

		Forward Module. Technical Specification of the components. Glues.	
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Forward Module Technical Specification of the Components.

2.7 Glues

This document summarise the different glues used on a end-cap module. It describes in detail the use and characteristics of the glues used to assemble the module components and also briefly mention other glues used in the production of two components, the spine and the hybrid of a module.

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Draft 1	06-6-2002	This is the first draft version of this document	1
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1. Introduction.

The Forward module has several components from different materials that have to be glued together. The main parts to be glued are: silicon microstrip detectors, TPG-AlN spine, glass fan-ins and hybrid.

Two types of epoxy adhesives are used; the basic requirements are:

- Curing at room temperature
- Radiation hardness and long term stability
- Acceptable leakage currents after gluing of the detectors at operation temperature.
- High thermal conductivity

A non electrical conductive epoxy is used to give the mechanical strength to the module and also to transfer heat from the sensors to the baseboard and hence the cooling block. This power dissipation is needed to avoid thermal runaway and to prevent the increasing of the leakage current on glued detectors which generate extra noise. Glue is recommended to be spread over more than 50% of the spine to detector contact area.

Also an electrically conductive epoxy is needed to connect the bias line of the hybrid to the detector backplane. Metal traces are placed on the spine wings, connecting the high voltage to the sensors through the conductive glue.

They have to be radiation tolerant and the module must not show any sign of damage to its mechanical and thermal properties after a radiation dose of $2 \cdot 10^{14}$ 1MeV neutrons/cm² after 10 years operation.[1]

The non electrical epoxy is applied on the spine of the module and also on the backside of the fan-ins with a glue dispensing robot following a defined line or dots pattern. This glue pattern is not the same on every laboratory. The electrical one is applied manually on selected points.

2.- Module assembly glues

2.1. Thermally conductive epoxy.

The thermally conductive epoxy is a two-component (AW 106/HV 953U), room temperature curing, known as Araldite 2011, supplied by Ciba-Geigy.

The mixture makes an adhesive of high strength and toughness with a thermal conductivity value of 0.22 W/m/°K at 23°C according to the vendor.

Mixture has to be done at a ratio (Resin:Hardener) of 1.25:1 parts by weight or 1:1 parts by volume; both components have to be blended until they form a homogeneous mix. Once blended it has a pot life of about 100 minutes.

This thermally conductive epoxy is used in the interfaces of :

1. Sensors and composite spine.
2. Fan-ins to kapton hybrid and also to composite spine.
3. Washers.

The Performance Polymers data from Ciba-Geigy is provided in appendix 3.1

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2.2. Electrically conductive epoxy.

Electrically conducting glue, TRA-DUCT 2902, has been chosen. It is a two part, silver-filled epoxy compound with good mechanical and electrical properties that cures at room temperature although it takes 24 hours.

It comes in a BIPAX mixing-dispenser package, where components are mixed until colour is uniform throughout. It has a pot life of 60 minutes and a thermal conductivity of 2.99 W/m/°K. This electrically conductive epoxy is used in the interfaces of :

1. Sensors to metal traces in the spine.
2. Hybrid tab to metal trace in the spine.

The technical data sheet from manufacturer is provided in the appendix 3.2.

2.3. Glues for subassembly components

Some components of the module are subassembled. To achieve the required performance of the component several materials with specific properties have to be combined.

These part materials are produced, cut to the right shape and then glued each other. After gluing a performance test is done.

The spine and the electronics hybrid are subassembled prior to be used in module assembly; following its a brief description of the glues used. Detailed information is provided in part documents.

2.3.1. Spine Glue

Three different materials are glued together to produce the spine [2]. Two of them, the central strip of TPG material (Thermal Pyrolytic Graphite) and some ceramic wings of AlN, have high thermal conductivity coefficient, therefore a glue with also high value of thermal conductivity was chosen.

After some tests [3], Elastosil 137-182 was selected for gluing the TPG to the ceramic wings; it has a thermal conductivity of 1.79 W/mK and good mechanical properties even after irradiation.

The third component is the spacer, an Al₂O₃ ceramic part with low thermal conductivity glued with plain Araldite 2011. It creates a heat barrier between hybrid and silicon detectors.

