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Technical Report ARAED-TR-94008

PA120 METAL CONTAINER DUNNAGE

Carlton A. Morrison

June 1995

US ARMY
TANK AUTOMOTIVE AND
ARMAMENTS COMMAND
ARMAMENT RDE CENTER

U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER

Armament Engineering Directorate

Picatinny Arsenal, New Jersey

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13. ABSTRACT (Maximum 200 words)

This report delineates the selection rationale, testing, and cost evaluation of proposed new cushioning for linked 40-mm grenades packed in the PA120 metal container. The purpose of the testing described in this report was to determine whether a one-piece molded polyethylene foam cushion could replace the top cushion assembly currently used in the packaging of linked 40-mm rounds in the PA120 metal container. Additionally, a smaller scale test and evaluation was performed on a softer density side cushion which could be used in place of the current side and secondary side filler components in the PA120 container. The softer cushion presently is used in the packaging of linked 40-mm rounds in the M548 metal container. In both instances, a potential cost savings could be realized, while maintaining an effective level of cushioning protection.

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FIGURES

BACKGROUND

The PA120 metal container was developed as the latest packaging for linked 40-mm grenades fired from the MK19 machine gun. It is used as both a shipping and storage container as well as an ammunition ready box, which simply means the rounds can be fired from the container reminiscent of a machine gun magazine.

Full scale production of the container and all its associated packaging components began in 1992. The container is packed using an array of foam and fiberboard dunnage as shown in figure 1. The top dunnage (which is the focus of this report) is comprised of several different components linked together with nylon strapping as shown in figures 2 and 2a. The purpose of this configuration is to provide cushioning for the top two layers of rounds, but also to provide a quick and easy one step means of extracting the top 2 layers of dunnage. The top two layers of dunnage must be removed prior to loading and firing the MK19 machine gun in order to prevent firing stoppages. This configuration, though very effective, requires manual labor to assemble, thus driving up cost approximately 70% to 74%. After some investigation, it was discovered that a one piece molded configuration might replace the current part providing equal protection at a significantly lower cost.

Pursuant to this effort, a one piece design was developed by Carlton Morrison of the U.S. Army Armament Research, Development and Engineering Center (ARDEC), Armament Engineering Directorate (AED), Packaging Division and prototype dunnage was prepared by Stanga Foam of Titusville, Florida, in February 1993. This report details the testing and evaluation of the prototype dunnage as a packaging component for linked 40-mm grenades placed in the PA120 metal container. In addition, another test was performed which involved replacing the side and secondary side fillers, figures 3 (drawing 12928038) and 4 (drawing 12928042-1), respectively, in the PA120 container with a softer, lower density foam cushion currently used in the packaging of 40-mm rounds in the M548 metal container (fig. 5, drawing 9362548). The lower density foam is less expensive than the higher density and will eliminate the need for secondary side fillers.

SCOPE

This report delineates the selection rationale, testing, and cost evaluation of proposed new cushioning for linked 40-mm grenades packed in the PA120 metal container. The purpose of the testing described in this report was to determine whether a one-piece molded polyethylene (PE) foam cushion (fig. 6 and 6a) could replace the top cushion assembly currently used in the packaging of linked 40-mm rounds in the PA120 metal container. Additionally, a smaller scale test and evaluation was performed on a lower density side cushion which could be used in place of the current side and secondary side filler components in the PA120 container. The softer cushion is presently used in the packaging of linked 40-mm rounds in the M548 metal container. In both instances, a potential cost savings could be realized.

The molded top cushion assembly (figs. 6 and 6a) is made up of pre-expanded beads of PE placed in a mold and fuzed together using pressure and high temperature steam. After fusion, the piece is cooled while still in the mold. Finally, the part is removed from the mold and is cured in a high temperature storage area for a minimum period of 24 hr. This stabilizes the plastic and permits the beads to recover their original shape. Tolerance of a molded piece can be held to within ±1% of the overall dimension. The particular advantage of this process over the traditional process, which uses cutting sheet stock material then machining and/or laminating, is the drastic reduction in material waste when manufacturing sophisticated parts. The PE beads were supplied by Kaneka Corporation in Houston, Texas. Property characteristics of the foam (trade name Eperan PE 20) are supplied in the attached brochure (app A). A brochure for a similar material (EPE resin) produced by Tuscarora of New Brighton, Pennsylvania is provided in appendix B.

In addition to examining the prototype top cushion, a softer foam side cushion was also reviewed for performance and cost effectiveness. The lower density side cushion was made by taking the side cushion (fig. 5) from the M548 container pack and modifying the dimensions to fit the PA120 container. Dimensions of the modified cushion are 17 in. L x 9 in. H x 5/8 in. W. The current PA120 configuration uses two side fillers (17 in. L x 9 in. H x 1/2 in. W), and because of clearance and tolerance variations in the width of the container, an additional 1 to 4 secondary side fillers to ensure a tight pack. Each secondary side filler measures 17 in. L x 9 in. H x 1/16 in. W. Because of their density, 8.5 to 10.5 lb/ft^3 or 50 to 120 psi compressive strength, the current side fillers are very rigid and were designed narrow enough to allow room for some clearance in order to place the rounds in the container, thus necessitating secondary side fillers to provide a tight pack. The lower density foam, 2.1 to 3.0 lb/ft^3 or 4 to 12 psi compressive strength, allows for thicker cushions, which provide a tight pack without the use of secondary side fillers. It also is soft enough to allow the rounds to be packed into and removed from the container.

In order to evaluate the ability of the top and side foams to effectively protect the rounds during shipping, storage, and transport, a series of rough handling tests were performed with fully loaded containers. First, 576 M430 high explosive, dual purpose (HEDP) 40-mm rounds were x-rayed for safety, then belts of 32 rounds were loaded into 18 PA120 containers using the prototype top dunnage. Only two containers were fitted with the softer side cushion. The 18 loaded containers were divided into three groups of six containers. Each group was conditioned and tested at one of the following temperatures for a minimum of 24 hr (cold -65°F, ambient, and hot +160°F) (Note: Of the two containers fitted with the modified side cushions, one was conditioned at hot and the other at cold.) Each group underwent the following test sequence:

- Secured cargo vibration (three axes)
- 3 ft drop (six drops per container)
- Horizontal loose cargo
- Vertical loose cargo
- 7 ft drop
- 10 ft stack test (at ambient only)

A pressure retention test, which is normally done, was not performed because the test facility does not have the appropriate equipment to do such a test on a container without a vent port such as the PA120. Furthermore, PA120 containers, previously, were proven to pass pressure retention testing thus negating the need for such a test. Test procedures were extracted from MIL-STD-1904A, "Design and Test Requirements for Level A Ammunition Packaging," under the section "Level A Tactical Test Procedures/Sequence for Exterior Packs 150 Pounds or Less".

After completion of the rough handling tests, all the rounds were X-rayed prior to undergoing a firing test. All the rounds were deemed safe for firing.

The firing test consisted of a single shot firing out of the MK19 machine gun downrange approximately 75 m to a 1 to 2 in. thick steel witness plate to insure accuracy and round function. Of the 576 rounds fired, all but two functioned properly. One round went low order and the other would not fire because the link retainer was misaligned and would not allow the round to chamber properly. It is speculated that the misalignment occurred during delinking and relinking between X-rays. All other rounds hit the target and functioned properly. Based on previous information supplied by ARDEC's Small Caliber Group, 5 duds out of 144 rounds is acceptable. The dud rate for this particular test was well within the acceptable range.

During loading of the rounds for firing it was noted that many of the rounds were switched to different containers and much of the foam dunnage was missing. This mishap apparently occurred when the X-ray department repacked the rounds. For some reason, they did not pack the rounds as they had been received and disregarded much of the foam dunnage. When questioned about this, the X-ray lab could not sufficiently answer why this had happened. The only significant ramification of this was that all the prototype pieces could not be examined for a final evaluation. One-third of the pieces were missing, another one-third only a section (usually half) remained, and the other third was fully intact.

