

RB.HV - the barrel RPC HV cable

Introduction

This document describes the materials used to build the cables which supply the HV to the barrel RPC. They are fully inside UXC55. Each cable begins from a RPC detector and goes up to one patch panel located at the base of each wheel. There are 7-10 of these cables each sector for a total of 96/wheel, so the grand total for all CMS is 480 pieces. The HV power supplies will be placed in the counting room USC55. The estimated medium length is around 20 [m].

The responsible person for technical aspects of these cables is:

Dott. Antonio Ranieri **INFN** Bari e-mail: antonio.ranieri@ba.infn.it

Cable

It's the **Novacavi** "1x(2X0.22+2X0.22) H2M1 15KV CC IEC 332-1 CERN IS23", ref. *P0825_03*. The cable is red colored and already **IS23** certified -excluding radiation resistance for sheath- by the firm. See **Appendix 1** for the data-sheets and details.

Fig. 1 shows a sketch of the routing of these cables in the central wheel. External wheels will follow the same schema except the patch panels' position (here placed in the orange zone) which will be near the feet, below the towers.

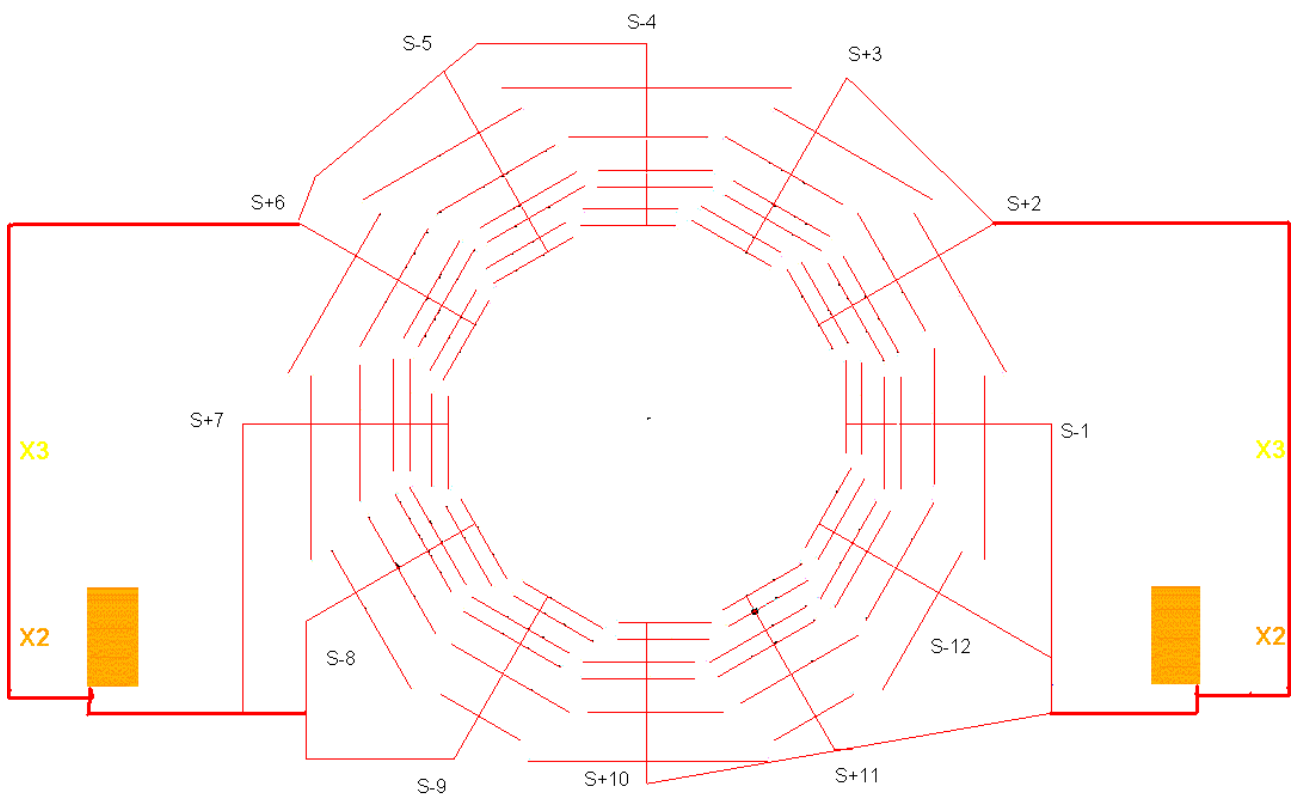


Fig. 1 Sketch of the RB.HV routing and patch panels' position estimation for the central wheel. The orange boxes show a possible position for the HV Patch Panels that will be between zone X2 and X3.

Connectors

Each cable is terminated at both ends by a female connector **CPE Italia**, cod 28.002.512-020. See **Appendix 2** for data sheet. **Fig 2** and **Fig. 3** show pictures of the connector.

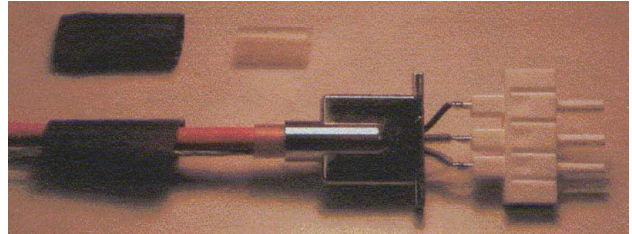
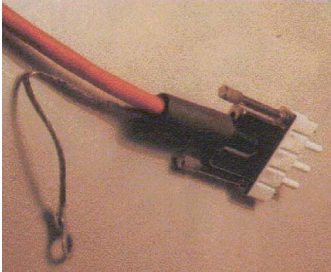


Fig. 2 The HV connector at the both sides.