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2.3.2. Hybrid glues

There are three different type of glues used in the hybrid of an end cap module [4]:

- 1) An acrylic glue foil, used to glue the multilayer flex circuit onto the carbon-carbon substrate.
- 2) A Boron Nitride filled epoxy glue film of 75µm thickness used to attach the thermal plugs underneath the chips to the substrate, ensuring a good thermal contact from them to the substrate.
- 3) A conductive epoxy adhesive Eotite P-102 for gluing the ASICs onto the hybrid. That's a two component resin adhesive with fine grained silver cured under a low temperature.

3. Appendix.

3.1 Performance Polymers and Safety Data Sheet, by Ciba Specialty Chemicals.

3.2 Technical Product Data, by Tra-Con.

References

- [1] S. Snow, SCT Forward Modules: Thermal and mechanical specifications and expected performance, ATL-IS-EN-0007.
- [2] H.-G. Moser, SCT End-cap module components: Spines, SCT-IS-EN-0009
- [3] A.Kholodenko, H.-G. Moser, V. Riadovikov, The thermal and mechanical properties of glues for the ATLAS SCT modules assembly, ATL-INDET-2000-007.
- [4] L.Feld, The electronics hybrid for the ATLAS SCT Endcap detector modules, ATL-IS-EN-0009

Araldite® 2011 (AW 106/HV 953U)

Two component epoxy paste adhesive

Key properties

- High shear and peel strength
- Tough and resilient
- Good resistance to dynamic loading
- Bonds a wide variety of materials in common use

Description

Araldite 2011 is a multipurpose, two component, room temperature curing, paste adhesive of high strength and toughness.

It is suitable for bonding a wide variety of metals, ceramics, glass, rubber, rigid plastics and most other materials in common use. It is a versatile adhesive for the craftsman as well as most industrial applications.

Product data

	2011/A	2011/B	2011 (mixed)
Colour (visual)	neutral	pale yellow	pale yellow
Specific gravity	ca. 1.15	ca. 0.95	ca. 1.05
Viscosity (Pas)	30-50	20-35	30-45
Pot Life (100 gm at 25°C)	-	-	100 minutes
Shelf life (2-40°C)	3 years	3 years	-

Processing

Pretreatment

The strength and durability of a bonded joint are dependant on proper treatment of the surfaces to be bonded. At the very least, joint surfaces should be cleaned with a good degreasing agent such as acetone, trichloroethylene or proprietary degreasing agent in order to remove all traces of oil, grease and dirt. Alcohol, gasoline (petrol) or paint thinners should never be used.

The strongest and most durable joints are obtained by either mechanically abrading or chemically etching ("pickling") the degreased surfaces. Abrading should be followed by a second degreasing treatment

Mix ratio	Parts by weight	Parts by volume
Araldite 2011/A	100	100
Araldite 2011/B	80	100

Resin and hardener should be blended until they form a homogeneous mix.

Resin and hardener are also available in cartridges incorporating mixers and can be applied as ready-to-use adhesive with the aid of the tool recommended by Ciba.

Application of adhesive

The resin/hardener mix is applied with a spatula, to the pretreated and dry joint surfaces.

A layer of adhesive 0.05 to 0.10 mm thick will normally impart the greatest lap shear strength to the joint.

The joint components should be assembled and clamped as soon as the adhesive has been applied. An even contact pressure throughout the joint area will ensure optimum cure.

Mechanical processing

Specialist firms have developed metering, mixing and spreading equipment that enables the bulk processing of adhesive.

Ciba Specialty Chemicals will be pleased to advise customers on the choice of equipment for their particular needs.

Equipment maintenance

All tools should be cleaned with hot water and soap before adhesives residues have had time to cure. The removal of cured residues is a difficult and time-consuming operation.

If solvents such as acetone are used for cleaning, operatives should take the appropriate precautions and, in addition, avoid skin and eye contact.

Times to minimum shear strength

Temperature	°C	10	15	23	40	60	100
Cure time to reach	hours	24	12	7	2	-	-
LSS > 1N/mm ²	minutes	-	-	-	-	30	6
Cure time to reach	hours	36	18	10	3	-	-
LSS > 10N/mm ²	minutes	-	-	-	-	45	7

LSS = Lap shear strength.