Since the x-ray lab could not provide any indication why certain sections were ripped, an investigation was done on the tensile properties of the foam. The tensile strength of the foam was 68.9 psi, as specified in the EPERAN brochure (app A). At the request of this office, tensile tests were also performed by ARDEC Materials Lab. Tensile specimens were prepared from prototype cushions. The samples measured 4 in. L x 0.75 in. W x 0.35 in. thick. The specimens were tested at -65°F, ambient, and 160°F at a 95% relative humidity. Specimens were preconditioned at one of those settings for 5 days. Tensile strength results ranged from 60.6 psi to 124.6 psi. The wide range in tensile strength was mainly due to foam quality rather than temperature. Although temperature had some effect, it appeared that those specimens which had a surface finish yielded tensile strengths in the upper ranges, while those which had no surface finish yielded results in the lower ranges. More detailed results are provided in appendix C. The item was also demonstrated to ARDEC, Human Engineering Lab, for evaluation. In the memo provided in appendix D, "it was determined that the subject design is not subject to any limitations based upon pull force requirements, and that the cushion assembly does not exceed the human engineering pull force limitation 6.8 lb (per MIL-STD-1472)."

In addition to the prequalification tests, a cost analysis was done on the proposed cushioning versus the currently used cushioning. Based on cost estimates provided by Milan Ammunition Army Plant (app E), the current top assembly cushion costs approximately $2.96/container based on production quantities of 140 k for 1993. (Note: Actual price shown is $2.85 for the year 1992, but 4% inflation is included as suggested in quoter's note.) Cost of materials is approximately $1.70 and the remaining cost is the associated labor cost to put the part together. This compares to the estimated $1.35 to $1.43 for the one piece molded configuration for production runs of 100 k and 50 k. These costs do not include the $12,250 tooling charge which, when amortized for the aforementioned production runs, increases the cost to approximately $1.47 to $1.68 a piece. These costs were provided in February 1993 by Stanga Foam as shown in appendix F. Quotes were good for 1993-1994. This results in a savings of $1.28 to $1.49 per container. Cost estimates were also provided by another molded foam manufacturer, Tuscarora in February 1994.. Tuscarora quotes (app G) were $2.10 and $2.35 for quantities of 100 k and 50 k, respectively. Their tooling costs were $19,500, which when amortized to their quoted prices, increases the unit price from $2.10 and $2.35 to $2.30 and $2.74, respectively. These prices, though higher than the Stanga quotes, still provides an estimated cost savings per unit of $0.22 to $0.66. These quotes were good for 1994.

The side and secondary side fillers cost approximately $2.04 to $2.24 a container (app E). The proposed lower density side cushion projected cost per container is $1.60 (two side cushions at $0.80 each, 100 k total) as provided by Cassemco Inc. of Cookeville, Tennessee (app H) in July 1994. Cassemco Inc. is a current vendor of the internal foam dunnage for the M548 container. This results in a savings of $0.44 to $0.64 per container. The potential overall cost savings for both changes is $1.72 to $2.13 per container.

CONCLUSIONS

Both the molded one-piece top cushion and the lower side density cushions provided adequate protection to the rounds. Out of 576 M430 rounds fired, only two did not function properly (one went low order and the other did not chamber properly due to misaligned link retainer).

Based on figures provided by Stanga Foam, the top assembly cushion could be made for approximately $1.47 to $1.68 based on production runs of 100 k to 50 k. This compares to the $2.96, based on production runs of 140 k, figure provided by Milan Army Ammunition Plant on the current top cushion assembly. The side and secondary side fillers combined cost is approximately $2.24 per container for runs of 280 k as shown by Milan Army Ammunition Plant. The lower density side cushion would cost approximately $1.60 per container based on production of 100 k side cushions. Overall cost savings for both changes could be $1.72 to $2.13 per container.

RECOMMENDATIONS

Both foam components show tremendous promise from a performance and cost standpoint. It is recommended that both foam cushions be considered for implementation into the PA120 container based on test results and potential cost savings.

