



**Fermilab**

**Particle Physics Division  
Mechanical Department Engineering Note**

Number: MD-ENG- *057*

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Project Internal Reference:

Project: *CRM*

Title: *VAC. VETO ASSEMBLY PROCEDURE*

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Reviewer(s):

Key Words:

Abstract Summary:

Applicable Codes:

*CKM Vacuum Veto System  
1m ID External Vacuum Windows  
Assembly Procedure*

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12/3/03*

*Scope:*

*One meter inside diameter vacuum window assemblies will be needed at both ends of the Vacuum Veto System and will be the primary 14.7psi vessel closures. There will be a secondary vacuum window, internal and inboard from these vacuum windows to improve inboard vacuum and address material permeability but will not be addressed herein. This procedure is meant to address the external window assemblies only, which are made up of a pair of flanges named inner and outer, sandwiching a kevlar woven fabric sheet (window support material) between two layers of mylar, one being the window and the other being a Kevlar protector (softener) and will be joined together by 36- 7/8" 9 Ferry Cap Countr-Bor Screws. This document provides a detailed assembly procedure, which has been followed on previous large window assemblies and MUST be adhered to, to insure assembly integrity.*

*Drawings/Materials needed for assembly procedure (all drawings listed herein are category #3921.260, only remaining designations will be listed hereafter).*

*Primary window components, see illustration #1 and following list with all hole locations and setup instructions referenced to pick points..*

*Vacuum Test Vessel Assembly MD-415049, used as assembly table.*

*Vacuum Flange Assembly drawing MD-415039*

*1-Inner Vacuum Flange w/o-ring groove drawing MD-415030*

*1-Outer Vacuum Flange w/ compress ring groove drawing MD-41503*

*1-Aluminized Mylar Window drawing MD-415032 NOT pre fab'd, make as per this assembly from .005" thick x 60" wide Mylar rolled stock. MSDS 12407*

*1-Kevlar Window Support drawing MD-415033 NOT pre fab'd, make as per this assembly from .023"x 60" wide Kevlar rolled stock. MSDS 12406*

*1-Aluminized Mylar Ring MD-415034 NOT pre fab'd, make as per this assembly from .005" x 60" wide Mylar rolled stock. MSDS 12407*

*1-Compression Ring fabricated per procedure from, 3/16" diameter Aluminum Alloy #1100, 41.782" reference mean diameter x 131.262" long.*

*1-O-ring fabricated per procedure from, 1/4" diameter Eagle Belting Orange Chord, 40.75" reference mean diameter x 189.574" long.*

*36 7/8-9UNRC x 3" long, Ferry Cap Count-r Bor Screws.*

*36-7/8" lock washers.*

*General requirements:*

*Spreader Bar #\*\*\*\*\**

*2-Hoist rings 1/2-13UNC 2 Jergens #47313 1800 # capacity each*

*6-Aluminum spacer block supports, for beneath 0-ring flange assembly, locations as per illustration #2*

*1-Worm Drive Band and Buckles 54" approximate diameter McMaster Carr*

*1-46 1/2" inside diameter inflatable inner tube make up from bicycle tube stock.*

*1-Fabric Rack for Mylar and Kevlar*

*Hysol, 826 Epoxy Resin as required MSDS 07625*

*Hysol, 308 Epoxy Hardener as required MSDS 06160*

*5 ml squeeze bottle as required*

*Tube general purpose RTV as required*

*Duct tape as required*

*Special serrated fabric shears for cutting Kevlar*

*Tongue depressors, as required*

*1-Test Vessel Removable Aluminum Cover 42" outside diameter x 1/4" thick w/ handles*

*Oxy-Acetylene Torch setup with #1 tip*

*Naderman Electrostatic air filter fitted with flexible exhaust extension for outside venting of fumes produced from burning Mylar and Kevlar fabric*