Typical cured properties

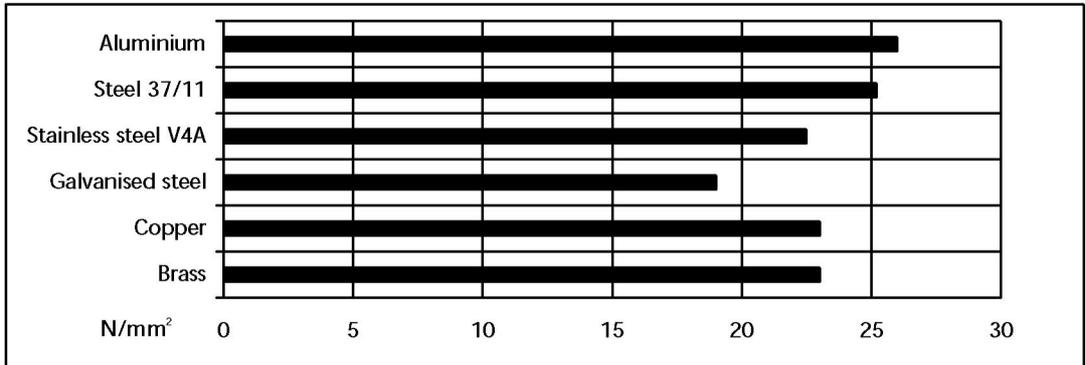
Unless otherwise stated, the figures given below were all determined by testing standard specimens made by lap-jointing 170 x 25 x 1.5 mm strips of aluminium alloy. The joint area was 12.5 x 25 mm in each case.

The figures were determined with typical production batches using standard testing methods. They are provided solely as technical information and do not constitute a product specification.

Average lap shear strengths of typical metal-to-metal joints (ISO 4587)

Cured for 16 hours at 40 °C and tested at 23°C

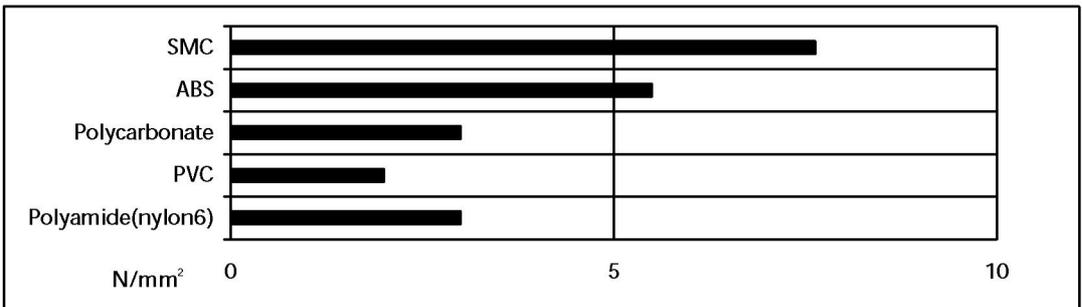
Pretreatment - Sand blasting



Average lap shear strengths of typical plastic-to-plastic joints (ISO 4587)

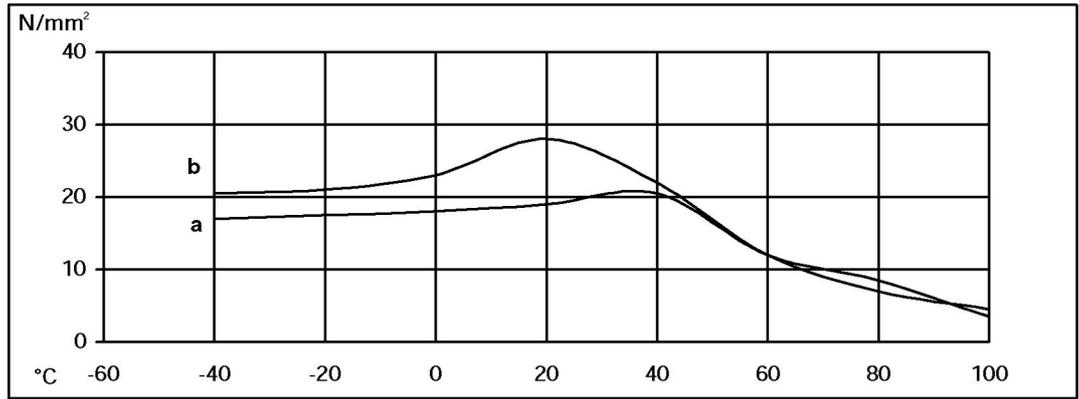
Cured for 16 hours at 23°C and tested at 23°C

Pretreatment - Lightly abrade and alcohol degrease.