Fig. 3 Exploded view. The farthest pin is connected to 2 return wires.

Summary on characteristics:

- 2 high voltage pins to supply -12 kV
- 1 pin for signal return
- insulating material
 - Polietilene HDPE (Eraclene Polimeri Europa (53%) with additive
 - Masterbatch (GP01282 Viba) (47%)
- Metal cover connected to external chamber aluminium frame
 - ZAMA (UNI 3717 G-Zn A14 Cu1)
- Operating voltage: 15 kV @ 2mA
- Testing conditions: 20 kV
- ULV0 rated

The **Appendix 2.2** shows the **TIS** Memorandum which approve the connector's materials. With this memorandum, TIS asked for further information. The answers are summarized by the e-mail and its attachment in **Appendix 2.3**. The **Appendix 2.4** shows the used resins.

Appendix 1 – Cable

1.1 Datasheet of the RB.HV cable.

11/03 17:00 NOVACAVI SPA → 0805442431

NUMB57 002

1X(2X0,22+2X0,22) H2M1 15 KV CC IEC 332-1 CERN IS23	Specification	P0825_03
	Rev.	Page 1 of 1

CONSTRUCTION DETAILS

2x0,22 15 KV DC

Conductor : nomin. sect. 0.22 mm² tinned copper 7X0,20 mm
cond. diam. 0.60

Conductor shield : conductive compound PE base
nominal diameter 1.00 mm

Insulation : Low density polyethylene, colours 1 natural, 1 natural with
white trace
nominal diameter 2.80 mm

2x0,22 signal return

Conductor : nomin. sect. 0.22 mm² tinned copper 7X0,20 mm
cond. diam. 0.60

Insulation : Low density polyethylene colour black
nominal diameter 1.80 mm

Assembly : conductors twisted in star quad
diameter over assembly 5.6 mm

Wrapping : polyester tape

Overall Shield : tinned copper braid
wire diameter 0.10 mm. cover. dens. nom. 85%

Outer sheath : Thermoplastic LSOH flame retardant compound
colour RED RAL 3000
nominal diameter 8.05 mm

