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AVCO SYSTEMS DIV WILMINGTON MA

F/S 16/3

MINUTEMAN III/MARK 12A REENTRY VEHICLE CARBON-CARBON NOSETIP PR--ETC(U)

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F04704-78-C-0036

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AVSD-0058-80-CR

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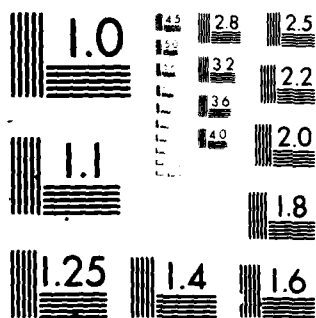
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(9) GENERAL TEST REPORT. 1 Sep-31 Nov 79.

PRODUCTION LOT SAMPLING

(14) AVSD-0058-80-CR

(6) MINUTEMAN III/MARK 12A REENTRY VEHICLE
CARBON-CARBON NOSETIP PRODUCTION.
CDRL SEQUENCE NUMBER 081A2

(REPORT PERIOD 1 SEPTEMBER 1979 - 31 NOVEMBER 1979)

(11) 21 FEB 1980

Prepared By

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FOREWORD

As required one (1) deminified 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. Several test results were encountered which did not fall within the values specified in the individual Quality Assurance Test Procedures (QATPs). A summary of all test results from PLS-2, -3, and -4 and rationale concerning the variances will be presented. 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 Page 11, Item 6.1.2.

Accession No.

PLS-0325-78-CR

14 March 1979

Letter on file

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1.0 SUMMARY OF TEST RESULTS

The summary of test results are presented for PLS-2 on Figures 1 through 4, for PLS-3 on Figures 5 through 8, and for PLS-4 on Figures 9 through 12.

Any test results not conforming to the requirements of Annex 1A to Attachment 1 of Contract F04704-78-C-0036 have been denoted by an asterisk.

The following is a summary of the test results which did not conform to the specification values:

<u>Test</u>	<u>Effectivity</u>
Thermal Conductivity	PLS-2, PLS-3, PLS-4
Compressive Yield Strength	Specimen CX-2 from PLS-2
45° Xy tension .1% offset Yield	Specimen TXY-1 from PLS-4

2.0 RATIONALE FOR NON-CONFORMING RESULTS

2.1 Thermal Conductivity - The underlined test results in Table 1 do not conform to the specification requirements.

TABLE 1

<u>Thermal Conductivity</u>	<u>Requirement</u> BTU in/hr ft ² °F	<u>PLS</u> <u>2</u>	<u>PLS</u> <u>3</u>	<u>PLS</u> <u>4</u>
z @ 500 °F	640 - 760	<u>824</u>	<u>638</u>	<u>630</u>
z @ 1500 °F	410 - 480	460	<u>490</u>	470
x @ 500 °F	810 - 965	<u>968</u>	915	910
x @ 1500 °F	495 - 590	<u>630</u>	<u>610</u>	<u>600</u>

2.1.2 Rationale - As has been discussed at recent TI/TD meetings, the specification requirements for thermal conductivity were established on a limited test data base (3 billets). Recent discussions between Aveco, BMO, TRW and SORI has resulted in agreement to reestablish the requirements when a sufficient data base has been reached (possibly when ten (10) PLS tests have been performed). In the meantime all conductivity tests will be performed at SORI with corresponding tests being performed at Aveco to establish a correlation of attainable values, equipment variables and test procedures.

2.2 Compressive Yield Strength - The compressive yield strength for PLS #2 test specimen CN-2 was 14,900 psi vs. the minimum requirement of 15,200 psi.

2.2.1 Rationale - The original test data for establishing the minimum requirement was based upon 6 tests. These tests yielded an average value of 17,400 psi and a standard deviation of 0.94. Further testing of the FWPF has revealed that after 18 tests the average value is 17,000 psi and the standard deviation is 1.21. Based upon these test data the test result is within the expected population. It appears that further testing of the FWPF is required to establish a more meaningful data base, which can then be used to possibly establish a new specification limit.

2.3 45° XY Tension - The 45° Xy tensile bar TXY-1 from PLS-4 did not meet the minimum specification requirement.