PA120 CONTAINER (32 ROUND CONFIGURATION) WITH MOD 2 DUNNAGE

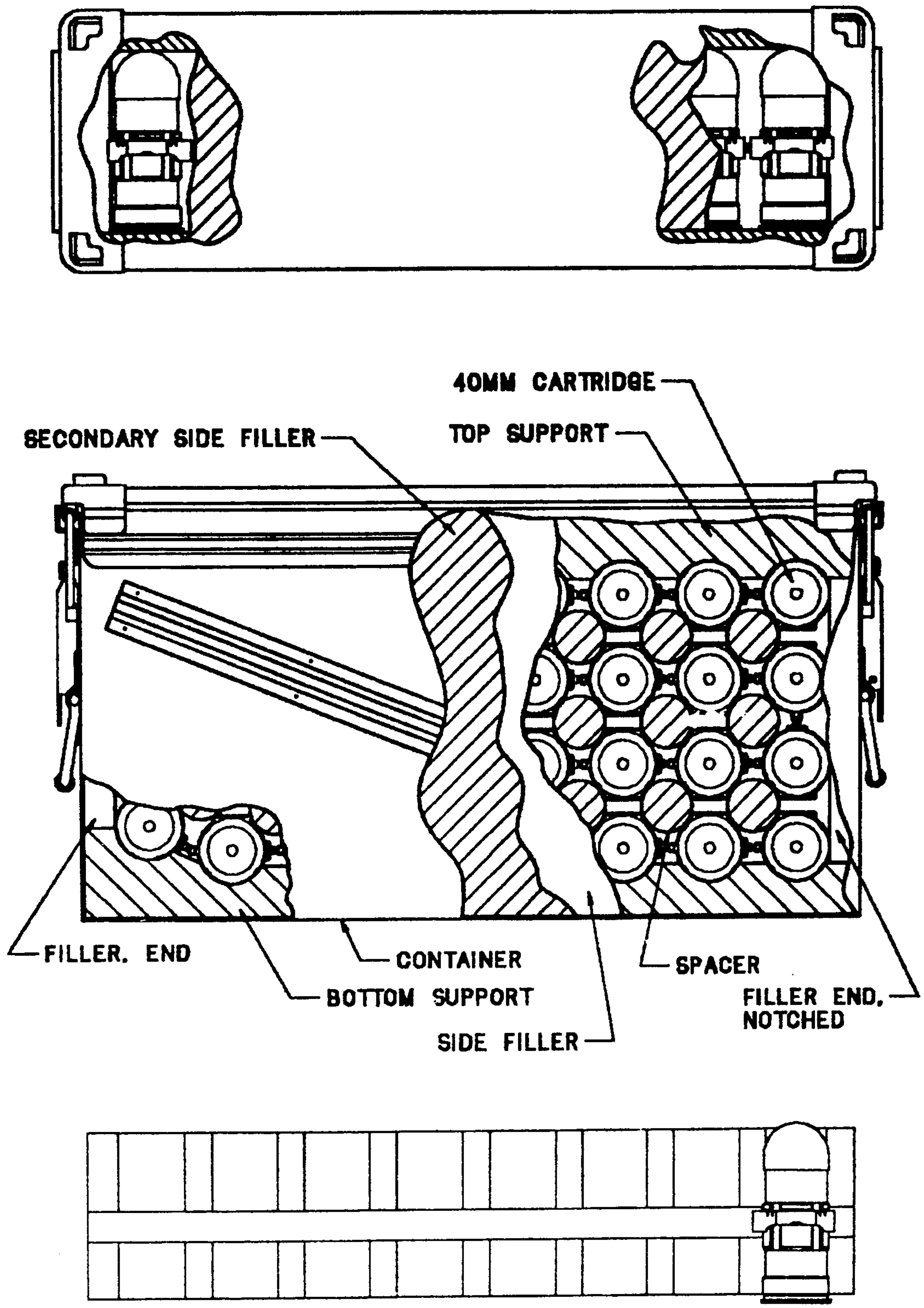


Figure 1
PA120 dunnage system for linked 40-mm grenades

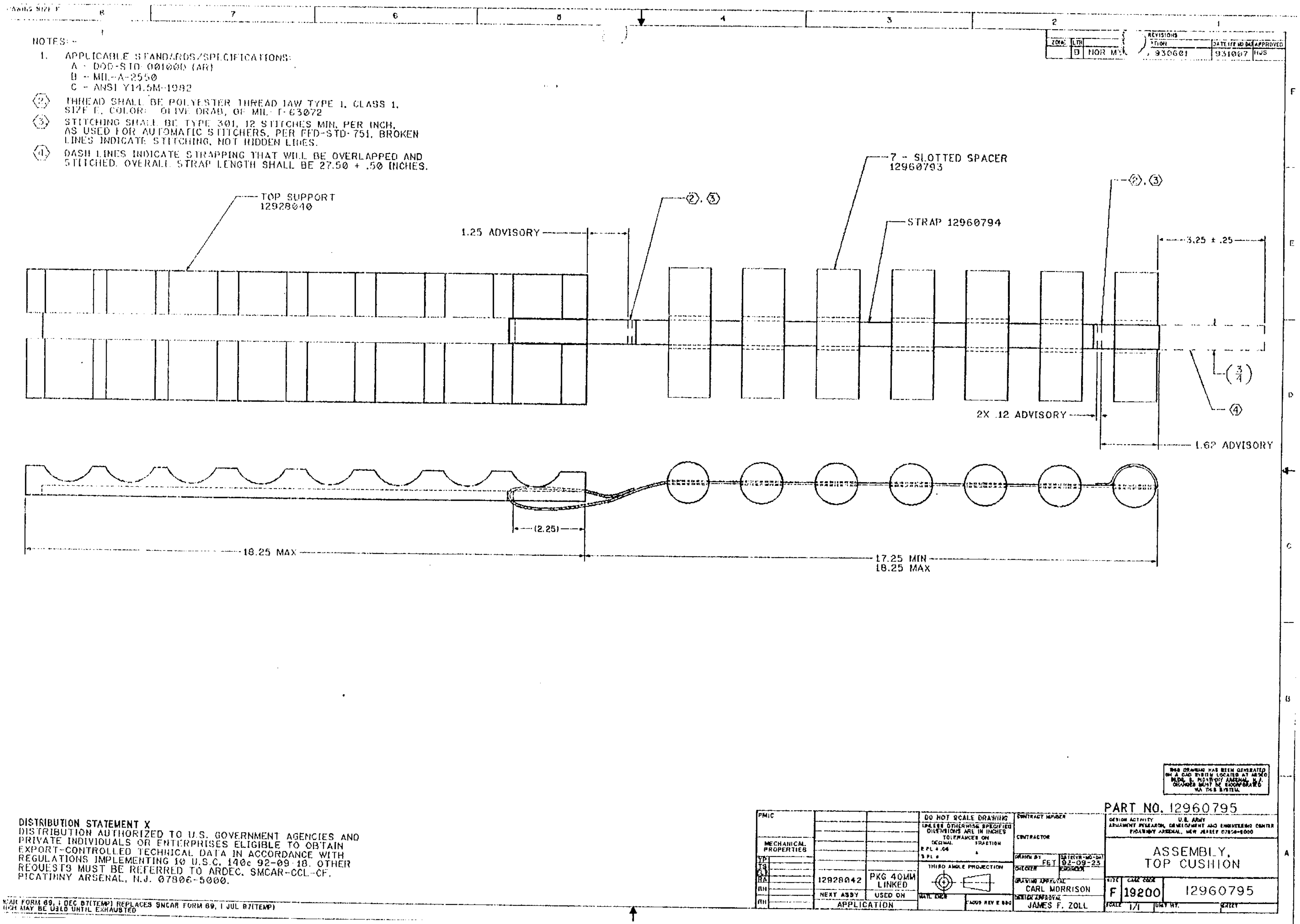


Figure 2
Current top cushion assembly (schematic)

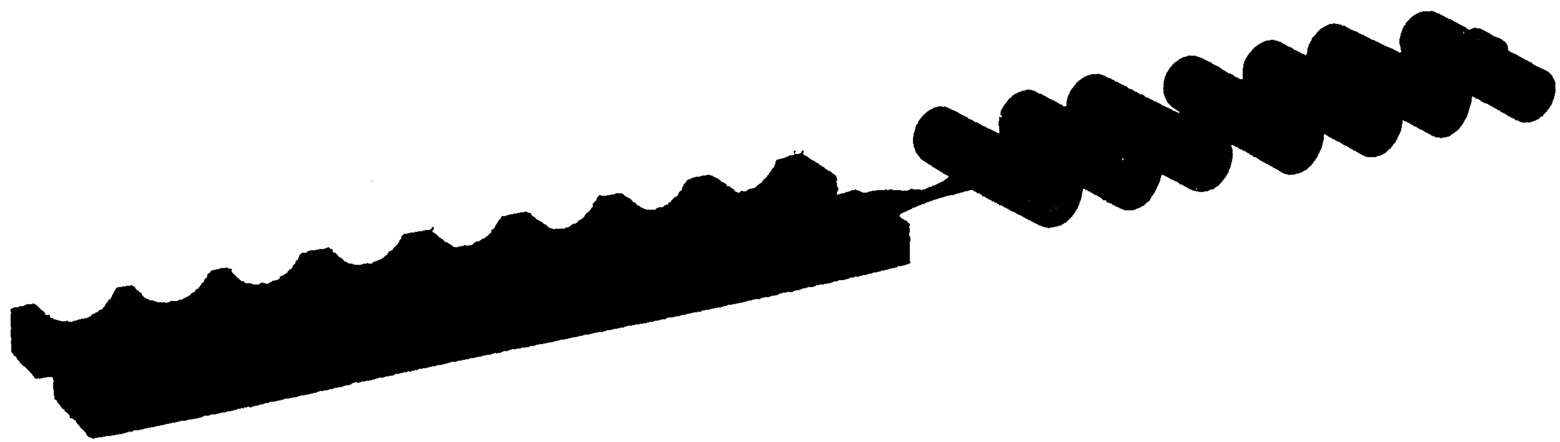


Figure 2a
Current top cushion assembly (actual)