Marking : "1x(2x0,22+2x0,22)H2M1 15 KV CC NOVACAVI MILANO"

ELECTRICAL AND PHYSICAL CHARACTERISTICS


Electrical resistance sect.: 0.22 < 90.900 ohm/km at 20°C
Insulation resistance > 1000 Mohm x km at 20° C
Test voltage 12 kV ac x 1 min

OTHER CHARACTERISTICS

Weight : 76 kg/km
Bending radius static : 50 mm
Working temperature range : from -30 to +80 °C

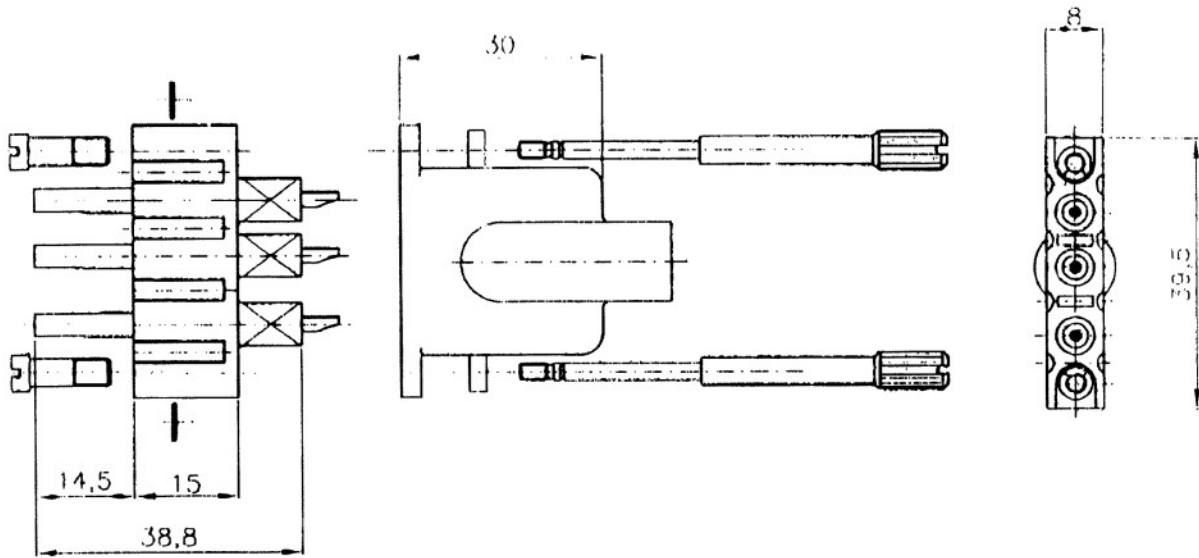
REFERENCE STANDARDS

IEC 332-1, CERN IS 23 excluding radiation resistance for sheath

 novacavi Electric cables for special purposes	Issued	Checked	Date
	F.D.	T.M.	14/11/03

Appendix 2 – Connectors

2.1.1 Datasheet of the female connector



MATERIALI E FINITURE

CORPO	PE-AD53+MB47	ULVO
CAPOTTINA	ABS METALLIZZATO	
CONTATTO	RAME BERILLIO, ISO CuBe	Ag 5μ
ALTRE PARTI METALLICHE	OTTONE, ISO Cu Zn40 Pb2	Ni 3μ

CARATTERISTICHE ELETTRICHE

TENSIONE DI LAVORO	15 kV c.c. - 2 mA
TENSIONE DI PROVA	20 kV c.c.

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 hereof, for any purposes without express written authorization by C.P.E. is
 forbidden. Any offenders are liable to pay all relevant damages.

