

END CAP INSPECTION GUIDE

30 Year Life Composite Cylinders

DOT SP-13583



***A guide for the Inspection and/or Replacement of
End Caps on SCI 30 Year Life Composite Cylinders***

TP-903.08/NC



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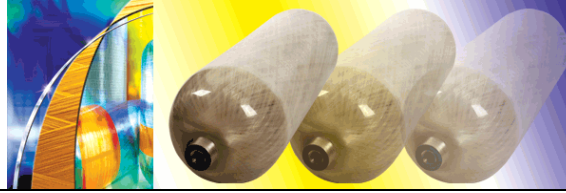
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GUIDELINES

NOTICE:

The information contained in this document was obtained from sources believed to be reliable and is based on technical information, experience, and regulations currently available from Structural Composites Industries, LLC (SCI) and other sources.

The guidelines provided herein are not intended to be comprehensive and are intended to assist suitably trained personnel in the safe operation and inspection of end caps used on some SCI composite cylinder designs. The use of these guidelines shall not create or give rise to any liability to SCI.

There may be situations, however, which may be outside the company's current experience and so are not included in this document. SCI, the national approval authority, or a government approved retest agency should be contacted for guidance if there is any doubt as to the cylinder's condition and/or integrity. If such consultation is not possible, the cylinder should be condemned.

It should be noted that these guidelines should not be used for inspecting caps on composite cylinders from any other manufacturer.

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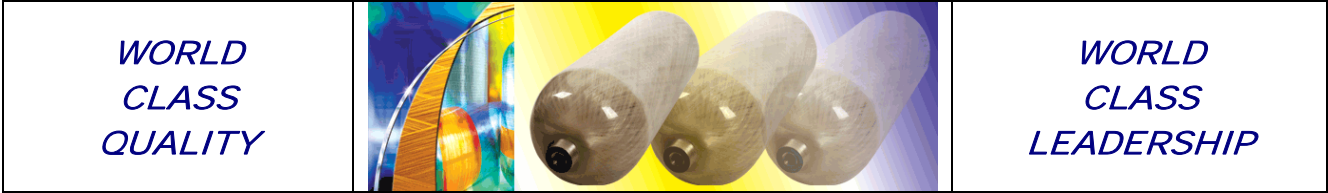


TABLE OF CONTENTS

Notice i

Table of Contents ii

Scope 1

Introduction 1

Definitions 1

Cap Inspection 1

Exterior Inspection 2

 Preparation For Inspection 2

Types of Damage 2

 Abrasion/Scuff Damage 2

 Cut/Tear Damage 3

 Impact Damage 4

 Structural Damage 4

 Heat or Fire Damage 4

Damage Level Classifications 5

 Level 1 5

 Level 2 5

Acceptance Criteria 5

 Abrasion/Scuff Damage 5

 Cut/Tear Damage 5

 Impact Damage 5

 Structural Damage 6

 Heat or Fire Damage 6

Rework or Replacement 6

 Cap Removal 6

 Preliminary Cap Fitting 7

 Cap Fitting 7

 Structural Damage 6

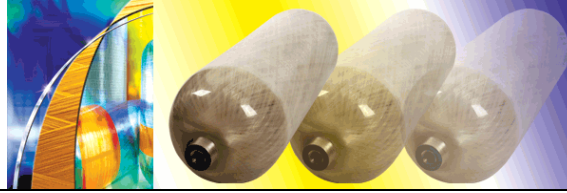
 Heat or Fire Damage 6

Materials and Equipment 8

Appendix A 9

Appendix A 11

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SCOPE

These guidelines are intended for suitably trained personnel, to assist them in carrying out the safe operation and inspection of end caps used on SCI's range of 30 Year Life composite cylinder designs manufactured to approved DOT specifications and standards.

These end caps are an integral part of the individual designs and should not be removed during normal service, or at periodic inspections.

These guidelines are specific in scope, and, no attempt will be made to reiterate all of the requirements of normal cylinder inspection which are covered in a separate publication. Instead, they highlight those items that are essential for an accurate appraisal of the end caps.