2.3.1 Rationale - The PLS-4 TXY-1 test specimen was preloaded prior to testing. This occurred during mounting which proceeds as follows. The specimen is first mounted in the upper grip. Next the lower grip is engaged by a collet action which closes the jaws around the test specimen. This action is created by twisting a handle below the specimen. As the lower jaw is closed, the lower cross-head should be raised to compensate for the upward travel in the lower jaw. The lower cross-head was not raised at this time to compensate for the travel in the lower jaw, thereby preloading the specimen. This preload was not recorded because the pen was not engaged and prior to testing the recorder pen was reset to zero, which precluded the possibility of making any determination as to the magnitude of the preload. If this preload could have been accounted for in the measured load, then in all likelihood the specimen would have passed. The minimum preload to be accounted for in this case would be 31 lbs. which when added to the 463 lbs. obtained, would have yielded a stress of 3500 psi. Based upon the preceding discussion this test should be considered a No Test. The corrective action for this anomaly was to revise QATP 30551 to preclude preloading of the specimen.

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

BILLET S/N H900410 (P1412A) PLS-2

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
ULTIMATE TENSILE STRENGTH			
X	TX-1	<u>21700</u>	18000 PSI
	TX-2	<u>29900</u>	
	TX-3	<u>27300</u>	
	TX-4	<u>26600</u>	
Z	TZ-1	<u>26100</u>	16500 PSI
	TZ-2	<u>26800</u>	
	TZ-3	<u>25600</u>	
TENSILE MODULUS			
X	TX-1	<u>14.1</u>	8.5×10^6 PSI
	TX-2	<u>13.3</u>	
	TX-3	<u>12.9</u>	
	TX-4	<u>13.0</u>	
Z	TZ-1	<u>12.0</u>	9.4×10^6 PSI
	TZ-2	<u>11.9</u>	
	TZ-3	<u>12.1</u>	
COMPRESSIVE YIELD STRENGTH			
X	CX-1	<u>15200</u>	15200 PSI
	CX-2	<u>14900 *</u>	
	CX-3	<u>15900</u>	
Z	CZ-1	<u>12600</u>	11000 PSI
	CZ-2	<u>11500</u>	
	CZ-3	<u>12900</u>	

FIGURE 1 (Cont.)

PLS SUMMARY DATA SHEET
MECHANICAL PROPERTIES - 7000 AL CAGE 11/CASE 11 BILLET

BILLET S/N H900410 (PI412A) PLS-2

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT</u> <u>(MIN.)</u>
COMPRESSIVE MODULUS			
X	CX-1	<u>13.2</u>	11.2 x 10 ⁶ PSI
	CX-2	<u>12.5</u>	
	CX-3	<u>13.2</u>	
Z	CZ-1	<u>10.6</u>	8.4 x 10 ⁶ PSI
	CZ-2	<u>9.3</u>	
	CZ-3	<u>9.9</u>	
45° XY TENSION, .1% OFFSET YIELD			
	TXY-1	<u>4690</u>	3500 PSI
	TXY-2	<u>4640</u>	
TORSIONAL SHEAR, .2% OFFSET YIELD			
	TS-1	<u>1470</u>	1100 PSI
	TS-2	<u>1470</u>	

PLS SUMMARY DATA SHEET
TYPE 11 CARBON/CARTON BILLET

THERMAL PROPERTIES

BILLET S/N: ES00010 (01/12A) H-2

TEST	TEST ID	TEST VALUE	PLS RANGE $\Delta L/L \times 10^3$ IN/IN @ 4000°F
THERMAL EXPANSION X @ 4000°F	TEX-1	<u>3.41</u>	3.2 TO 4.1
	TEX-2	<u>3.35</u>	
Z @ 4000°F	TEZ-1	<u>3.29</u>	3.1 TO 4.1
	TEZ-2	<u>3.43</u>	

THERMAL CONDUCTIVITY			BTU IN/HR FT ² °F
Z @ 500°F	TCZ-1	<u>824 *</u>	640 - 760
Z @ 1500°F	TCZ-1	<u>460</u>	410 - 480
X @ 500°F	TCX-1	<u>968 *</u>	810 - 965
X @ 1500°F	TCX-1	<u>630 *</u>	495 - 590