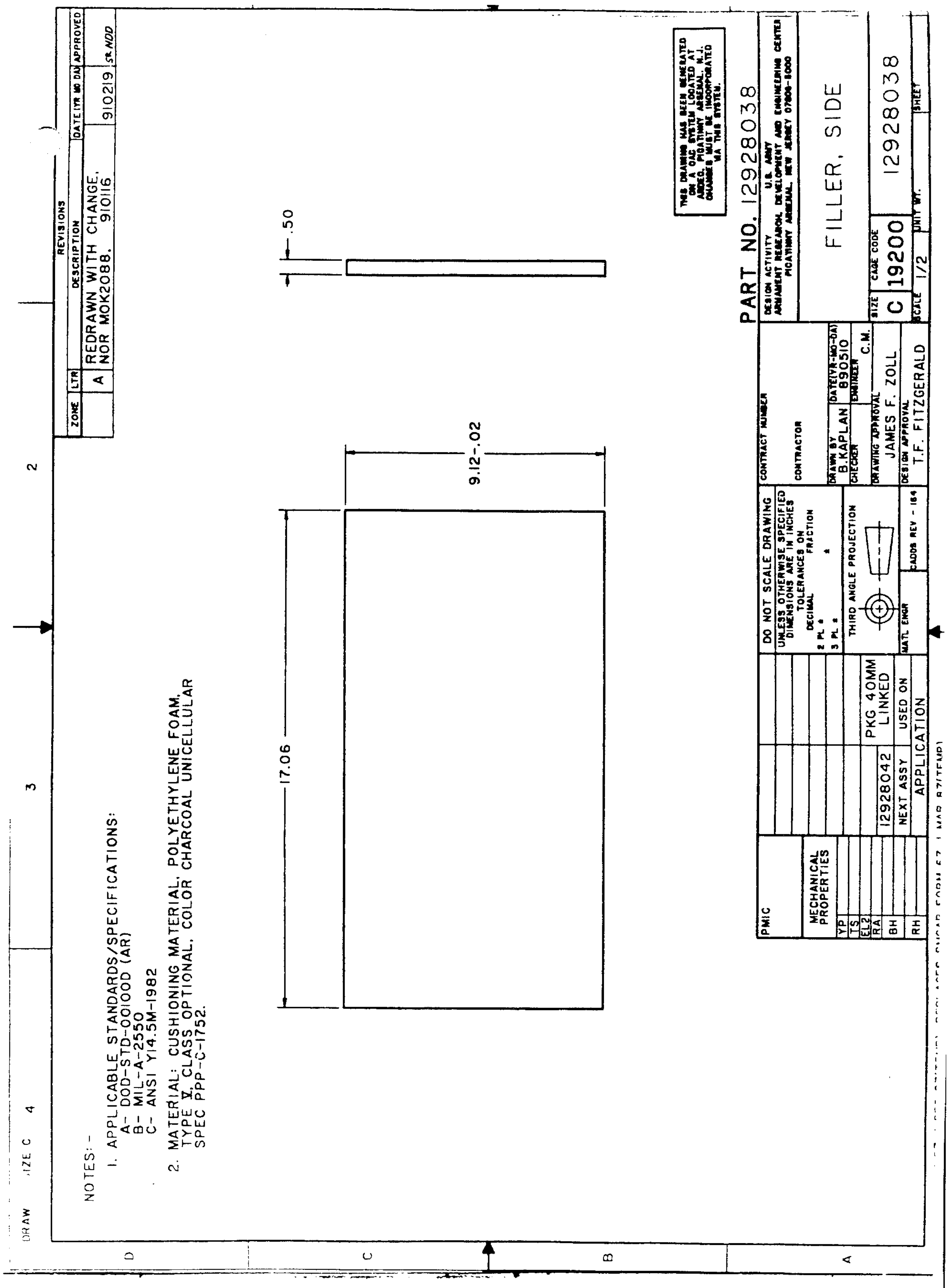


Figure 3
PA120 side filler

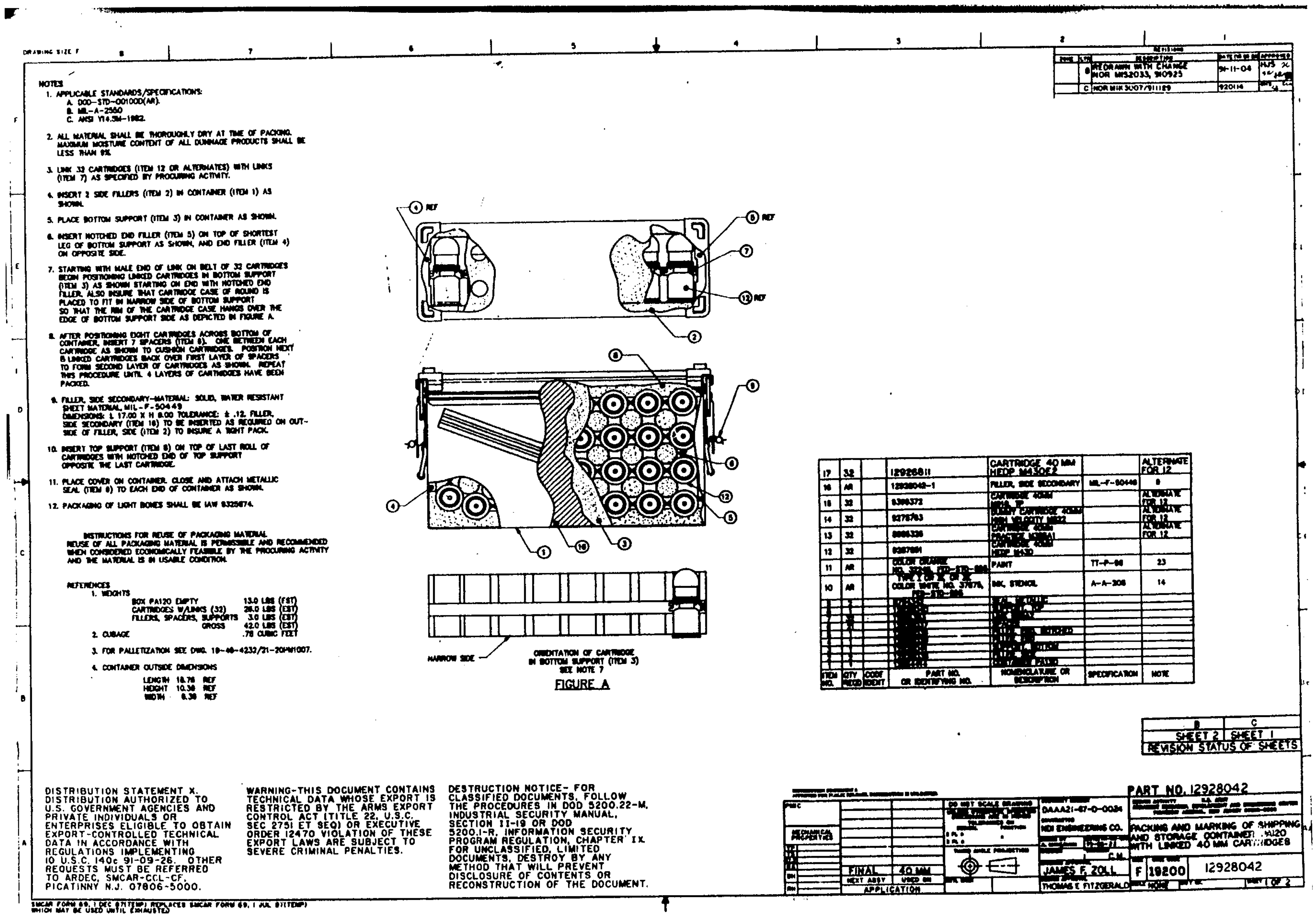


Figure 4
PA120 secondary side filler

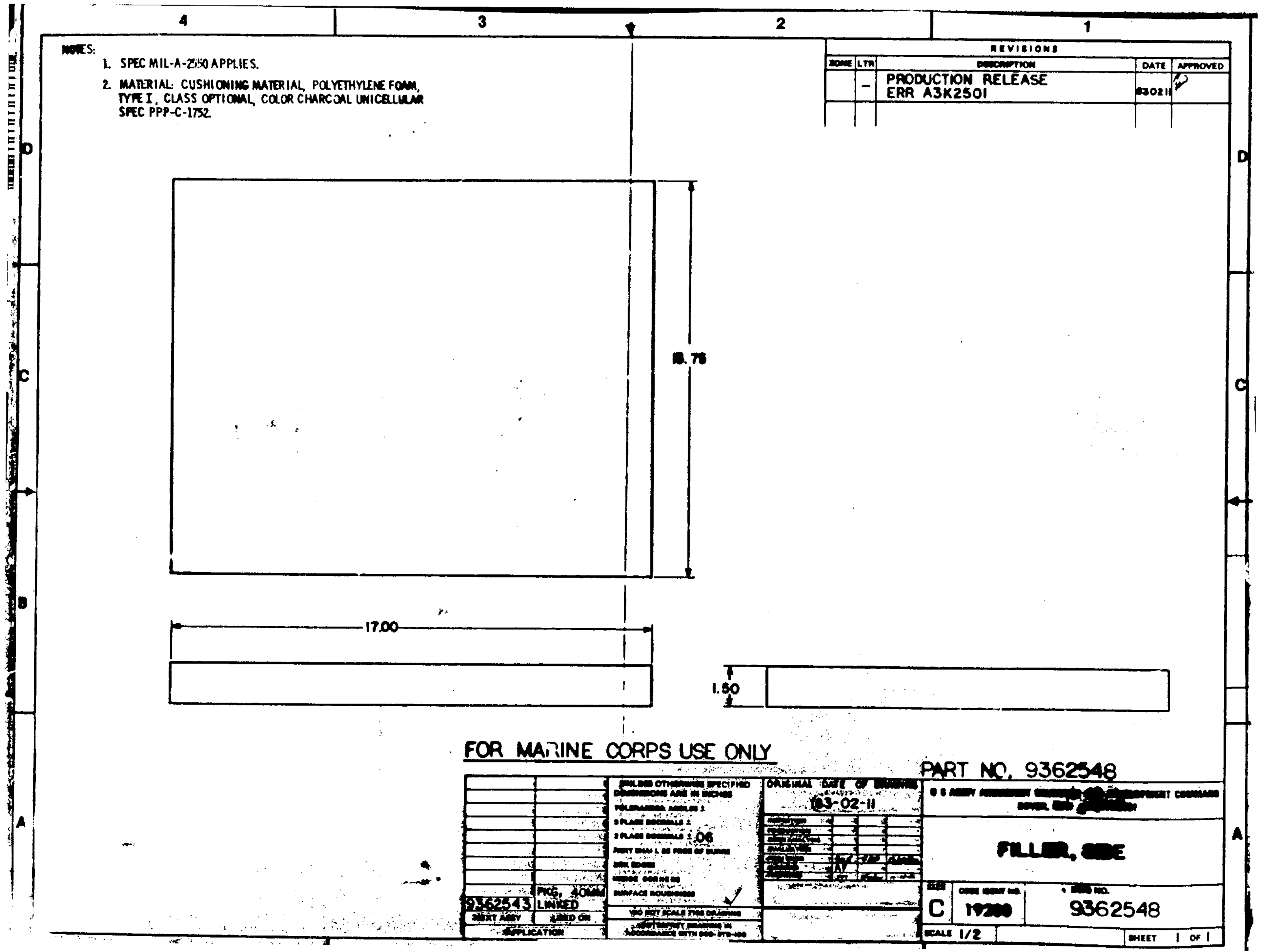


Figure 5
