2</u>	18.2 x 10 <sup>3</sup> PSI
	TX-2	<u>23.6</u>	
	TX-3	<u>20.9</u>	
	TX-4	<u>20.2</u>	
Z	TZ-1	<u>22.2</u>	16.5 x 10 <sup>3</sup> PSI
	TZ-2	<u>23.0</u>	
	TZ-3	<u>23.7</u>	
<b>TENSILE MODULUS</b>			
X	TX-1	<u>12.6</u>	8.5 x 10 <sup>6</sup> PSI
	TX-2	<u>12.1</u>	
	TX-3	<u>12.7</u>	
	TX-4	<u>12.8</u>	
Z	TZ-1	<u>11.2</u>	9.4 x 10 <sup>6</sup> PSI
	TZ-2	<u>11.3</u>	
	TZ-3	<u>11.9</u>	
<b>COMPRESSIVE YIELD STRENGTH</b>			
X	CX-1	<u>18.5</u>	15.2 x 10 <sup>3</sup> PSI
	CX-2	<u>19.0</u>	
	CX-3	<u>17.4</u>	
Z	CZ-1	<u>16.5</u>	11.0 x 10 <sup>3</sup> PSI
	CZ-2	<u>16.2</u>	
	CZ-3	<u>16.6</u>	

PLS SUMMARY DATA SHEET  
MECHANICAL PROPERTIES - TYPE 11 CARBON/CARBON BILLETS

BILLET S/N B000287 (P1476B) PLS #7

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
COMPRESSIVE MODULUS			
X	CX-1	<u>13.2</u>	11.2 x 10 <sup>6</sup> PSI
	CX-2	<u>13.9</u>	
	CX-3	<u>13.5</u>	
Z	CZ-1	<u>10.1</u>	8.4 x 10 <sup>6</sup> PSI
	CZ-2	<u>12.0</u>	
	CZ-3	<u>10.8</u>	
45° XY TENSION, .1% OFFSET YIELD			
	TXY-1	<u>4070</u>	3500 PSI
	TXY-2	<u>3860</u>	
TORSIONAL SHEAR, .2% OFFSET YIELD			
	TS-1	<u>1430</u>	950 PSI
	TS-2	<u>1440</u>	

TEST REPORT DATA SHEET  
TYPE 11 CARBON/CARBON BILLET

THERMAL PROPERTIES

BILLET S/N B000287 (P1476B) PLS #7

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT</u>
<b>THERMAL EXPANSION</b>			
			$\Delta L/L \times 10^3$ IN/IN @ 4000°F
X @ 4000°F	TEX-1	<u>3.59</u>	3.1 TO 4.1
	TEX-2	<u>3.46</u>	
Z @ 4000°F	TEZ-1	<u>3.20</u>	3.1 TO 4.1
	TEZ-2	<u>3.40</u>	
<b>THERMAL CONDUCTIVITY</b>			
			BTU IN/HR FT <sup>2</sup> OF
Z @ 500°F	TCZ-1	<u>680</u>	580 - 740
Z @ 1500°F	TCZ-1	<u>470</u>	410 - 520
X @ 500°F	TCX-1	<u>900</u>	770 - 1010
X @ 1500°F	TCX-1	<u>601</u>	500 - 655

DATA SUMMARY

PLS #8

DENSIFICATION LOT 10

PLS SUMMARY DATA SHEET  
TYPE II CARBON/CARBON BILLET

BILLET S/N B000658 (PLS #8)