PLS BOKING DATA SHEET
TYPE 11 CARBON/CARBON BILLET

BILLET S/N H900410 (PLS 2)

DATE 12/07/79

PREFORM S/N A950011 (P1412A)

DENSIFICATION LOT(S) 3

BILLET SIZE 8.127 x 3.241 x 3.242

BILLET WEIGHT 2790.2 grams

BULK DENSITY 1.994 gm/cc

RADIOMETRIC DENSITY

EDGE TO CORE RATIO 0.993

END TO END GRADIENT 0.0013

SIDE TO SIDE GRADIENT 0.021

OPEN POROSITY 4.17%

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 1.096 gms/cc

DENSITY GRADIENT (MAX) 0.154 gm/cc

FIGURE 4

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

BILLET S/N H900410 (PLS-2)

REFORM S/N A950011 (P1412A)

FABRIC ACCEPTANCE DATA

WEAVER Textile Products

LOT NUMBER 203

DEFECTS Accept

CONTAMINATION Accept

WEAVE CONSTRUCTION 8 Harness Satin

VOLATILE CONTENT 4.45

YARN COUNT 30 Warp 30 Fill

WEIGHT 4.92 oz./sq. yd.

THICKNESS 0.13

BREAKING STRENGTH 302.4 Warp 292 Fill

YARN ACCEPTANCE DATA (FOR ABOVE CLOTH)

TYPE	LOT NO.	TENILE STRENGTH (PSI)	MODULUS X 10 ⁶ PSI	Length/unit wt. in/yd	DENSITY gm/cc
EN-1000 PAN	83-4	294 x 10 ³	56.9	15	1.355
	XXXX				
EN-2000 PAN	75-4	300 x 10 ³	56.1	15	1.355
	YYY				

PLS SUMMARY DATA SHEET
MECHANICAL PROPERTIES - TENSILE AND COMPRESSIVE BILLET

BILLET S/N R000106 (P1128A) FLS-3

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
ULTIMATE TENSILE STRENGTH			
X	TX-1	<u>31800</u>	16500 PSI
	TX-2	<u>31800</u>	
	TX-3	<u>28400</u>	
	TX-4	<u>32500</u>	
Z	TZ-1	<u>19600</u>	16500 PSI
	TZ-2	<u>19700</u>	
	TZ-3	<u>22500</u>	
TENSILE MODULUS			
X	TX-1	<u>14.0</u>	8.5×10^6 PSI
	TX-2	<u>14.0</u>	
	TX-3	<u>13.5</u>	
	TX-4	<u>16.8</u>	
Z	TZ-1	<u>9.7</u>	9.4×10^6 PSI
	TZ-2	<u>9.4</u>	
	TZ-3	<u>10.9</u>	
COMPRESSIVE YIELD STRENGTH			
X	CX-1	<u>16700</u>	15200 PSI
	CX-2	<u>16900</u>	
	CX-3	<u>17200</u>	
Z	CZ-1	<u>11100</u>	11000 PSI
	CZ-2	<u>16000</u>	
	CZ-3	<u>16000</u>	

* Tested to Requirement 1 of QATP 30552

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

BILLET S/N R000106 (P140SA) PLS-3

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT</u> <u>(MIN.)</u>
COMPRESSIVE MODULUS			
X	CX-1	<u>15.5</u>	11.2 x 10 ⁶ PSI
	CX-2	<u>14.9</u>	
	CX-3	<u>14.5</u>	
Z	CZ-1	<u>10.6</u>	8.4 x 10 ⁶ PSI
	CZ-2	<u>10.4</u>	
	CZ-3	<u>11.1</u>	
45° XY TENSION, .1% OFFSET YIELD			
	TXY-1	<u>3810</u>	3500 PSI
	TXY-2	<u>3770</u>	
TORSIONAL SHEAR, .2% OFFSET YIELD			
	TS-1	<u>1140</u>	1100 PSI
	TS-2	<u>1170</u>	