*Pre preparation:*

*Urethane 0-ring fabrication:*

*Using groove in o-ring flange MD-415030 as a guide make 0-ring from 1/4" diameter Eagle Belting Orange Chord Stock. Fit into groove (nominal 40 3/4" mean diameter), join and check, then store in clean place for later use. As you want the o-ring to lay flat in the groove it is best to have snug diametric fit.*

*Aluminum Compression Ring:*

*Using the groove in the compression ring flange MD-415031 as a guide make compression ring from 3/16" diameter Series #1100 wire coil stock (41.782" nominal mean diameter). As this material is very soft, care must be taken not to nick or scratch its surface. Start by clamping beginning of wire in groove using tongue depressor as softener between material and c-clamp then proceed around groove clamping every 19" in same fashion until entirely clamped adding an additional 1/8" of material for welding shrinkage. Bevel ends allowing 1/8" land for alignment. After welding clean up with file and 120 grit abrasive cloth. Finally use fine scotch bright to polish entire ring before storing for later use.*

### *Initial Assembly Setup with Inner Flange:*

- 1. Use Vacuum Test Vessel MD-415049 as a table upon which the window assembly can be stacked. Position in a clean area giving consideration to crane coverage, rolled material rack, excess traffic, dirt, and near an outside wall penetration for fume exhausting purposes. Anchor to floor with clamp tabs for safety before proceeding.*
- 2. Using spreader bar #\*\*\* and two hoist rings attach Inner Vacuum Flange with o-ring groove MD-415030 positioning flange upon 3 equally spaced 2 7/8" OD x 1" thick Nylon spacer supports, oriented as per illustration #2, with the o-ring groove facing upward. Use the same 7/8" x 3' Ferry Cap Countr-Bor Screws, to secure test vessel, spacer and flange together.*
- 3. After secure clean top surface and groove with alcohol.*

### *Window Material Preparation:*

#### *1<sup>st</sup> Mylar Layer*

*Putting down the first layer of Aluminized Mylar (see reference drawing MD-415034) will require three people. Set up the rack containing the rolled materials, Mylar MSDS 12407 and Kevlar MSDS 12406 in appropriate alignment with assembly setup (see illustration #2). With the aluminized face of the Mylar facing up, use one person to throttle the roll and two others to pull the Mylar into position across face of flange extending past edge by about an inch. Cut 1" square tab on this leading edge with orientation 17.5 degrees from pick points (see illustration #2), fold over flange edge and secure to side with duct tape. Continue trimming Mylar to flange outside diameter leaving one inch tabs approximately every foot (30 degrees). Working across from each other pull Mylar taught and tape to side of flange. Continue working around flange staggering pulling locations as necessary and eliminate all sag and wrinkles in material, taping as you go until Mylar is flush with flange face all around except at tabs.*

#### *Kevlar*

- 1. Now with the first layer of Mylar in place and secure, stretch the non-inflated inner tube around the flange outside diameter as near the top of the flange as possible with the valve stems pointing outward.*
- 2. Unroll enough Kevlar in same direction as Mylar to cover the flange plus an additional 6" start and finish to overhang the flange. The Mylar beneath it will support the Kevlar fabric making it easier to work with. At this point check the fabric for cuts or pulled threads before proceeding. As the window size makes it difficult to eliminate all defects in the material, and there may be small knots that seem to be where the ends of a thread overlap in the weave these are OK, but discard the entire piece if there are obvious defects.*
- 3. Use the special shears to trim the Kevlar leaving an additional 6" all around. Be careful not to pull any threads through the fabric.*