3	MODIFICATO MATERIALE CORPO	28/01/02 FC							
2	MODIFICATO MATERIALE CORPO	24/09/01 FC							
1	EMESSO DISEGNO	27/08/01 FC							
N°	REVISIONE / REVISION	DATA	DIS.	CONT.	APPR.				
DENOMINAZIONE / DESCRIPTION		DATE	DRAWN	CHECK	APPR.				
CONNETTORE SERIE ALTA TENSIONE 3 POLI FEMMINA (A SALDARE) CON CALOTTA MAGGIORATA METALLIZZATA						DATA/DATE	28/01/02	U.M. min Form Scala/scale	A4 1:1
						N. DISEGNO DRAWING N°	28--020r03		
						CODICE / CODE	28.002.512-020		



S.p.A. MILANO

PROPRIETÀ RISERVATA "C.P.E." SENZA AUTORIZZAZIONE SCRITTA DELLA STESSA
 IL PRESENTE DISEGNO NON POTRÀ ESSERE UTILIZZATO PER LA COSTRUZIONE DEL
 L'OGGETTO RAPPRESENTATO NE VENIRE COMUNICATO A TERZI O RIPRODOTTO. LA
 SOCIETÀ PROPRIETARIA TUTELA I PROPRI DIRITTI A NORMA DI LEGGE.

INFN BARI ITALY TEL: -003980542420 01 FEB'02 10:43 N. 006 P. 09

2.1.2 Flame retardant' s datasheet of the used in the connector



Scheda Tecnica

Edizione 1 Revisione 0

Data 2001-07-23

GP FLAME RETARDANT 01282

Composizione

Il VIBATAN GP FLAME RETARDANT 01282 è una dispersione di ritardanti alla fiamma, esenti da alogeno, derivati del fosforo e dell' azoto in speciale copolimero poliolefinico.

Impiego

Il VIBATAN GP FLAME RETARDANT 01282 è una formulazione intumescente, quindi a bassa emissione di fumi e gas tossici rispetto ai tradizionali concentrati basati su composti alogenati.

Inoltre, il VIBATAN GP FLAME RETARDANT 01282 è idoneo per tutti i polimeri poliolefinici e può essere impiegato anche in PP rinforzato con fibra di vetro, ma non con i carichi minerali.

<i>Dosaggi:</i>		<i>spessori</i>
30% MB + 70% PP	V-0	a 3,2 mm
46% MB + 54% PP	V-0	a 1,6 mm
25% MB + 75% PP	V-2	a 3,2 mm e a 1,6 mm
LDPE -HDPE		
47% MB + 53% PE	V-0	a 3,2 mm
50% MB + 50% PE	V-0	a 1,6 mm
25% MB + 75% PE	V-2	a 3,2 mm e a 1,6 mm

Imballi

Il VIBATAN GP FLAME RETARDANT 01282 è fornito in sacchi da Kg 25 cadauno posti su bancali da Kg 1.000 avvolti con film estensibile.


Le informazioni contenute in questo documento si basano sulle nostre attuali conoscenze e sono state ottenute mediante controlli ed esperimenti eseguiti con la massima accuratezza. Esse non costituiscono tuttavia garanzia qualitativa assoluta.

01 FEB '02 10:42 N. 006 P.07

TEL:-0039805442470

INFN BARI ITALY

2.2 Approval of the connector's materials by TIS

	Memorandum	TIS/GS/fs_02031 3 Mar 13th, 2002
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de/from : F. Szoncsó TIS GS

à/to: J.-P. Lyonne SPL, A. Ranieri EP

Concernant le connecteur Haute Tension destiné à l'utilisation par Mr. Ranieri:

TIS/GS/ES constate que

Les matériaux utilisés sont conformes avec CERN IS23.