INTRODUCTION

Composite cylinders, with integral end caps, have been used commercially in Europe since the late 1990s. The addition of end caps, to composite cylinder designs, provides additional protection to the cylinder ends and so enabled the design to be optimized for weight. The caps that SCI has incorporated into their design of high pressure cylinders are primarily used for additional impact protection.

The caps, in these guidelines, are specific to SCI's 30 Year Life range of cylinders which are DOT approved and certified in the USA.

DEFINITIONS

The following definitions are applicable to the guidelines contained in this document:

Abrasion - Damage resulting from wear, friction, or intense rubbing of the end cap surface.

Cut - Damage resulting from a sharp object in contact with the end cap.

Heat/Fire Damage - Damage caused by exposure to excessive heat and/or flames from a fire.

Impact Damage - Damage caused by dropping or by a blow from another object. Impact damage may be at the surface, internal to the structure, or both.

Structural Damage - Damage caused by a severe blow or impact by another object resulting in damage to the end cap, composite, and liner.

CAP INSPECTION

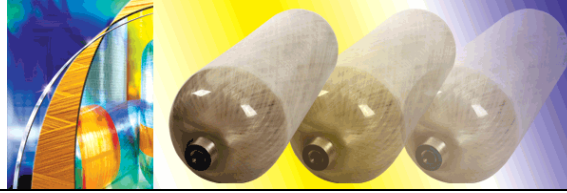
The cylinder and end caps should only be inspected by trained personnel who are knowledgeable in the care, maintenance, and safe handling of gas cylinders.

The caps need to be inspected:

- Prior to the cylinder being filled
- As part of the periodic retest procedure



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The exterior surface of the dome cap does not look or feel the same as that of the composite cylinder. The foam dome cap will protrude like a cap over the dome ends, depending on the thickness of the dome cap. It will feel slightly spongy when pressed hard with the finger. However, the visual inspection procedure for dome caps is similar, in much respect, to composite cylinders.

EXTERIOR INSPECTION

The caps have a generally 'smooth' surface and will typically remain in this condition under normal circumstances. However, they do provide protection for the cylinder and so will become dirty, scuffed, and scratched in service. This is considered normal wear and tear, and, the caps can safely remain in service.

Where the caps have been exposed to severe damage, which is detailed in the following section, there will be need for additional work to be carried out.

Preparation For Inspection

Where the caps are very dirty and require cleaning, they may be wiped clean with mild soap and water solution.

TYPES OF DAMAGE

These caps will withstand the normal wear and tear that SCBA cylinders will experience in their day to day use, but, in some extreme environments, they may become damaged at which point they may need to be replaced. The typical types of damage that will be encountered in service are:

Abrasion/Scuff Damage

This type of damage is caused by wearing, grinding or rubbing away by friction.

- Scuffs are minor abrasion damage to the dome caps. Examples are shown in Fig. 1 and Fig. 2 below.



Fig. 1
Abrasion/Scuff Damage



Fig. 2
Abrasion/Scuff Damage

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- Abrasion involves a greater loss of surface than scuffs with more raw material showing. These can be caused by sliding contact with a rough surface. Excessive rough spots and flat spots on the surface are evident of excessive loss of thickness. An example is shown in Fig. 3 below.



**Fig. 3
Abrasion Damage**

Cut/Tear Damage

This type of damage is usually caused by a sharp object, or by being caught on a projection.

- Tears are usually separations caused by excessive force by pulling or ripping. Examples of cuts and tears are shown in Fig. 4, Fig. 5, and Fig. 6 below.