4. *Locate the inner tube valve stems and cut a small slit through the Kevlar to allow them to protrude through. When cutting these slits avoid cutting any of the fibers that run across the diameter of the window.*
5. *Pull the fabric over the inner tube and use the 54" diameter hose clamp to secure it tightly to the flange, near the flange bottom beneath tube. Watch for snags in the fabric, paying particular attention to the area where the screws from the hose clamp tighten.*
6. *Working around the perimeter, pull any slack fabric through the hose clamp, while keeping an eye out for snags. The fabric should now be fairly flat with even tension in all directions, if good tighten clamping screws securely.*
7. *Turn the pressure regulator down to 20 psi and inflate the inner tube enough to stretch the fabric without pulling it out of the hose clamp.*
8. *Let the fabric stretch for a few minutes then deflate the inner tube.*
9. *Work around the window pulling any slack fabric through the hose clamp that might have gathered near the inner tube and re-inflate.*
10. *Repeat steps seven, eight and nine until there is less than 1/16" sag at the center of the window which can be checked by laying a straight edge across the window flange and measuring the gap between material and flange.*
11. *The inner tube shall now remain inflated keeping the Kevlar taught through the remainder of the assembly procedure until such time that the flanges are bolted together.*

## *2<sup>nd</sup> Mylar Layer*

1. *Unroll this second layer of Mylar reference MD- 415032 across the Kevlar fabric with the aluminized side facing up and inspect for creases and scratches, discarding if any flaws are recognized. If okay, continue.*
2. *Trim Mylar two inches larger than the flange outside diameter, pull taught and tape down to test vessel flange sides, keeping any tape off the surface of the window where the two flanges meet.*
3. *Locate four tapped bolt hole locations, centered on test vessel legs beneath the window materials 90 degrees apart by pressing down the Mylar/Kevlar with your finger tips then tracing outline with a felt tipped pen. These four circles will be used to time the holes in the two flanges as they mate together*

## *Preparation for burning out, bolt holes through window materials:*

1. *Once again using spreader bar #\*\*\* with two hoist rings to Outer Flange with compression ring groove MD-415031, set flange, groove down, without seal ring, upon assembled materials, aligning 42.5 degree clearance holes with marked felt tipped pen tapped hole locations prior to final touchdown.*
2. *Place aluminum cover over window assembly for protection against accidental damage.*
3. *Remove lifting fixture and clamp flanges together in four equal radial locations.*

4. *Inspect the hose clamp holding the Kevlar fabric to verify that it has not slipped from its flange location.*

*Safety Note Cautions:*

1. *Fumes produced by burning through Mylar/Kevlar contain hazardous compounds that MUST be vented to the outside of the building.*
2. *Attach the long flexible hose from the oil separator to the exhaust side of the Nederman electrostatic filter. Check to see that internal filters are clean. If hose is not long enough to exit building make up the difference with tube or pipe.*
3. *Kevlar fabric burns very bright therefore use the darkest brazing glasses available for eye protection. Previous experience indicates #5 shade works well.*

*Burning out the bolt holes:*

1. *Set up the oxy-acetylene unit with #1 torch tip. Ignite torch and adjust to a slightly oxidizing flame. Verify that aluminum protective cover is in place.*
2. *Put a piece of 1/16" aluminum sheet stock under holes to protect test vessel flange machined surfaces and also catch debris from burned holes.*
3. *Using a circular motion quickly burn out the fabric in first hole creating a clear opening through assembled materials. Repeat in four additional locations 90 degrees apart.*
4. *Before proceeding shut down torch and check alignment of holes. If holes are not properly aligned carefully bump flange to re-align. After this operation use 4-7/8 9 x 3" long ferry countr-bor screws in the burned holes to join the flanges, tightening snugly to secure position then resume burning all remaining accessible holes skipping around to prevent heat build up in any local area. C-clamps can now be removed.*
5. *Now proceed to mark holes that are blocked by the spacer blocks. Move spacer blocks to gain access to unburned holes and complete burning.*

*Final Assembly Preparation:*

1. *Using hoist rings as before raise outer flange about 1/4". Using tongue depressor, separate any Mylar that might have stuck to flange bottom. When clearly separated remove outer flange from the assembly.*
2. *Again using spreader bar and hoist rings rotate outer flange 180 degrees to allow for installation of compression ring. Clean groove and flange face*

*with alcohol and also check that pre-made ring has remained free of nicks and scratches and is clean.*