Concernant l'utilisation du connecteur au CERN pour la tension et le courant indiqué TIS/GS/ES ne fait pas de commentaire conclusif a cause du nombre de questions qui se posent:

- 1) Y aurait-il un 3^{eme} contact utilisé pour asservir le coupure de la source à la séparation des connecteurs et/ou autorisant la mise sous tension lors de la connexion ?
- 2) Où ce connecteur sera mis en oeuvre ?
- 3) La résistance mécanique est-elle adaptée ?
- 4) L'indice de protection est-il approprié ? Chocs, liquides...
- 5) Seront-ils installés dans des zones d'accès interdites en fonctionnement, des zones d'accès pour l'entretien ?
- 6) La mise en œuvre de la résine nécessite-t-elle une vérification de la tenue diélectrique ?
- 7) Quelle partie du connecteur est placée du côté de la source (mâle ou femelle)?
- 8) Le serrage par vis des deux connecteurs nécessite-t-il un outil (tournevis)?
- 9) Aucune référence normative n'est indiquée.

2.3 E-mail and its attachments with the answers to the TIS's questions

Date: Tue, 11 Nov 2003 10:37:05 +0100
 From: "antonio ranieri" <antonio.ranieri@ba.infn.it>
 To: "Fabio Montecassiano" <Fabio.Montecassiano@cern.ch>
 Cc: <flavio.loddo@ba.infn.it>
 Subject: Re: mancano i data-sheet dei cavi]

Caro Fabio,

ti invio in allegato un foglio con la dichiarazione della ditta costruttrice (CPE) riguardo la rigidità dielettrica, le prove di tenuta dell'alta tensione, il numero di inserzioni etc., circa il connettore di HV usato, a completamento delle richieste rimaste in sospeso del TIS, e di cui tu hai già copia. Sempre riferendomi al documento TIS, le risposte alle loro domande, sono le seguenti:

- 1) sì, c'è un terzo contatto;
- 2) il connettore maschio è sul lato camera e il connettore femmina, sul lato cavo;
- 3) trovi la risposta sull'allegato;
- 4) idem come per la 3);
- 5) sono connettori che andranno dal rivelatore ai patch panel alla base della ruota;
- 6) la resina è garantita (vedi sue specifiche che ti ho già allegato);
- 7) ho risposto prima;
- 8) no;
- 9) le trovi sull'allegato.

Tutto questo per quanto riguarda il connettore, viceversa per i cavi, spero di avere quanto prima i data-sheet dalla NOVACAVI, che ti invierò quanto prima.

Cordiali saluti.

Antonio

===== TRANSLATION =====

Date: Tue, 11 Nov 2003 10:37:05 +0100
 From: "antonio ranieri" <antonio.ranieri@ba.infn.it>
 To: "Fabio Montecassiano" <Fabio.Montecassiano@cern.ch>
 Cc: <flavio.loddo@ba.infn.it>
 Subject: Re: mancano i data-sheet dei cavi]

Dear Fabio,

I send you in attachment a sheet with the declaration of manufacturing company (CPE) about the dielectric rigidity, the high tension's tests, the number of insertions etc., concerning the used HV connector, in order to complete the suspended demands from TIS, and of which you have already copy. Concerning the TIS document, the answers to their questions, are following:

- 1) yes, there is a third contact;
- 2) the male connector is on the detector and the female on the cable;
- 3) the answer on the attached file;
- 4) the same as for 3);
- 5) they are connectors that will go from the detector to the patch panel to the base of the wheel;
- 6) the resin is guaranteed (sees its specifications which I have to you already attached);
- 7) I have answered before;
- 8) no;
- 9) they are on the attached file.

All this as far as the connector. Concerning cables, I hope to get data-sheets as soon as possible from the NOVACAVI, than I will send you.

Best regards.

Antonio

ATT. PROF. RANIERI

INFN.