**Fig. 4
Cut Damage**

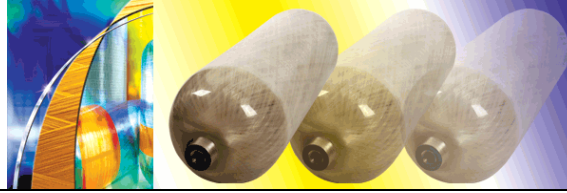


**Fig. 5
Cut Damage**



**Fig. 6
Tear Damage**

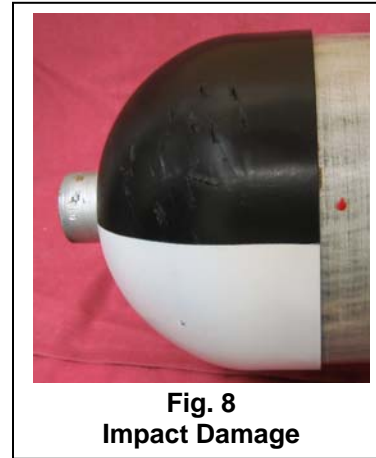
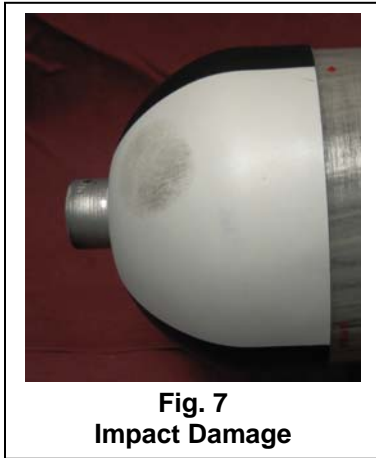
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Impact Damage

This type of damage is caused by dropping or by a blow from a blunt instrument and may appear as crazing, permanent dent, or deformation and sometimes a tear. Examples are shown in Fig. 7 and Fig. 8 below.

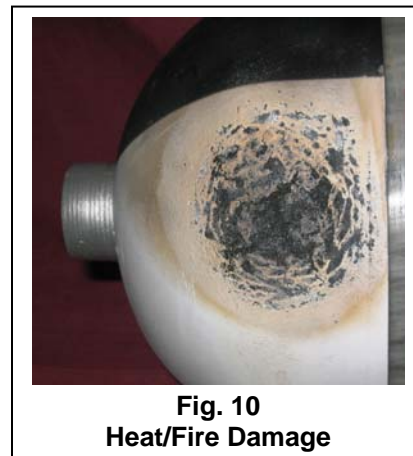


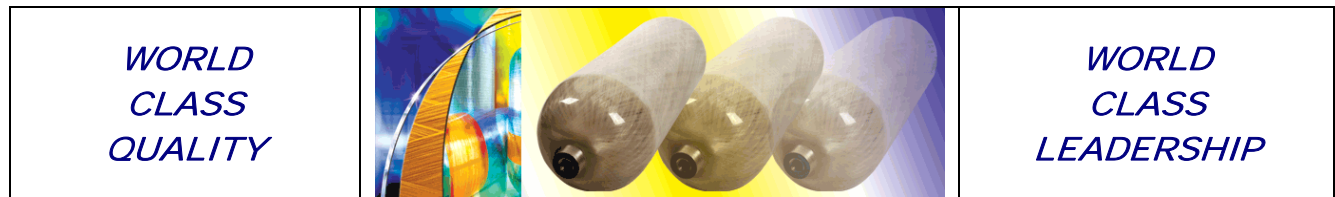
Structural Damage

This is a general inclusive term for severe damage. Such damage is extreme and may involve damage to the composite as well as the liner. If structural damage is found under the cap, or by drop light or borescope inspection, the cylinder shall be condemned.

Heat or Fire Damage

Heat or fire damage is evident by discoloration, charring, or melting of the caps. Examples are shown in Fig. 9 and Fig. 10 below.





DAMAGE LEVEL CLASSIFICATION

Damage has been classified at two levels: Acceptable (Level 1) and Unacceptable (Level 2).

Level 1 Damage (Acceptable)

Level 1 damage is minor and would be considered normal. Such damage should have no adverse effects on the safety of the cylinder and its continued use. Such items as scratches, nicks, minor cuts and discoloration are considered in this category.

Level 2 Damage (Unacceptable)

Level 2 damage is such that the dome cap has been rendered unfit for continued service and cannot be reworked. In this case, the dome cap shall be removed and the cylinder dome inspected for damage. If no damage is found, replace the cap. If damage exists, remove the cylinder from service.

ACCEPTANCE CRITERIA

Abrasion/Scuff Damage

Level 1 - Minor abrasions in the shoulder area such as scuffs less than 0.12 in (3 mm) deep are acceptable. Where painted areas are scuffed, touch up or rework is allowed. Refer back to Fig. 1 and Fig. 2 for examples of acceptable Level 1 abrasion damage.