*3. Fit ring into groove and use RTV dabs about eight places on outer edge of around the ring to hold in place during final assembly (Use RTV sparingly and clean off any excess). Doing this step early, will allow time for RTV to set up before installation.*

*4. The top layer of Mylar must be separated from the Kevlar. Again using tongue depressor gently work layers apart taking care not to pull any Kevlar fibers or tear the Mylar.*

*5. Lift Mylar locally away from Kevlar and use light air pressure to blow away any debris that may have settled between layers. Keep remainder of area clean.*

*Install pre made Eagle belting 1/4" diameter Urethane o-ring*

*1. Any use of vacuum grease on o-ring, during installation is prohibited and would be detrimental to clamping requirements.*

*2. Working from beneath window materials, push o-ring into groove working around flange until fully installed.*

*3. Fold over top layer of Mylar and trace ridge formed by o-ring onto the Kevlar fabric with a felt tipped marker. This mark will act as a guide for applying the epoxy resin.*

*Final Assembly:*

*1. Prepare 200 ml of epoxy by mixing 100 ml of Hysol 826 Resin MSDS 07625 with 100 ml of Hysol 308 Hardener MSDS 01160. If resin is too thick to work with, let it sit in a warm water bath until the crystals dissolve.*

*Quickly remove from bath once crystals have dissolved, as excess heat will accelerate the reaction time. This mixture has a 24 hour cure time, allowing enough time to properly tighten bolts*

*2. Fill a 125 ml squeeze bottle with this epoxy mixture saving the remainder in mixing container to be used for later application around bolt, holes.*

*3. Fold back the top layer of Mylar without creasing to expose about one third of holes and traced o-ring path. Using squeeze bottle apply a 3/16" bead of epoxy along the ridge of the o-ring using the line as a guide. Using a tongue depressor, work the epoxy into the fabric.*

*4. Pryor testing has revealed that when Kevlar windows failed, fabric from the area in front of the holes pulled away therefore epoxy will be applied around holes also.*

- 5. For easier application of epoxy around holes use 1 1/2" tube 1/16" wall. Dip end of tube in left over epoxy, shake off excess and stamp a ring around the hole on the Kevlar fabric. As only a small amount of epoxy is required around holed this method brings uniformity to the process.*
- 6. After completing a given area fold Mylar back to its original location, align holes then repeat process until all holes have been completed.*

#### *Re-assembly:*

- 1. Check outer flange to verify that RTV at compression ring has cured, remove clamps and remove any excess dried RTV from area, also verify that mating surface is clear.*
- 2. Again using spreader bar and hoist rings rotate flange 180 degrees with compression ring now facing down, place back into its previous burning position and re-bolt using 7/8 9 x 3" long bolts and lock washers at four locations 90 degrees apart.*
- 4. Return protective cover, remove rigging and continue installing the remaining 32 bolts and lock washers finger tight.*

#### *Required bolt and torque sequence:*

- 1. Pryor testing has revealed that the torque needed to provide the maximum clamping force for the Mylar/Kevlar window was 250 ft.-lbs. It is also important to follow the sequence provided herein.*
- 2. Following the sequence numbering in figure 1 tighten all bolts down to 25 ft-lbs torque initially.*
- 3. Again following the same numbering sequence retighten all bolts down to 50 ft-lbs torque. All subsequent sequence tightening shall be done in 50 ft-lb increments until 250 ft-lb of torque is reached then once around again to double check. Let epoxy cure for 2r hours.*

#### *Installation:*

- 1. The initial layer of Mylar with the 1 inch square tabs ultimately requires that the window be cut out but should be left in place to protect the Kevlar during transit to the installation site.*
- 2. At the installation site pull the Mylar away from Kevlar with a piece of duct tape and with blunt nosed scissors carefully cut out window opening to within 1 1/2" from inside edge of flange.*

*3. Damaging the Kevlar at this juncture will mean starting over so great care must be taken in cutting.*