M548 side filler

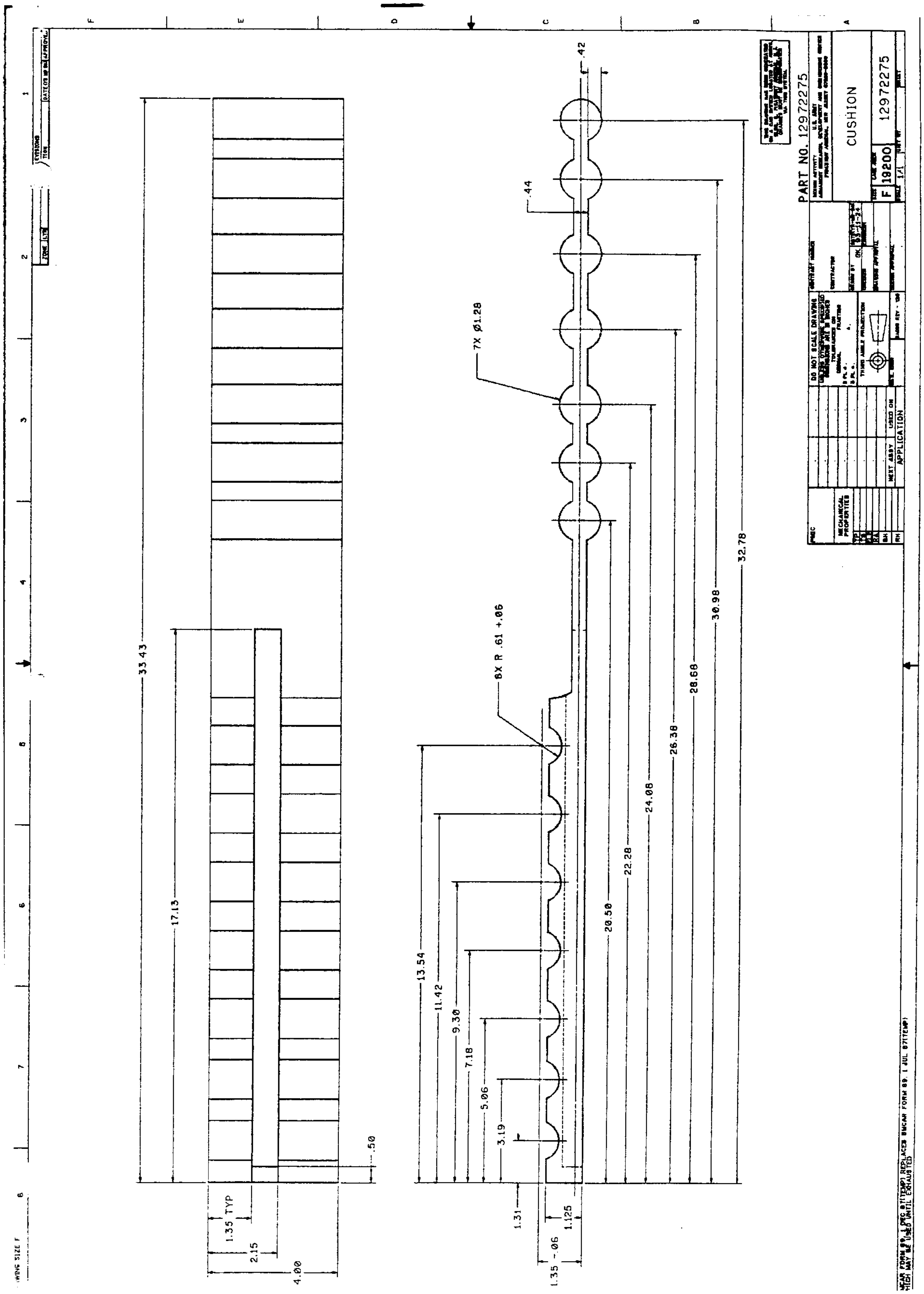


Figure 6
Proposed molded top cushion assembly (schematic)

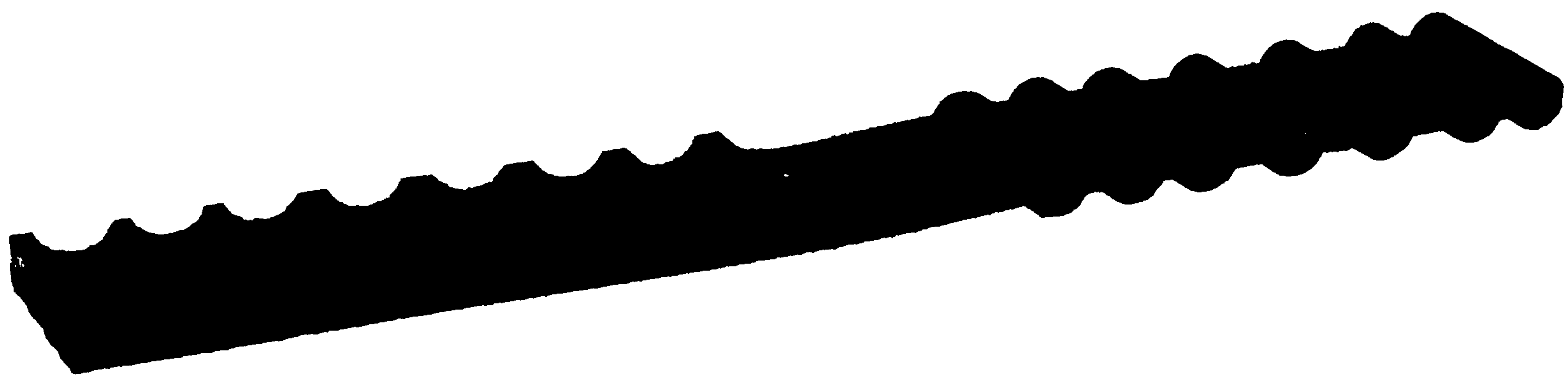


Figure 6a
Proposed molded top cushion assembly (actual)