Lap shear strength versus temperature (ISO 4587) (typical average values)

Cure: (a) = 7 days /23°C; (b) = 24 hours/23°C + 30 minutes/80°C



Roller peel test (ISO 4578) Cured 16 hours/40°C 5 N/mm

Glass transition temperature Cure: 16 hours at 40°C ca. 45°C

Electrolytic corrosion (DIN 53489) (cure 16hrs at 40°C or 20 mins at 100°C)

Test: 4 days in a conditioning chamber in 40/92 climate as specified by DIN 50015

Rating according to specified standard A -A/B 1,2

Minimum dielectric strength at 50 Hz, 24°C (VSM 77170)

Mix ratio Instantaneous value 1-minute value

100:80 pbw 25-27 kV/mm 22-24 kV/mm

Water vapour permeability (NF 41001) (38°C, 90% rh) Cure: 5 days/23°C

Test on a 1mm thick film 16g/m²/24 hours

Water absorption (ISO 62-80)

24 hours at 23°C 0.8%

30 mins at 100°C 1.3%

Thermal conductivity (ISO 8894/90) Cure: 20 minutes/100°C

Test: At 23°C 0.22W/mK

Shear modulus (DIN 53445) Cure: 16 hours/40°C

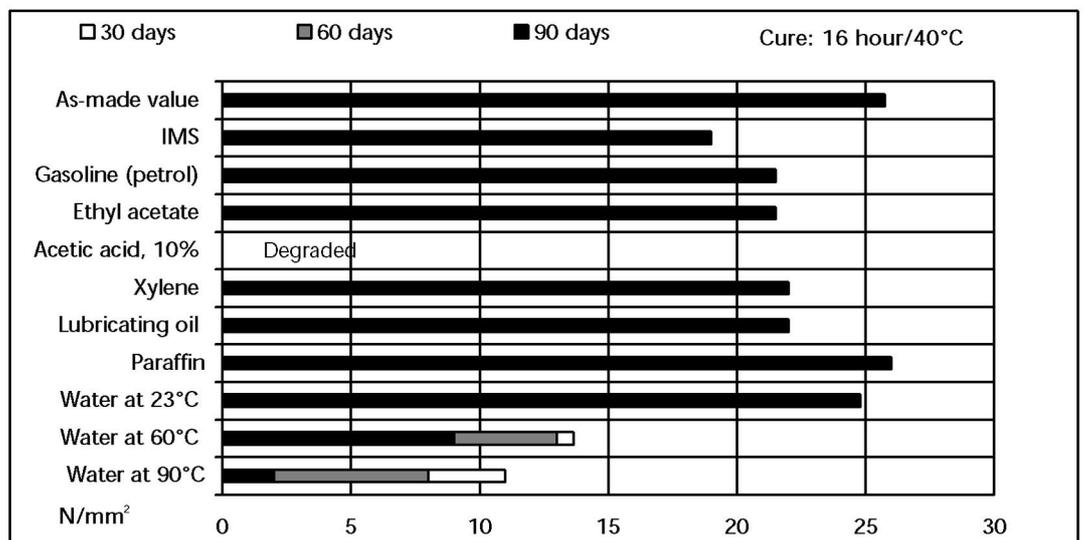
-50°C - 1.5GPa

0°C - 1.2GPa

50°C - 0.2GPa

100°C - 7MPa

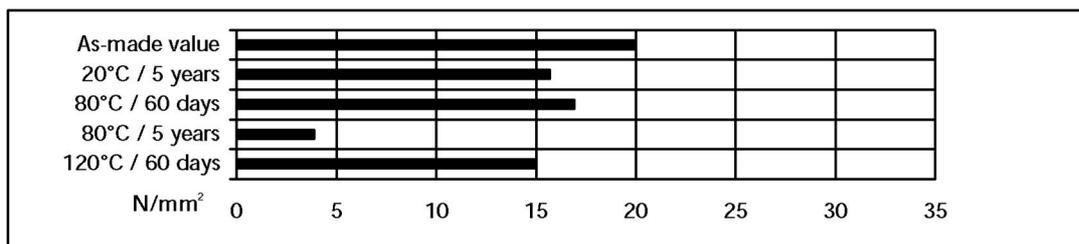
Lap shear strength versus immersion in various media at 23°C. (typical average values)