PREFORM S/N (P1487A) F901036

DENSIFICATION LOT(S) 10

BILLET SIZE 8.141 x 3.244 x 3.243

BILLET WEIGHT 2756.8 grams

BULK DENSITY 1.964 gms/cc

RADIOMETRIC DENSITY

EDGE TO CORE RATIO 0.9984

END TO END GRADIENT 0.0019

SIDE TO SIDE GRADIENT 0.015

OPEN POROSITY 4.68%

FRACTURES (X) None  
& INCLUSIONS (Y) None

VISUAL INSPECTION Accept

PREFORM DATA SUMMARY

MISSING/DISPLACED YARN  
BUNDLES (Z) None

FIBER ORIENTATION  $\perp$  W/In  $2^{\circ}$

Z AXIS BENDING None

Z ELEMENT SPACING W/In  $\pm$  .005

XY LAYER SPACING W/In  $\pm$  .002

BULK DENSITY 1.116 gms/cc

DENSITY GRADIENT (MAX) 0.068 gm/cc

PLS SUMMARY DATA SHEET (FOR PLS BILLETS ONLY)  
 TYPE II CARBON/CARBON BILLET

BILLET S/N B000658 (PLS #8)  
 PREFORM S/N (PI487A) F900832  
 FABRIC ACCEPTANCE DATA  
 WEAVER Textile Products  
 LOT NUMBER 247 - 249  
 DEFECTS Accept  
 CONTAMINATION Accept  
 WEAVE CONSTRUCTION 8 Harness Satin  
 VOLATILE CONTENT 2.6 - 3.0  
 YARN COUNT 29 Warp 29 Fill  
 WEIGHT 5.19 - 5.3 oz./sq. vd.  
 THICKNESS .012 - .0135  
 BREAKING STRENGTH 245-264 Warp 232-259 Fill

YARN ACCEPTANCE DATA

<u>TYPE</u>	<u>LOT NO.</u>	<u>TENSILE STRENGTH (PSI)</u>	<u>MODULUS X 10<sup>6</sup> PSI</u>	<u>Length/unit wt. (M/Kg)</u>	<u>DENSITY gm/cc</u>
HM-1000 PAM (For Fabric)	137-3, 4	385 x 10 <sup>3</sup>	55.1	13331	1.82
HM-3000 PAM (For Rods)	97-3	385 x 10 <sup>3</sup>	64.0	13350	1.83

PLS PRIMARY DATA SHEET  
 MECHANICAL PROPERTIES - TYPE 316 CARBON/CARBON FIBERS

BILLET S/N B000658 (P1487A) PLS #8

DATE 5/20/80

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
<b>ULTIMATE TENSILE STRENGTH</b>			
X	TX-1	<u>35.0</u>	$18.2 \times 10^3$ PSI
	TX-2	<u>33.4</u>	
	TX-3	<u>34.8</u>	
	TX-4	<u>32.4</u>	
Z	TZ-1	<u>27.1</u>	$16.5 \times 10^3$ PSI
	TZ-2	<u>24.3</u>	
	TZ-3	<u>24.7</u>	
<b>TENSILE MODULUS</b>			
X	TX-1	<u>15.4</u>	$8.5 \times 10^6$ PSI
	TX-2	<u>13.9</u>	
	TX-3	<u>15.1</u>	
	TX-4	<u>15.1</u>	
Z	TZ-1	<u>10.5</u>	$9.4 \times 10^6$ PSI
	TZ-2	<u>12.9</u>	
	TZ-3	<u>13.2</u>	
<b>COMPRESSIVE YIELD STRENGTH</b>			
X	CX-1	<u>18.8</u>	$15.2 \times 10^3$ PSI
	CX-2	<u>19.4</u>	
	CX-3	<u>18.7</u>	
Z	CZ-1	<u>14.9</u>	$11.0 \times 10^3$ PSI
	CZ-2	<u>16.5</u>	
	CZ-3	<u>16.7</u>	