* Tested to Amendment I of QATP 30553

PLS SUMMARY DATA SHEET
TYPE 11 CATECH/CARBON PILET

THERMAL PROPERTIES

PILET S/N K900166 (P11284) PLS-3

THERMAL EXPANSION		TEMP. RANGE	PLS-3
			$\Delta L/L \times 10^{-4}$ IN/IN @ 4000°F
X @ 4000°F	TEX-1	<u>3.40</u>	3.2 TO 4.1
	TEX-2	<u>3.26</u>	
Z @ 4000°F	TEZ-1	<u>3.49</u>	3.1 TO 4.1
	TEZ-2	<u>3.42</u>	

THERMAL CONDUCTIVITY			BTU IN/HR FT ² OF
Z @ 500°F	TCZ-1	<u>638 *</u>	640 - 760
Z @ 1500°F	TCZ-1	<u>490 *</u>	410 - 480
X @ 500°F	TCX-1	<u>915</u>	810 - 965
X @ 1500°F	TCX-1	<u>610 *</u>	495 - 590

FIGURE 7

TYPE 11 CARBON/CARBON BILLET

BILLET S/R 1290110 (112-5)

DATE 12/6/77

PREFORM S/R 090529 (PL428A)

DENSIFICATION LOT(S) 1

BILLET SIZE 3.129 x 3.228 x 3.229

BILLET WEIGHT 2760.7 gms

100% BILLET 1.0010

RADIOMETRIC DENSITY

EDGE TO CORE RATIO 1.0010

END TO END GRADIENT 0.010

SIDE TO SIDE GRADIENT 0.010

OPEN POROSITY 4.27%

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 1.691 gms/cc

DENSITY GRADIENT (MAX) 0.069 gm/cc

FIGURE 3

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

BILLET S/N K990196 (PLS-3)

PREFORM S/N 0990629 (PL426A)

FABRIC ACCEPTANCE DATA

WEAVER Textile Products

LOT NUMBER 260

DEFECTS Accept.

CONTAMINATION Accept

WEAVE CONSTRUCTION 8 Harness Satin

VOLATILE CONTENT 1.25

YARN COUNT 29.0 Warp 29.0 Fill

WEIGHT 5.12 oz./sq. yd.

THICKNESS .012/.013

BREAKING STRENGTH 261.7 WARP 254.6 FILL

YARN ACCEPTANCE DATA (FOR ABOVE CLOTH)

TYPE	LOT NO.	TENSILE STRENGTH (PSI)	MOISTURE X 100 PSI	Length Unit Wt (m/lb)	DENSITY gm/cc
EX-1000 PAN	118-1	428 x 10 ³	54.7	122	1.63
	XXXX				
EX-3000 PAN	97.3	387 x 10 ³	54.7	122	1.63
	YYY				

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

BILLET S/N M200164 (P1435A) PLS-4

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
ULTIMATE TENSILE STRENGTH			
X	TX-1	<u>31500</u>	18200 PSI
	TX-2	<u>27900</u>	
	TX-3	<u>28900</u>	
	TX-4	<u>31600</u>	
Z	TZ-1	<u>25500</u>	16500 PSI
	TZ-2	<u>26800</u>	
	TZ-3	<u>29100</u>	
TENSILE MODULUS			
X	TX-1	<u>12.6</u>	8.5×10^6 PSI
	TX-2	<u>14.9</u>	
	TX-3	<u>12.7</u>	
	TX-4	<u>15.4</u>	
Z	TZ-1	<u>12.6</u>	9.4×10^6 PSI
	TZ-2	<u>13.0</u>	
	TZ-3	<u>12.6</u>	
COMPRESSIVE YIELD STRENGTH*			
X	CX-1	<u>16200</u>	15200 PSI
	CX-2	<u>18300</u>	
	CX-3	<u>17700</u>	
Z	CZ-1	<u>16500</u>	11000 PSI
	CZ-2	<u>17000</u>	
	CZ-3	<u>16300</u>	