Lap shear strength versus heat ageing

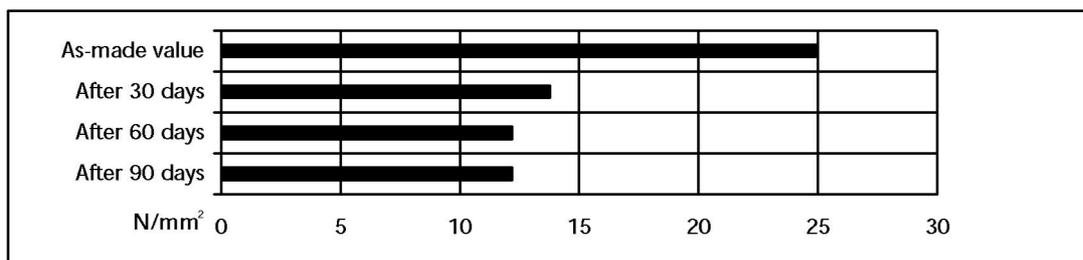
Cure: 16 hours/40°C

Test: at 23°C, 50% rh



Lap shear strength versus tropical weathering (40/92, DIN 50015; typical average values)

Cure: 16 hours/40°C Lap shear strength was determined after immersion for 90 days at 23°C in media shown.



Fatigue test on simple lap joints (DIN 53285)

Cure: 20 minutes/100°C Mean static lap shear strength: 16.3N/mm²

Fluctuating load as % of static shear strength

No. of load cycles to joint failure

30	10 ⁵ - 10 ⁶
20	10 ⁶ - 10 ⁷
15	> 10 ⁷

Storage

Araldite 2011/A and Araldite 2011/B may be stored for up to 3 years at room temperature provided the components are stored in sealed containers. The expiry date is indicated on the label.

Handling precautions

Caution

Ciba Specialty Chemicals' products are generally quite harmless to handle provided that certain precautions normally taken when handling chemicals are observed. The uncured materials must not, for instance, be allowed to come into contact with foodstuffs or food utensils, and measures should be taken to prevent the uncured materials from coming in contact with the skin, since people with particularly sensitive skin may be affected. The wearing of impervious rubber or plastic gloves will normally be necessary; likewise the use of eye protection. The skin should be thoroughly cleansed at the end of each working period by washing with soap and warm water. The use of solvents is to be avoided. Disposable paper - not cloth towels - should be used to dry the skin. Adequate ventilation of the working area is recommended. These precautions are described in greater detail in Ciba Specialty Chemicals publication No. 24264/3/e Hygienic precautions for handling plastics products of Ciba Specialty Chemicals and in the Ciba Specialty Chemicals Material Safety Data sheets for the individual products. These publications are available on request and should be referred to for fuller information.

Ciba Specialty Chemicals
Performance Polymers

All recommendations for the use of our products, whether given by us in writing, verbally, or to be implied from the results of tests carried out by us, are based on the current state of our knowledge. Notwithstanding any such recommendations the Buyer shall remain responsible for satisfying himself that the products as supplied by us are suitable for his intended process or purpose. Since we cannot control the application, use or processing of the products, we cannot accept responsibility therefor. The Buyer shall ensure that the intended use of the products will not infringe any third party's intellectual property rights. We warrant that our products are free from defects in accordance with and subject to our general conditions of supply.

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TRA-DUCT 2902 ROOM TEMPERATURE CONDUCTIVE SILVER EPOXY ADHESIVE

TRA-DUCT 2902 is an electrically conducting silver-filled epoxy compound recommended for electronic bonding and sealing applications that require a combination of good mechanical and electrical properties. This two-part, smooth paste formulation of refined pure silver and epoxy is free of solvents and copper or carbon additives. It develops strong, durable, electrically and thermally conducting bonds and coatings between many different and dissimilar materials such as metals, ceramics, glass and plastic laminates. TRA-DUCT 2902 cures at room temperature and can be used as a cold solder for heat-sensitive components where hot-soldering is impractical. It also can be used for the assembly and repair of electrical modules, printed circuits, wave guides, flat cables and high frequency shields. This adhesive complies with the requirements of NASA's Outgassing Specification.