PLS MOUNTING DATA SHEET  
MECHANICAL PROPERTIES - TYPE 11 CARBON/CARBON BILLETS

BILLET S/N B000658(P1487A) PLS #8

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
<b>COMPRESSIVE MODULUS</b>			
X	CX-1	<u>15.2</u>	11.2 x 10 <sup>6</sup> PSI
	CX-2	<u>15.0</u>	
	CX-3	<u>13.2</u>	
Z	CZ-1	<u>10.5</u>	8.4 x 10 <sup>6</sup> PSI
	CZ-2	<u>10.3</u>	
	CZ-3	<u>10.1</u>	
<b>45° XY TENSION, .1% OFFSET YIELD</b>			
	TXY-1	<u>3910</u>	3500 PSI
	TXY-2	<u>3710</u>	
<b>TORSIONAL SHEAR, .2% OFFSET YIELD</b>			
	TS-1	<u>1230</u>	950 PSI
	TS-2	<u>1270</u>	

PLS SUMMARY DATA SHEET  
TYPE 11 CARBIDE/CARBON BILLET

THERMAL PROPERTIES

BILLET S/N B000658 (P1487A) PLS #8

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT</u>
THERMAL EXPANSION			$\Delta L/L \times 10^3$ IN/IN @ 4000°F
X @ 4000°F	TEX-1	<u>3.37</u>	3.1 TO 4.1
	TEX-2	<u>3.46</u>	
Z @ 4000°F	TEZ-1	<u>3.42</u>	3.1 TO 4.1
	TEZ-2	<u>3.52</u>	
THERMAL CONDUCTIVITY			BTU IN/HR FT <sup>2</sup> °F
Z @ 500°F	TCZ-1	<u>666</u>	580 - 740
Z @ 1500°F	TCZ-1	<u>456</u>	410 - 520
X @ 500°F	TCX-1	<u>876</u>	770 - 1010
X @ 1500°F	TCX-1	<u>606</u>	500 - 655

DATA SUMMARY

PLS #7

DENSIFICATION LOT 11

PLS SUMMARY DATA SHEET  
TYPE II CARBON/CARBON BILLET

BILLET S/N B000688 (PLS #9)

PREFORM S/N P1494A F901064

DENSIFICATION LOT(S) 11

BILLET SIZE 8.059 x 3.237 x 3.237

BILLET WEIGHT 2731.9 grams

BULK DENSITY 1.971 gms/cc

RADIOMETRIC DENSITY

EDGE TO CORE RATIO 0.9974

END TO END GRADIENT 0.0076

SIDE TO SIDE GRADIENT 0.016

OPEN POROSITY 4.42%

FRACTURES (X) None

& INCLUSIONS (Y) None

VISUAL INSPECTION Accept

PREFORM DATA SUMMARY

MISSING/DISPLACED YARN  
BUNDLES (Z) None

FIBER ORIENTATION ⊥ W/In 2°

Z AXIS BENDING None

Z ELEMENT SPACING W/In  $\pm$  .005

XY LAYER SPACING W/In  $\pm$  .002

BULK DENSITY 1.102 gms/cc

DENSITY GRADIENT (MAX) 0.029 gm/cc

**PLS SUMMARY DATA SHEET (FOR PLS BILLETS ONLY)**  
**TYPE II CARBON/CARBON BILLET**

**BILLET S/NB000688 (PLS #9)**

**PREFORM S/N P1494A F900839**

**FABRIC ACCEPTANCE DATA**

<b>WEAVER</b>	<b>Textile Products</b>	<b>Fabric Development</b>
LOT NUMBER 247	249	8
DEFECTS Accept	Accept	Accept
CONTAMINATION Accept	Accept	Accept
WEAVE CONSTRUCTION 8 Harness Satin	8 Harness Satin	8 Harness Satin
VOLATILE CONTENT 3.7%	2.5%	3.9%
YARN COUNT 29 Warp 29 Fill	29 Warp 29 Fill	30 Warp 30 Fill
WEIGHT 5.3 oz./sq. yd.	5.4 oz./sq. yd.	5.3 oz./sq. yd.
THICKNESS 0.013	0.012	0.013
BREAKING STRENGTH 251.9 Warp 259.6 Fill	234.2 Warp 231.6 Fill	434 Warp 560 Fill