Level 2 - Abrasions and flat spots in the shoulder area exceeding a depth of 0.12 in (3 mm) are unacceptable. Caps with this level of damage shall be replaced. Refer back to Fig. 3 for an example of unacceptable Level 2 abrasion damage.

Cut/Tear Damage

Level 1 - Cuts or scratches in the shoulder area less than 0.20 in (5 mm) deep are acceptable. The number of scratches with depths of 0.20 in (5 mm) shall not exceed 3 per quadrant, regardless of direction, with a maximum length of 1.50 in (38 mm). Refer back to Fig. 4 and Fig. 5 for examples of acceptable Level 1 cut damage.

Torn caps are acceptable provided tears are not in the shoulder area. Refer back to Fig. 6 for an example of acceptable Level 1 tear damage.

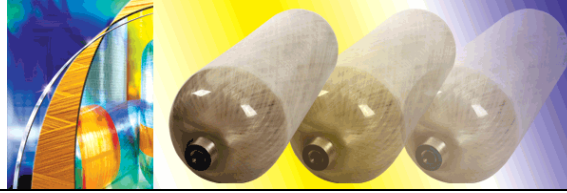
Level 2 - Cuts in the shoulder area greater than 0.20 in (5 mm) deep and with a length greater than 1.50 in (38 mm) are unacceptable and the caps must be replaced. Tears in the shoulder area are unacceptable and the caps must be replaced.

Impact Damage

Level 1 - The foam dome caps are very resistant to this type of damage and a significant impact is required to cause damage sufficient to warrant replacement. Damage which is relatively slight, from normal use, will show nothing or a very light scuff mark in the impact area and the cylinder may be returned to service. Refer back to Fig. 7 for an example of acceptable impact damage.



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Level 2 - Damage is severe if structural damage is present. Refer back to Fig. 8 for an example of unacceptable impact damage.

Structural Damage

Level 2 - Visual evidence of structural damage to dome caps would be a significant change from the original configuration. The dome cap must be replaced, but the cylinder dome must first be inspected for damage. If there is any doubt about the cylinder's integrity, then the cylinder should be retested.

Heat/Fire Damage

Level 1 - Smoke, staining, or discoloration of the dome cap is to be expected over time.

Level 2 - Caps with signs of heat or fire damage (charring, melting, or bubbling) are considered to be unacceptable and must be replaced. If the cylinder is thought to have been exposed to excessive temperatures, then it should be taken out of service. Refer back to Fig. 9 and Fig. 10 for examples of unacceptable heat/fire damage

REWORK OR REPLACEMENT

Any rework or replacement of dome caps must be conducted by suitably trained operators. Where the cylinder shoulder, under the cap, has been damaged, or there is any concern about the cylinder's integrity, the cylinder should be removed from service.

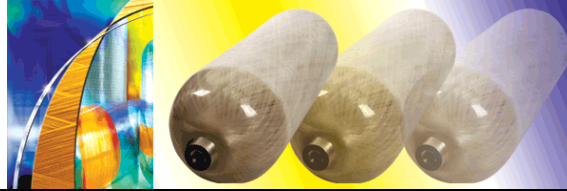
Cap Removal

- Secure the composite cylinder body using an appropriate fixture, as it very important not to damage the cylinder.
- Remove the end cap by forcibly peeling back the cap with both hands (see Fig. 11 below). A careful cut with a sharp hook razor blade may be used for ease of removal, taking care not to cut the composite.



**Fig. 11
Cap Removal**

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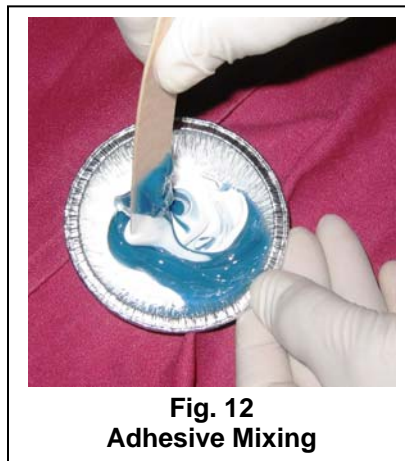
- After end cap removal, wipe dome with acetone or alcohol. Do not attempt to remove the remaining adhesive.