PROPERTY		TYPICAL VALUES
Color		Silver
Specific gravity, mixed		2.450
Viscosity, cps, mixed	cp# 52 @ 10 rpm	20,000
Operating temperature range, °C		-60 to 110
Hardness, Shore D		80
Mix ratio, parts by weight, Resin/Hardener		100/6
Thermal conductivity, W/M/°K		2.99E+00
Lap shear, alum to alum, psi	1 hour @ 110°C	1,600
	15 minutes @ 150°C	1,600
	2 hours @ 65°C	1,000
	24 hours @ 25°C	700
Glass transition (Tg), °C, ultimate	24 hours @ 25°C	52.00
Coefficient of expansion, cm/cm/°C		4.90E-05
Volume resistivity, ohm-cm @ 25°C	1 hour @ 110°C	6.00E-04
	15 min @ 150°C	5.00E-04
	2 hours @ 65°C	9.00E-04
	24 hours @ 25°C	1.00E-03
	5 min @ 160°C	3.00E-04
Outgassing, NASA		Passes
Outgassing, NASA, %CVCM		0.050
Cytotoxicity study	ISO (10993-5) elution method	Passes

POT LIFE 60 minutes

CURE SCHEDULE
24 hours @ 25°C or
1 to 4 hours @ 65°C

APPLICATION DIRECTIONS

- (1) Carefully clean and dry all surfaces to be bonded.
- (2) Remove clamp and thoroughly mix the TRA-BOND 2902 epoxy adhesive system components in the handy BIPAX mixing-dispenser package until color is uniform throughout.
- (3) Apply this completely mixed adhesive to the prepared surfaces, and gently press these surfaces together. Contact pressure is adequate for strong, reliable bonds -- however maintain contact until adhesive is completely cured.

AVAILABILITY

Please contact TRA-CON's technical service department at 800-TRA-CON1 for packaging options for this material that will best suit your process.

EXPIRATION DATE

TRA-CON resin products are marked with an expiration date at the time of manufacture which is similar to the the dating system used for most perishable materials such as foodstuffs, photographic films, pharmaceuticals and most reactive products. This date is marked "Use Before" which indicates that the product will yield its best properties when mixed and cured before the date shown. The expiration date should be monitored to ensure that inventory levels are replenished in adequate time to avoid unnecessary interruptions in the manufacturing process.

STORAGE AND HANDLING CONDITIONS

The expiration date is based upon dry storage conditions at or below 80°F (27°C) in the original, sealed and unopened containers for BIPAX, TRA-PAX and bulk packaged materials. The expiration date for pre-mixed and frozen materials is based upon dry storage conditions at or below the temperature indicated on each package. Contents may separate during storage. Resin or hardener in bulk containers (e.g. quarts, gallons) should be thoroughly mixed prior to combining them to obtain all the benefits of the properties designed into the formulation.

Contents may settle either during storage or during the curing cycle, therefore complete mixing of the individual resin and hardener components prior to combining them is recommended to obtain all the benefits of the properties designed in the formulation

Some ingredients in this formulation provided in BIPAX, TRA-PAX and bulk packaging may crystallize when subjected to low temperature storage. Merely returning the product back to room temperature will not always redissolve the crystals and a gentle warming cycle of 125°F for 30 minutes prior to mixing the resin and hardener components may be necessary to return the product to its best condition. Crystallized epoxy components do not react as well as liquid components and should be redissolved prior to use for best results.

WARNING: THIS MATERIAL IS SOLD FOR INDUSTRIAL USE ONLY

Uncured epoxy adhesives - consisting of resin and hardener components - may cause dermatitis, skin sensitization or other allergic responses. Prevent all contact with skin and eyes. If contact occurs, flush immediately with plenty of water (get prompt medical attention for eyes). Keep away from heat and open flame. KEEP OUT OF REACH OF CHILDREN. Immediately clean up any spills that may occur.

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