* Tested to Amendment I of QAPP 30552

PLS SUMMARY DATA SHEET
 MECHANICAL PROPERTIES - TYPE 316L CARBON/CARBON BILLETS

BILLET S/N 0900154 (01435A) PLS-4

<u>PROPERTY</u>	<u>TEST SPECIMEN</u>	<u>TEST VALUE</u>	<u>REQUIREMENT (MIN.)</u>
COMPRESSIVE MODULUS			
X	CX-1	<u>13.1</u>	11.2 x 10 ⁶ PSI
	CX-2	<u>13.3</u>	
	CX-3	<u>12.4</u>	
Z	CZ-1	<u>10.9</u>	8.4 x 10 ⁶ PSI
	CZ-2	<u>11.5</u>	
	CZ-3	<u>11.6</u>	
45° XY TENSION, .1% OFFSET YIELD			
	TXY-1	<u>No Test *</u>	3500 PSI
	TXY-2	<u>3660</u>	
TORSIONAL SHEAR, .2% OFFSET YIELD *			
	TS-1	<u>1250</u>	1100 PSI
	TS-2	<u>1230</u>	

* Tested to Amendment I of QATP 30553

PLS SUMMARY DATA SHEET
TYPE 11 CARBON/CARBON BILLET

THERMAL PROPERTIES

BILLET S/N N900154 (P1435A) PIS-4

THERMAL EXPANSION		THERMAL EXPANSION		TEMPERATURE $\Delta L/L \times 10^3$ IN/IN @ 4000°F
X @ 4000°F	TEX-1		<u>3.65</u>	3.2 TO 4.1
	TEX-2		<u>3.50</u>	
Z @ 4000°F	TEZ-1		<u>3.60</u>	3.1 TO 4.1
	TEZ-2		<u>3.52</u>	

THERMAL CONDUCTIVITY		THERMAL CONDUCTIVITY		BTU IN/HR FT ² °F
Z @ 500°F	TCZ-1		<u>630 *</u>	640 - 760
Z @ 1500°F	TCZ-1		<u>470</u>	410 - 480
X @ 500°F	TCX-1		<u>910</u>	810 - 965
X @ 1500°F	TCX-1		<u>600 *</u>	495 - 590

FIGURE 11

TYPE II CARBON/CARBON BILLET

BILLET S/N 0900154 (PL-4)DATE 1/15/79PREFORM S/N 0900735 (1135A)DENSIFICATION LOT(S) 5BILLET SIZE 8.065 x 3.240 x 3.239BILLET WEIGHT 2729.6BULK DENSITY 1.091 gm/cc

RADIOMETRIC DENSITY

EDGE TO CORE RATIO 1.007END TO END GRADIENT 0.000SIDE TO SIDE GRADIENT 0.000OPEN POROSITY 4.42%FRACTURES (X) None& INCLUSIONS (Y) NoneVISUAL INSPECTION AcceptPREFORM DATA SUMMARY

MISSING/DISPLACED YARN

BUNDLES (Z) NoneFIBER ORIENTATION W/In 2°Z AXIS BENDING NoneZ ELEMENT SPACING W/In + .005XY LAYER SPACING W/In + .002BULK DENSITY 1.091 gm/ccDENSITY GRADIENT (MAX) 0.070 gm/cc

FIGURE 12

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

BILLET S/N H900154 (PLS-4)
 PREFORM S/N 0900735 (PL435)
 FABRIC ACCEPTANCE DATA
 FEMTER Textile Products
 LOT NUMBER 232
 DEFECTS Accept
 CONTAMINATION Accept
 WEAVE CONSTRUCTION 8 Harness Satin
 VOLATILE CONTENT 1.0
 YARN COUNT 29 WARP 29 FILL
 WEIGHT 5.19 oz/sq. yd.
 THICKNESS .0135 to .0138
 BREAKING STRENGTH 258 WARP 271 FILL
 YARN ACCEPTANCE DATA (FOR ABOVE CLOTH)

TYPE	LOT NO.	TENTILE STRENGTH (PSI)	NOVULUS X 10 ³ FILL	LONGER INCH	AIR W.G.	DENSITY oz/oz
H24-1000 PAN	118-2	405 x 10 ³	57.0	1	9	1.00
	XXXX					
H24-3000 PAN	97-3	287 x 10 ³	51.7		8	1.00
	YYY					