APPENDIX A

EPERAN MOLDED BEAD FOAM PRODUCT PROPERTIES DATA

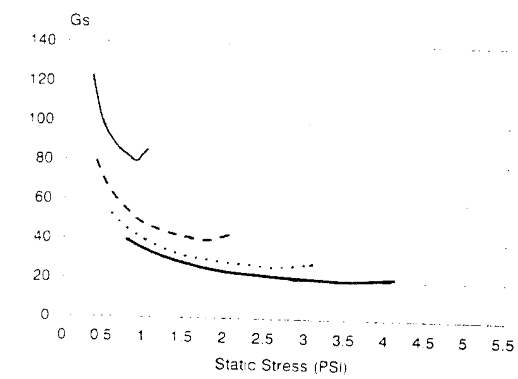
Product And Properties

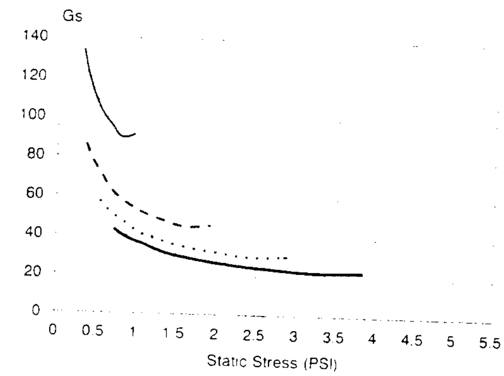
PROPERTY	TEST METHOD	VALUE		EPERAN Polyethylene BEAD TYPE PE 38	PE 30	PE 20	EPERAN PP Polypropylene BEAD TYPE PP 45	PP 30	LBS 20
Density	ASTM D-3575	lb/ft^3		1.5	1.9	2.8	1.3	1.9	2.8
Compressive Strength	ASTM D-3575	% @	25%	11.4	11.4	20.2	13.6	21.5	43.4
			50%	19.9	21.3	33.4	21.7	32.9	58.7
			75%	51.1	52.5	72.7	51.6	72.3	119.8
Tensile Strength	ASTM D-3575	PSI		48.3	39.8	68.9	34.7	61.4	87.5
Elongation	ASTM D-3575	%		34.2	38.4	28.5	16.6	15.7	13.4
Tear Strength	ASTM D-3575	lb/in		15.2	17.4	17.9	11.5	20.3	17.7
Compressive Set	ASTM D-3575	%		3.0	4.2	2.1	8.1	8.2	8.3
Buoyancy	ASTM D-3575	lb/ft^3		60.2	60.3	59.3	61.4	60.7	59.2
Thermal Conductivity	ASTM D-3575	BTU/ft-hr-°F		.028	.026	.025	.024	.024	.024
Combustion Speed	MVSS 302	in/min		2.0	2.0	1.5	2.0	1.5	1.5

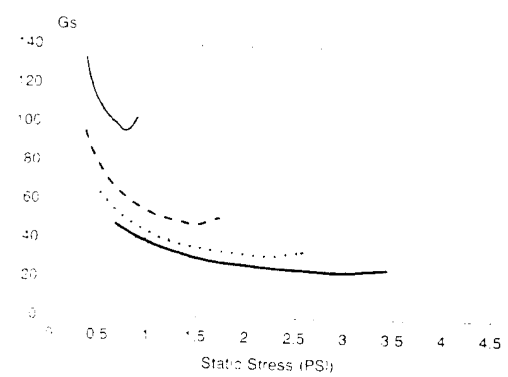
PRODUCT TYPE	COLOR/PROPERTY	BEAD TYPE PE 38	PE 30	PE 20	PP 45	PP 30	PP 20
Molded Shape	White	XL38	M30	XL20	LBS45	LBS30	LBS20
	Black		MB30		LBSB45	LBSB30	LBSB20
	Anti-Static	XL38AS					
Plank	White	E150	E190	E280	P125	P190	P280
	Black		BE190		BP125	BP190	BP280
	Anti-static	AS150					
	Recycled content	E150R			P125R	P190R	

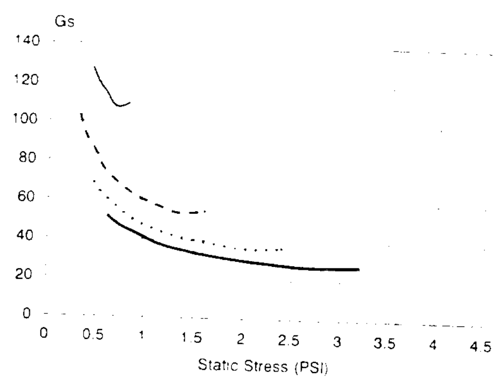
This information is believed accurate and reliable. However, as conditions of use are not within its control, Kaneka Texas Corporation does not guarantee results from use of such products or other information herein; no warranty, express or implied, is given. It is the user's responsibility to determine the appropriateness of the products for their specific end uses.

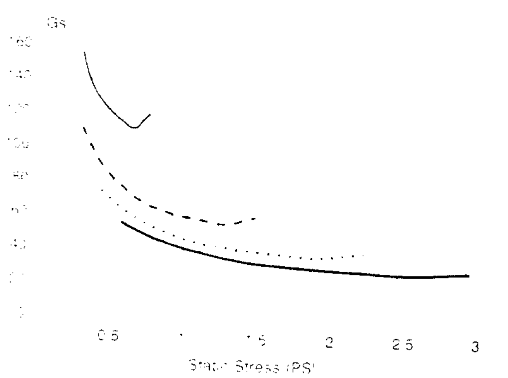
Dynamic Cushioning Curves/2.8 PCF Polyethylene

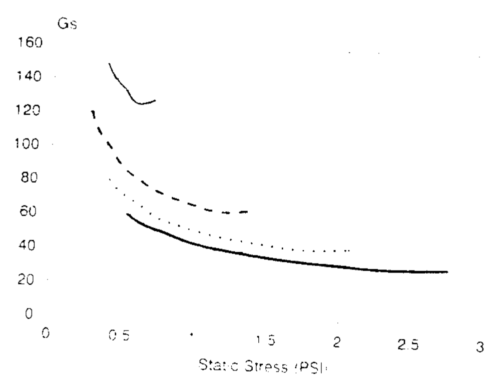








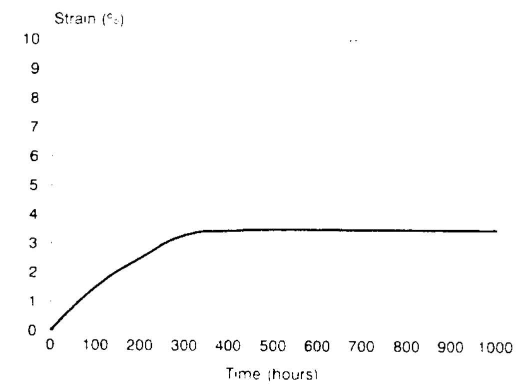


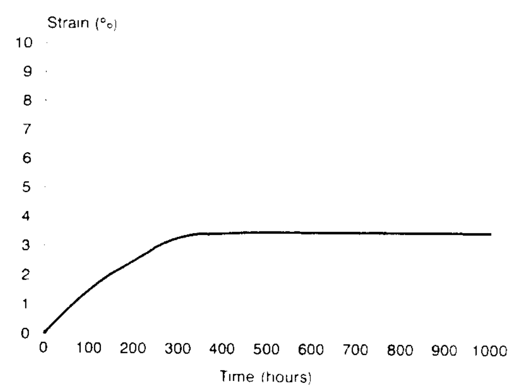


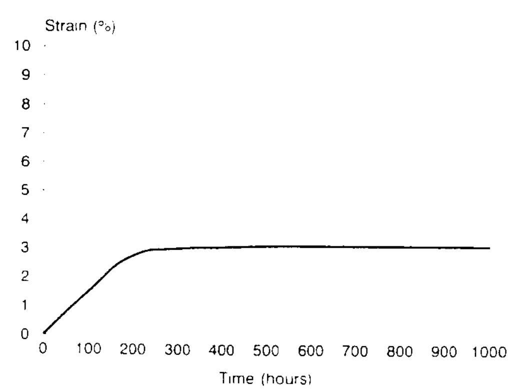
Thickness ——1" - - - 2" ····· 3" ——4"

COMPRESSIVE CREEP CHARACTERISTICS

Polyethylene @ 73°F, 1.0 PSI Load







APPENDIX B

TUSCARORA PACKAGING AND PROTECTIVE PRODUCTS DATA very large part of nature's most plentiful resource – air – and a very small part of various high-performing plastic resins. Each of these different resins has its own unique set of physical properties. Tuscarora's design team can help you by selecting the resin that is best suited to your packaging, material handling or other requirements.