Preliminary Cap Fitting

- Place cylinder in an upright or vertical position.
- Take a new replacement end cap and dry fit it over the dome, making sure it is positioned straight.
- Mask along the edge of the end cap and cylinder, using 2 in (50 mm) wide masking tape.
- Remove the end cap and prepare for bonding.

Cap Fitting

- Mix a small equal amount of part A and part B adhesive (see Materials and Equipment section) in a clean container. Mix quickly and thoroughly; until the blue and white colors turn a uniform light blue color (see Fig. 12 below). The adhesive sets very quickly (approximately 5 to 6 minutes), so it is important that everything is prepared.



- Quickly apply a thin coat of the mixed adhesive to the inside surface of the new end cap (see Fig. 13 on the following page).
- Carefully and quickly hold the outside of the end cap the place over the dome (see Fig. 14 on the following page).
- Position the end cap in line with the edge of the 2 in (50 mm) masking tape.
- Press firmly with both hands.
- Remove as much trapped air pockets as possible.
- Remove masking tape and excess flash.
- Allow end cap to dry for a minimum of 2 hours before placing the cylinder back in service.

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Fig. 13
Adhesive Applied



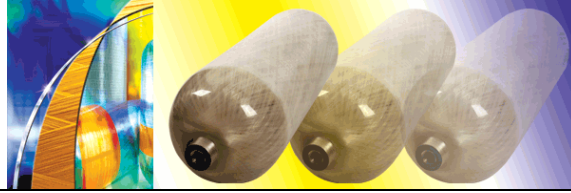
Fig. 14
End Cap Placement

Materials and Equipment

The following materials and equipment are needed in order to remove and replace the end cap of a cylinder:

- Tongue depressor, or similar, for mixing adhesive
- Hook razor blade
- 2 in (50 mm) wide masking tape
- Mixing container
- Cylinder holding fixture or strap
- Two part resin adhesive (Resin Lab, P/N: EP1167-8 Blue)

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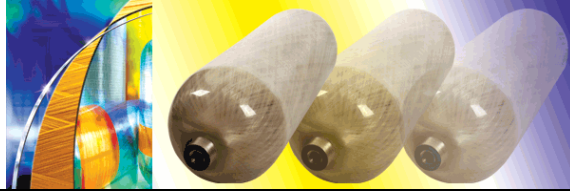


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APPENDIX A

FWD DOME END CAP DRAWING

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NOTE:

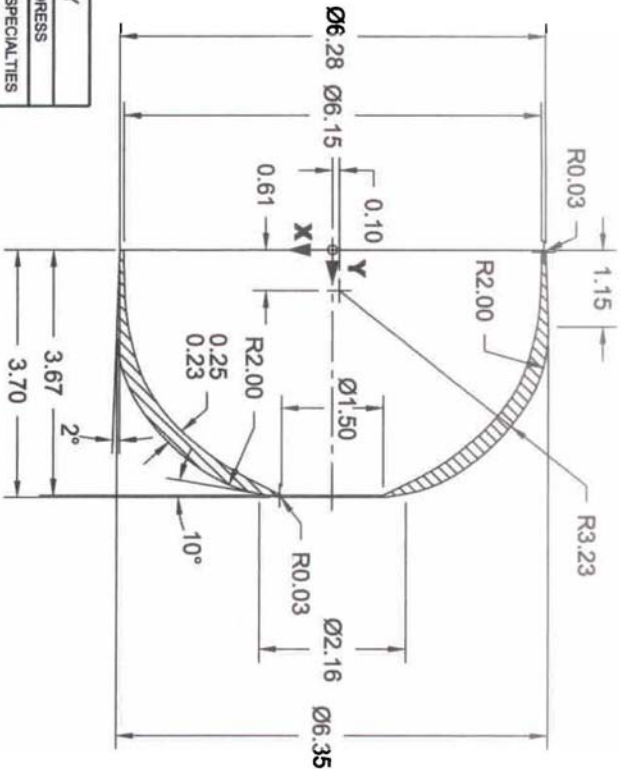
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- IDENTIFICATION OF THE APPROVED SOURCE(S) OF SUPPLY HEREON IS NOT TO BE CONSTRUED AS A GUARANTEE OF PRESENT OR CONTINUED AVAILABILITY AS A SOURCE OF SUPPLY FOR THE ITEM DESCRIBED ON THE DRAWING
- MATERIAL:
 - A. POLYURETHANE, CLOSED-CELL FOAM, WT. TBD GRMS., BLACK, FIRE RETARDANT