Per il Sig. Gaffuri**Caratteristiche da garantire per i connettori ad alta tensione.**

- Grado di protezione: IP 44. (Prima cifra 4 = protezione da corpi estranei di spessore superiore a 1mm. Seconda cifra 4 = protezione da spruzzi d'acqua).
- Numero di manovre (inserzioni e disinserzioni senza alterazione delle caratteristiche elettriche e/o meccaniche). 10
- Infiammabilità. (comportamento delle parti componenti il connettore a contatto di una fiamma esterna). (*)
- Prove UL-94 V-O (autoestinguimento).
- Vibrazione
- Saldabilità
- Resistenza ai solventi. (*)
- Rigidità dielettrica / Tensione di prova (22,5 KV pari a 1,5 volte la tensione di lavoro come prescritto dalle norme IEC 169-1).
- Resistenza di isolamento.
- Resistenza di contatto

Nota: si fa riferimento, in generale, alle norme MIL-STD-202F

(*)- Dati desumibili dalle caratteristiche dei materiali impiegati.

G. Boschetti 4 aprile 2002

===== TRANSLATION =====

To Mr. Gaffuri

Characteristics to guarantee for the high tension connectors

- Degree of protection: IP44 (....)
- Nr. of handling (insertion and removal without alteration of the electrical and/or mechanics characteristic). 10
- Inflammability, (behavior of the component parts the connector to contact of one external flame). (*)
- Tests UL-94 V-0
- Vibration
- Weldability
- Resistance to dissolvents, (*)
- Dielectric rigidity / test's tension (22,5 KV equal to 1,5 times the work's tension like stated by IEC 169-1)
- Resistance of isolation
- Resistance of contact

Note: reference is made, in a generalized manner, to norms MEL-STD-202F

(*) - This specifications could be extracted from the characteristics of the employed materials.

G. Boschetti 4 Aprile 2002

2.4 Resins used for connectors mounting

There are two kind of resins used mounting the connectors

- 3M Scotch-Weld 2216 B/A gray Epoxy Adhesive
- SYLGARD Elastomers (see data-sheet below)

Information about Sylgard® Elastomers

FAX 02 66105156
Tel 02 6617791
SILVANA ROSA
BARILE



Silviana Rosa

DESCRIPTION

Sylgard® 170 A and B silicone elastomer is a two-component, low-viscosity silicone that cures to a flexible, flame-retardant rubber when parts A and B are properly mixed. Developed for use in general potting applications, Sylgard 170 is economical, self-extinguishing, easy to repair, serviceable over a wide temperature range, and an excellent electrical-insulating material.

Sylgard 170 A and B silicone elastomer can be cured in unlimited thicknesses without exotherm or corrosive by-products — either at room temperature or with the application of heat.

The base component is black, and the curing agent is buff. The colour difference insures thorough blending of the one-to-one recommended mixing ratio.

USES

Sylgard 170 A and B silicone elastomer is designed for general potting and encapsulating applications such as modules, relays, power supplies, amplifiers, transformers, ferrite cores and connectors.

Particular application fields are TV fly-back transformers, large lifting magnets and automobile electronic units.

FLAME RETARDANCY

Sylgard 170 A and B silicone elastomer exhibits excellent flame retardancy. The Vertical Flame Test and the Limiting Oxygen Test have been proposed to provide a basis for comparison of the innate flame retardancy of materials. Sylgard 170 typically has a Limiting Oxygen

SYLGARD® 170 A AND B SILICONE ELASTOMER

Type	Two-part silicone elastomer
Colour	Black
Physical form :	
— as supplied	Medium-low-viscosity liquid
— as cured	Flexible rubber
Cure	At room temperature or with application of heat
Special properties	Flame retardant ; easy to repair
Primary uses	Potting and encapsulating
Benefits	Low cost ; no fire hazard ; processing versatility

Index number of 43. Typical Vertical Flame Test results are :

Time in flame	Time to self-extinguish
5 seconds	0 second
10 seconds	1 second
15 seconds	3 seconds

REPAIRABILITY

Because Sylgard 170 A and B silicone elastomer cures to a flexible rubbery solid, it is easily repaired, if needed.

To repot a repaired unit, first abraid the Sylgard 170 adjacent to the repaired area. Do not cut away irregular areas adjacent to the repaired area, merely abraid them.