These tables show a comparison of the properties and performance features of the various types of moldable foams. Upon request, cushion curves and other more detailed information are available to assist you in selecting the most cost-effective foam for your needs.

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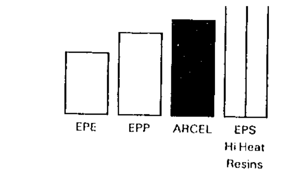
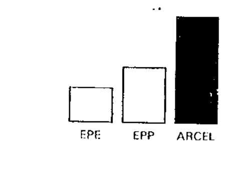
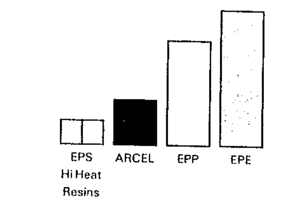
Resin	Properties	Applications	Products
(4) EPE Resins Expanded Polyethylene	Resilient – very low permanent set Excellent multiple drop cushioning High solvent resistance	highly fragile electronics Solvent-resistant packaging Furniture – bedding and seating	EPERAN® ARPAK®
(5) EPP Resins Expanded Polypropylene	High energy absorption Excellent cushioning over broad loading range High service temperature	Protective packaging of high-value, highly fragile electronics Heat-resistant packaging Energy-absorbing automotive bumpers and components	ARPRO® EPERAN PP® NEOPOLEN P®
(6) EPS Resins Expandable Polystyrene	Good strength Good first drop cushioning performance Excellent insulation value	Packaging for consumer electronics, appliances, toys Food service – cups, coolers Insulation – roof insulation, sheathing board	STYROPOR® DYLITE® HUNTSMAN
(7) [redacted]			
(7) Hi Heat Resins Expandable Copolymers	High strength characteristics Moldable in very high densities, up to 10 pcf High service temperature, up to 250 °F	Lightweight automotive interior components Building panels and solar panels Cabinetry	DYTHERM® GECET™

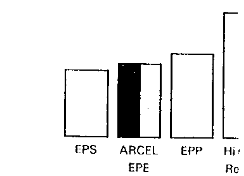




Resiliency Comparison



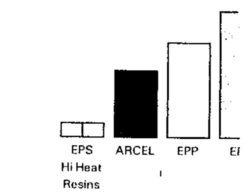
Service Temperature Comparison



Typical Physical Properties of Molded Foams

Properties	Typical Density Range (pcf)	Density of Foam Tested (pcf)	Compressive Strength (psi at 25% compression)	Tensile Strength (psi at break)	Tensile Elongation (%)	Tear Strength (lbs./in.)	Dynamic Set (%)	Compressive Creep (% of 4 psi after 1,000 hours)	Service Temperature (°F)	Thermal Resistivity per Inch (R)
ASTM Test	--	--	D3575	D3575	D3575	D3575	D1596	D3575	ARCO	C518
Products										
EPE Resins	1.5 - 3.5	2.2	8	40	33	8.0	2.2	5.2 @ 1 psi	180	3.4
EPP Resins	1.0 - 5.0	1.3 1.9	10 16	35 52	18 22	7.0 9.0	1.1 1.0	2.2 @ 1 psi 3.4 @ 1 psi	190 210	3.6 3.7
EPS Resins	0.8 - 5.0	1.25	21	45	<5	4.0	18	2.0	175	3.9
[redacted]										
Hi Heat Resins	2.0-10.0	6.0	225	200	<5	–	N.A.	<0.2	250	4.0

Chemical Resistance Comp (to Gasoline-type solvents)



APPENDIX C

MILAN AAP COST ESTIMATE ON PA120 CURRENT TOP CUSHION ASSEMBLY

MARTIN MARIETTA

MARTIN MARIETTA ORDNANCE SYSTEMS, INC.

MILAN ARMY AMMUNITION PLANT
MILAN, TENNESSEE 38358
TELEPHONE (901) 686-6101

December 14, 1993
Nance

Administrative Contracting Officer
Contract DAAA09-91-Z-0010
Milan Army Ammunition Plant
Milan, Tennessee 38358

Attention: SMCMI-CM

Subject: Unit Cost of Internal Dunnage for PA120 and M548 (40mm)

Reference: AMSMC-PDM-CB Memorandum dated 07 DEC 1993

Dear Sir:

The following information is provided in accordance with your request in the referenced memorandum:

FOR PA120-PACKED 40mm ITEMS:

Item	MMOS Stock Number	Unit Price	Last P.O.	Usage per Container	Last Buy
Filler, End, Notched	W12-96052	1.0750	92-1864	1 each	140,521
Spacer	W12-96051	.0775	92-1863	14 each	292,000
Filler, Side	W12-96055	.9800	92-1866	2 each	280,000
Filler, End	W12-96053	1.0600	92-1865	1 each	139,100
Support, Bottom	W12-96054	1.3400	92-1862	1 each	140,000
Filler, Second, Side	W12-34398	.2048	N/A	N/A	See Note
Ass'y, Top Cushion		2.8530	(See Note)	CONSISTING OF:	
Support, Top	W12-96050	1.0100	92-1862	1 each	140,000
Strap	W12-96086	.1200	92-2221	.78 yard	178,000
Spacer	W12-96051	.0775	92-1863	7 each	292,000
Thread	W12-96087	14.7500	93-1678	.000032 lb	15

NOTES: Unit Prices are per unit of purchase (i.e., "each," "lb," "yd," etc.). In order to arrive at cost per container, the unit price should be multiplied by the Usage per Container.

Secondary Side Filler material is purchased in 4' x 8' sheets under stock number W12-6192X and cut down for use on these items. The Unit Price shown is actual cost based upon production of 620,557 units (M430 in PA120 pack) for CY 1993. THIS NUMBER SHOULD BE USED AS IS FOR COST PER CONTAINER CALCULATION.

NOTES (Cont):

Top Cushion Assembly cost includes all labor, overhead and material, but DOES NOT include Fee at 4.93%. Fee is added to the end-item cost.

FOR M548-PACKED 40mm ITEMS:

Item	MMOS Stock Number	Unit Price	Last P.O.	Usage per Container	Last Buy
Spacer	W12-95563	.1592	91-1458	28 each	3,866,500
Filler, End, Short	W12-95564	.9960	91-1459	1 each	1,315,615
Filler, End, Long	W12-95565	.9820	91-1460	1 each	191,950
Support, Bottom	W12-95566	1.5950	91-1461	1 each	136,700
Filler, Side	W12-95567	1.7150	91-1462	2 each	281,500

NOTES: See NOTES, above, for proper calculation of per-container cost based upon Unit Price and Usage per Container.

The above information contains purchases made in CYs 1991 and 1992. The prices given for 1991 and 1992 purchases should, in our opinion, be escalated to reflect a reasonable estimation of the effect of inflation from then to now, especially if this information is to be used to calculate a 1993 or 1994 cost.

Should you have any questions regarding the above, please do not hesitate to contact Mr. Bill Nance, (901) 686-6680 or DSN 966-6680.

Very truly yours,

MARTIN MARIETTA ORDNANCE SYSTEMS, INC.