**YARN ACCEPTANCE DATA**

<b>TYPE</b>	<b>LOT NO.</b>	<b>TENSILE STRENGTH (PSI)</b>	<b>MODULUS X 10<sup>6</sup> PSI</b>	<b>Length/unit wt. (M/Kg)</b>	<b>DENSITY gm/cc</b>
HY-1000 PAN (For Fabric)	137-3, 4	385 x 10 <sup>3</sup>	55.1	13331	1.82
HY-3000 PAN (For Rods)	141-1	445 x 10 <sup>3</sup>	51.7	1110	1.82

**PLS SUMMARY DATA SHEET**  
**MECHANICAL PROPERTIES - TYPE II CARBON/CARBON BILLETS**

BILLET S/N B000688 (P1494A) PLS#9

DATE 6/6/80

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
<b>ULTIMATE TENSILE STRENGTH</b>			
X	TX-1	<u>33.2</u>	$18.2 \times 10^3$ PSI
	TX-2	<u>35.7</u>	
	TX-3	<u>31.7</u>	
	TX-4	<u>35.5</u>	
Z	TZ-1	<u>25.7</u>	$16.5 \times 10^3$ PSI
	TZ-2	<u>26.5</u>	
	TZ-3	<u>23.1</u>	
<b>TENSILE MODULUS</b>			
X	TX-1	<u>15.8</u>	$8.5 \times 10^6$ PSI
	TX-2	<u>17.3</u>	
	TX-3	<u>14.2</u>	
	TX-4	<u>15.3</u>	
Z	TZ-1	<u>13.3</u>	$9.4 \times 10^6$ PSI
	TZ-2	<u>13.3</u>	
	TZ-3	<u>11.4</u>	
<b>COMPRESSIVE YIELD STRENGTH</b>			
X	CX-1	<u>18.8</u>	$15.2 \times 10^3$ PSI
	CX-2	<u>18.0</u>	
	CX-3	<u>17.8</u>	
Z	CZ-1	<u>15.4</u>	$11.0 \times 10^3$ PSI
	CZ-2	<u>16.4</u>	
	CZ-3	<u>15.7</u>	

PLS SUMMARY DATA SHEET  
MECHANICAL PROPERTIES - TYPE II CARBON/CARBON BILLETS

BILLET S/NB0000688 (P149.1A) PLS#9

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
COMPRESSIVE MODULUS			
X	CX-1	<u>13.5</u>	11.2 x 10 <sup>6</sup> PSI
	CX-2	<u>14.7</u>	
	CX-3	<u>12.6</u>	
Z	CZ-1	<u>9.8</u>	8.4 x 10 <sup>6</sup> PSI
	CZ-2	<u>10.1</u>	
	CZ-3	<u>10.1</u>	
45° XY TENSION, .1% OFFSET YIELD			
	TXY-1	<u>3670</u>	3500 PSI
	TXY-2	<u>4080</u>	
TORSIONAL SHEAR, .2% OFFSET YIELD			
	TS-1	<u>1130</u>	950 PSI
	TS-2	<u>1130</u>	

PLS SUMMARY DATA SHEET  
TYPE II CARBON/CARBON BILLET

THERMAL PROPERTIES

BILLET S/N B000688 (P1494A) PLS#9

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT</u>
THERMAL EXPANSION			$\Delta L/L \times 10^3$ IN/IN @ 4000°F
X @ 4000°F	TEX-1	<u>3.36</u>	3.2 TO 4.1
	TEX-2	<u>3.38</u>	
Z @ 4000°F	TEZ-1	<u>3.29</u>	3.1 TO 4.1
	TEZ-2	<u>3.36</u>	
THERMAL CONDUCTIVITY			BTU IN/HR FT <sup>2</sup> °F
X @ 500°F	TCX-1	<u>897</u>	770 to 1010
X @ 1500°F	TCX-1	<u>600</u>	500 to 655
Z @ 500°F	TCZ-1	<u>670</u>	580 to 740
Z @ 1500°F	TCZ-1	<u>438</u>	410 to 520