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| FWD DOME INSIDE CONTOUR | X | Y |
|----------------------------|-------|---|
| 3.075 | 0 | |
| 3.075 | 0.200 | |
| 3.071 | 0.550 | |
| 3.049 | 0.926 | |
| 2.989 | 1.272 | |
| 2.895 | 1.638 | |
| 2.763 | 1.998 | |
| 2.578 | 2.288 | |
| 2.360 | 2.572 | |
| 2.095 | 2.834 | |
| 1.800 | 3.070 | |
| 1.479 | 3.293 | |
| 1.152 | 3.465 | |
| 0.750 | 3.665 | |

| APPROVED SOURCE(S) OF SUPPLY | | |
|------------------------------|------------------|---|
| DASH NO. | VENDOR PART NO. | NAME AND ADDRESS |
| -1 | FMS 74001-10FR#1 | FOAM MOLDERS & SPECIALTIES 20004 STATE RD. CERRITOS, CA. 90703-6466 |

| PART NO. | QTY. | RECD. | PER ASSY. | FINAL | NEXT ASSY. | USED ON | APPLICATION |
|----------|------|-------|-----------|-------|------------|---------|-------------|
| -1 | 1 | 1 | 1 | | ALT 1088C | | |



| REVISIONS (CAD CONTROLLED) DO NOT MANUALLY REVISE | | | | |
|---|-------|-------------------|---------|-------------|
| LTR | DCN | DESCRIPTION | DATE | APPROVED |
| A | 5294A | MULTIPLE CHANGES. | 2/24/10 | [Signature] |

SOURCE CONTROL DRAWING

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| -1 | | BOOT, FWD DOME | POLYURETHANE |

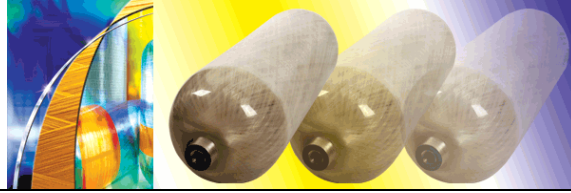
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|---------------------|----------|
| Drawn: QUONG LE | 11-15-05 |
| Check: R. ALMAGRO | 11-18-05 |
| Eng'g: E. SCHINDLER | 11-18-05 |
| Mfg: R. CAUDILL | 11-21-05 |
| QA: R.L. BECK | 11-18-05 |

| | |
|--|--|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS IN [] ARE IN INCHES TOLERANCE ON DECIMALS XXS 0.03 XXXXS 0.10 ANGULAR ±0.5° | |
| DO NOT SCALE DRAWING | |

| | |
|-------------------------|---|
| LIST OF MATERIAL | STRUCTURAL COMPOSITES INDUSTRIES |
| TITLE | BOOT, FWD DOME PROTECTION |
| CAGE CODE | 63L MIL CSBA CYLINDER |
| 58943 | SCI MODEL 1088C |
| DWG. NO. | 1274278 |
| SCALE: NONE | REL. DATE: 11-23-05 |
| | SHT 1 OF 1 |



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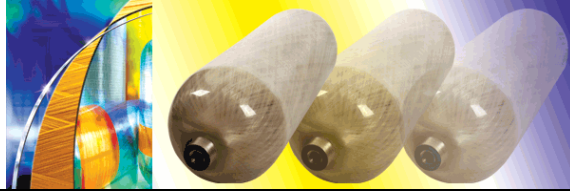