The more irregular the area is, the stronger the bond will be. Repot with Sylgard 170 using moderate to low cure temperatures.

REVERSION RESISTANT

Sylgard 170 A and B silicone elastomer offers long term reliability, even in thick sections in confinement. It will not revert when exposed to temperatures from —60 to 200°C.

HIGH-TEMPERATURE STABILITY

Sylgard 170 A and B silicone elastomer has excellent high-temperature stability. Electrical and physical properties after aging illustrate the material's ability to withstand long term aging at elevated temperatures.

Figures 2, 3 and 4 show the effects of heat aging on the dielectric constant, dissipation factor, and volume resistivity of Sylgard 170.

Figures 5, 6 and 7 show aging effects on durometer, tensile strength, and elongation.

HOW TO USE

Mixing

Sylgard 170 A and B silicone elastomer is supplied in two parts. It is mixed in a one-to-one ratio by weight or volume, significantly simplifying the proportioning process. The one-to-one mix ratio also permits proportioning variations of up to 20 % without significantly affecting the properties of the cured material.

Processing

- Mix equal parts of base and catalyst, by weight or volume.

PHYSICAL PROPERTIES

These values are not intended for use in preparing specifications.

As supplied

Colour (base/curing agent)	black/buff
ASTM D 445 Viscosity at 25°C, cP	4 000/1 500*
Mixing ratio, by weight	1 : 1
ASTM D 792 Specific gravity at 25°C	1.38

Catalyzed

Colour	gray-black
ASTM D 445 Viscosity at 25°C, cP after 2 min	3000*
cP after 30 min.	11 000*
Cure time*** at 150°C, minutes	3
at 100°C, minutes	8
at 70°C, minutes	15
at 25°C, hours	8

Physical properties, cured 30 minutes at 70°C

Colour	gray-black
ASTM D 676 Durometer hardness, Shore A	55
ASTM D 412 Tensile strength, kg/cm ²	35
ASTM D 412 Elongation, percent	150
Specific gravity at 25°C	1.38
Limiting oxygen index	43
Vertical flame test	pass
Volume coefficient of thermal expansion, cc/cc/°C (0-100°C)	8×10^{-4}
Mil-I-16923 Thermal shock	pass
Water absorption,** percent	0.1

Electrical properties, cured 30 minutes at 70°C

ASTM D 149 Electric strength, 3.2 mm thickness, kV/mm	18
ASTM D 150 Dielectric constant at	
100 Hz	3.15
100 kHz	3.10
ASTM D 150 Dissipation factor at	
100 Hz	0.008
100 kHz	0.002
ASTM D 150 Volume resistivity, ohm-cm	1.0×10^{15}

* Brookfield viscometer HAF, No. 2 spindle at 5 rpm.

** 7 days immersion at 25°C.

*** Base on full cure of one cubic inch.

Specification Writers : Please contact Dow Corning Europe S.A., Brussels, Belgium, before writing specifications on this product.

- Deair the mixture under vacuum (normally 29-in Hg for 2 to 5 minutes).

- Clean and degrease application surfaces using solvents. Remove all solvent before potting.

- For best adhesion, coat surfaces with Dow Corning 92-023 primer.

CAUTION : Dow Corning 92-023 primer is flammable. Avoid heat and open flame. Use only with adequate ventilation.

- Using care to minimize trapped air, apply catalyzed elastomer to component.

- Cure, according to the schedule that follows, allowing time for the material to reach temperature (the larger the mass, the longer the time).

Cure schedule

8 hr at 25°C
15 min at 70°C
8 min at 100°C
3 min at 150°C.

NOTE : In some cases, Sylgard 170 may fail to cure to optimum properties when in contact with certain plastics and/or rubbers. This inhibition occurs when these materials are inadequately cured or when they utilize large amounts of certain chemical plasticizers. Baking the package slightly above the cure temperature will normally eliminate the problem. At all times the unit should be inspected for component compatibility and proper curing.