B. R. Browning, Vice President

APPENDIX D

STANGA FOAM COST ESTIMATE ON PA120 PROPOSED TOP CUSHION ASSEMBLY

QUOTATION

FROM: STANGA ENTERPRISES, INC.
4265 SR 405
TITUSVILLE, FL. 32780
EDWARD M. STANGA

TO: CARL MORRISON
PICATINNY ARSENAL, NJ.
(201) 724-2233
(201) 724-4187

OCTOBER 27, 1993

TERMS: 2% 10 - NET 30

DELIVERY: 1ST ARTICLE - 8 WEEKS ARO

PRICES QUOTED ARE F.O.B: DESTINATION

QUANTITY	DESCRIPTION	PRICE
100 M	40 MM CARTRIDGE SPACER MOLDED EPE, BLACK, 3#/FT3	$ 1.35
50 M	" "	1.43
25 M	" "	1.57
10 M	" "	1.69
5 M	" "	1.98
1 EA	TOOLING CHARGE	$ 12,250.00

APPENDIX E

TUSCARORA COST ESTIMATE ON PA120 PROPOSED TOP CUSHION ASSEMBLY

TUSCARORA

Tuscarora Incorporated
800 Fifth Avenue
New Brighton, PA 15066
412.843.8200
Fax 412.847.2140

Picatinny Arsenal
Picatinny, NJ 07806-5000

Attn: Carl Morrison

ANTICIPATED PRODUCTION PLANT / FOB

Plant	FOB	Location	Location	Plant	FOB
☐	☐	Putnam, CT	Butner, NC	☐	☐
☐	☐	Conyers, GA	Marion, OH	☐	☐
☐	☐	Antioch, IL	Beaver, PA	☐	☐
☐	☐	Streator, IL	New Brighton, PA	☒	☒
☐	☐	Martinsville, IN	Greeneville, TN	☐	☐
☐	☐	Chesaning, MI	Lewisburg, TN	☐	☐
☐	☐	Saginaw, MI	Sterling, VA	☐	☐
☐	☐	Tupelo, MS	Pardeeville, WI	☐	☐
☐	☐	Las Cruces, NM		☐	☐
☐	☐	Cortland, NY		☐	☐
☐	☐			☐	☐

WE ARE PLEASED TO SUBMIT THE FOLLOWING QUOTATION:

QUOTATION NUMBER 101794

TERMS: NET 30 DAYS

DATE 2/24/94 | INQUIRY NO. 1594 | PRICE PER Piece

PART NO., DRAWING NO. OR DESCRIPTION	QUANTITY	Molded	Fabricated	
2.8 PCF EPE Strap	100,000	$2.10 ea.	$4.55 ea.	
	50,000	$2.35 ea.	$4.70 ea.	
TOOLING CHARGE		$19,500.00	$850.00	
NUMBER OF CAVITIES				
WEEKLY PRODUCTION				

REMARKS:

2.8 PCF expanded polyethylene, black

Tuscarora Incorporated

TOOLING DELIVERY (10) WEEKS AFTER RECEIPT OF ORDER AND APPROVED DRAWINGS.

QUOTATION SUBJECT TO CONDITIONS ON REVERSE SIDE.

By ______________________

Scott Menard, Account Manager

CUSTOMER

APPENDIX F

CASSEMCO INC. COST ESTIMATE OF PA120 PROPOSED SIDE CUSHION

CASSEMCO

P.O. BOX 1495
726 E. 15TH STREET
COOKEVILLE TN
38503-1495
1-800 844 3626
FAX 615-528-2290
BUS 615 528 6568

July 26, 1994

Mr. Carl Morrison
U.S. Army
Picatinny Arsenal
Packaging Division

Dear Mr. Morrison:

It is a pleasure to quote you the following:

Spec MIL-A-2550

Material : Cushioning Material, Polyethylene Foam, Type 1, Class Optional, Color Charcoal Unicellular Spec PPP-C-1752 D.

Part Size: 19/32" + or - .030 x 9" + or - .060 x 17" + or - .060

Price : .80 ea.

This price is based on 100,000 pieces, approximately 3 truckloads. Terms will be Net 30 days. Freight is FOB Cookeville, Tennessee 38501. The lead time needed on this project is 8 - 10 weeks. This quote will be good for 30 days from the date of this letter.

Again, I thank you for the opportunity to quote you on this project and, I invite you to contact me on any future projects that we may be helpful with.

Sincerly,

Jerry E. Samon
General Manager

APPENDIX G

TENSILE STRENGTH TEST BY MATERIALS LAB (ARDEC)

9 Dec 93 10:44:02 EST
From: Timothy Woo (AED-MATD) <twoo@PICA.ARMY.MIL>
To: morrison@PICA.ARMY.MIL
cc: twoo@PICA.ARMY.MIL
Subject: 40mm Foam Test Results
Message-ID: <9312091044.aa11977@AED.PICA.ARMY.MIL>

Carl,

I took the three remaining foam samples and cut them into tensile specimens measuring 0.75 inches wide, 4 inches in length and 0.35 inches thick (thickness was left as is from samples). The specimens were cut lengthwise along the foam samples, because it would be representative of the foam when it is bent over during the actual packaging conditions. In addition, when the foam is bent over all the tensile stress is applied lengthwise at that outside curvature area (worst case stress). The inside curvature would be under compressive stress. I also noticed that there were two different types of the foam samples (with skin and without) and made a note of it, because as you will find out later there is a big difference between the two.

The specimens were tested as you specified at -65 deg F, ambient, and +160 deg F, 95 % relative humidity. Specimens were preconditioned at those settings for five days prior to testing.

The results are as follows and are averages:

Condition	Specimen	Breaking stress
-65 deg F	molded foam w/skin	98.29 psi
	molded foam no skin	60.57 psi
Ambient	foam w/skin	124.57 psi
	foam no skin	73.91 psi
+160 deg F	foam w/skin	102.8 psi
	foam no skin	65.33 psi

As you can see the foam with a skin has an considerable increase in strength compared to the foam without a skin. This is probably due to better compaction and surface finish of the molded parts with a skin backing. There is a decrease in strength at the extreme conditions, and is to be expected. There is approximately a 17 % decrease in breaking strength at the elevated temperature and a 21 % decrease in breaking strength at the low temperature.

Conclusions drawn from this test are that proper molding conditions are extremely important as evident by the data in all the conditions tested. The difference between a molded part w/skin vs a molded part without skin has more of an impact then the extreme conditions. It is suggested that a long term creep test be conducted on the foam with inert rounds, to determine the environmental stress cracking rate from creep effects. If you have any questions, feel free to call me.

Timothy Woo
Materials Engineer

APPENDIX H

HUMAN FACTORS ASSESSMENT BY HUMAN ENGINEERING LAB (ARDEC)

Received: from cor3.pica.army.mil by AED.PICA.ARMY.MIL id aa15169;
17 May 94 11:15 EDT
Date: Tue, 17 May 94 11:15:34 EDT
From: "Lester Jee (ARL, HRED - ARDEC Field Element)" <ljee@PICA.ARMY.MIL>
To: "Carlton A. Morrison" <morrison@PICA.ARMY.MIL>
Subject: Re: PA120 Proposed Top Cushion Assembly
Message-ID: <9405171115.aa28264@COR3.PICA.ARMY.MIL>

1. The ARL, HRED ARDEC Field Element performed a hands-on human engineering evaluation of the proposed PA120 container top assembly on 12 May 94.

2. Based upon the HE evaluation, it was determined that the subject design is not subject to any limitations based upon pull force requirements, and that the cushion assembly does not exceed the HE pull force limitation of 6.8 pounds (per MIL STD 1472).

3. In addition, it was concluded that the cushion assembly can easily be removed without interfering with weapon operations.

4. Please direct any questions or comments to Mr. Lester Jee, AMSRL-HR-MG, X45618.

Lester Jee
Human Factors Engineer

DISTRIBUTION LIST

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Armament Research, Development and Engineering Center
U.S. Army Tank-automotive and Armaments Command
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AMSTA-AR-GCL
AMSTA-AR-AEP, Carl Morisson (10)
Picatinny Arsenal, NJ 07806-5000

Administrator
Defense Technical Information Center
ATTN: Accessions Division (12)
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U.S. Army Material Systems Analysis Activity
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