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APPENDIX B

AFT DOME END CAP DRAWING

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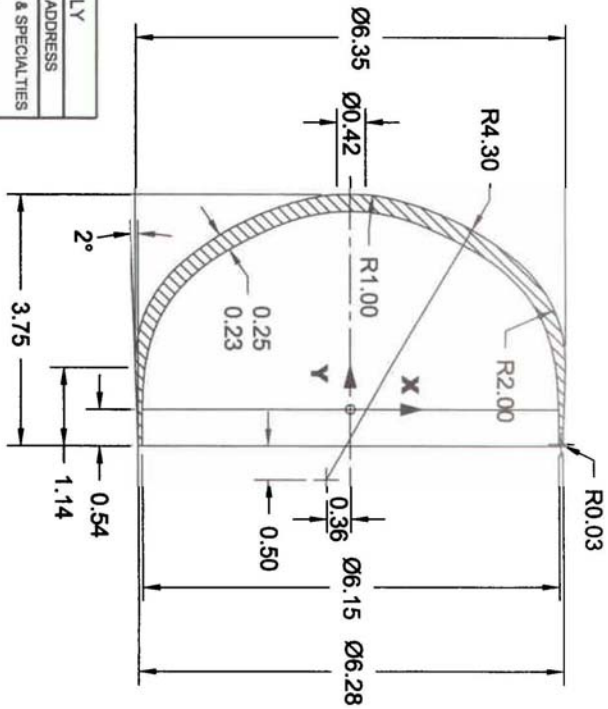
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NOTES:

1. ONLY THE ITEM DESCRIBED ON THIS DRAWING WHEN PROCURED FROM THE VENDOR(S) LISTED HEREON IS APPROVED BY STRUCTURAL COMPOSITES INDUSTRIES FOR USE IN THE APPLICATION(S) SPECIFIED HEREON. A SUBSTITUTE ITEM SHALL NOT BE USED WITHOUT PRIOR APPROVAL BY STRUCTURAL COMPOSITES INDUSTRIES.
2. IDENTIFICATION OF THE APPROVED SOURCE(S) OF SUPPLY HEREON IS NOT TO BE CONSTRUED AS A GUARANTEE OF PRESENT OR CONTINUED AVAILABILITY AS A SOURCE OF SUPPLY FOR THE ITEM DESCRIBED ON THE DRAWING
3. MATERIAL:
A. POLYURETHANE, CLOSED-CELL FOAM,
WT. TBD GRMS., BLACK, FIRE RETARDANT

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| REVISIONS (CAD CONTROLLED DO NOT MANUALLY REVISE) | | | | |
|---|------|-------------------|----------|----------|
| LTR | DCN | DESCRIPTION | DATE | APPROVED |
| A | 5294 | MULTIPLE CHANGES. | 02-06-06 | GB |



| APPROVED SOURCE(S) OF SUPPLY | | | |
|------------------------------|------------------|---|--|
| DASH NO. | VENDOR PART NO. | NAME AND ADDRESS | |
| -1 | FMS 74001-10FR#1 | FOAM MOLDERS & SPECIALTIES 20004 STATE RD. CERRITOS, CA. 90703-4456 | |

| AFT DOME INSIDE CONTOUR | |
|----------------------------|-------|
| X | Y |
| 3.075 | 0 |
| 3.066 | 0.486 |
| 2.977 | 0.962 |
| 2.798 | 1.429 |
| 2.515 | 1.826 |
| 2.141 | 2.176 |
| 1.725 | 2.435 |
| 1.305 | 2.652 |
| 0.880 | 2.829 |
| 0.580 | 2.910 |
| 0.250 | 2.965 |
| 0 | 2.965 |

| PART NO. | QTY. | RECD. | PER ASSY. | NEXT ASSY. | USED ON |
|----------|------|-------|-----------|------------|---------|
| -1 | 1 | 1 | | AL-T 1088C | |

| APPROVALS | | | LIST OF MATERIAL | | |
|-----------|------------|--------------|------------------|----------|------------------------|
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| | R. CAUDILL | R. L. BECK | | 11-21-05 | POLYURETHANE |
| | | | | 11-18-05 | MATERIAL/SPECIFICATION |

SOURCE CONTROL DRAWING

| UNLESS OTHERWISE SPECIFIED | |
|--------------------------------------|---------------------|
| DIMENSIONS ARE IN INCHES | |
| DIMENSIONS IN [] ARE IN MILLIMETERS | |
| TOLERANCE ON DECIMALS | |
| XXX 0.03 XXXX 0.10 | |
| ANGULAR | ±0.5° |
| DO NOT SCALE DRAWING | |
| GAGE CODE | DWG. NO. |
| 58943 | 1274277 |
| SCALE: NONE | REL. DATE: 11-22-05 |
| SHT 1 OF 1 | |

