

# Raychem



## Raysulate

Insulation Enhancement System

## Raychem Raysulate Insulation Enhancement System

Raychem RPG develops, manufactures and markets products and systems for the electrical power industry. Our products are extensively employed by power utilities and equipment manufacturers, in rail transport systems and in industry around the world.

Raychem RPG produces high voltage insulating products, cable accessories and protection systems for electrical supply companies and utilities, original equipment manufacturers and major industrial companies.

Safety and reliability of high voltage equipment is vital and Raychem RPG is committed to improving performance for our customers at all levels. Our development teams work to create a superior range of high performance products and technologies for high voltage applications.

Raysulate - Raychem's insulation enhancement range of products have unmatched field performance within the industry.

Raysulate products come in the form of Heat Shrink Tubes, Tapes, Sheets and pre-formed shapes to enhance insulation of live points of any shape and voltage grade.

All the products are made of special formulations for Electrical use and are UV stable & weather resistant.

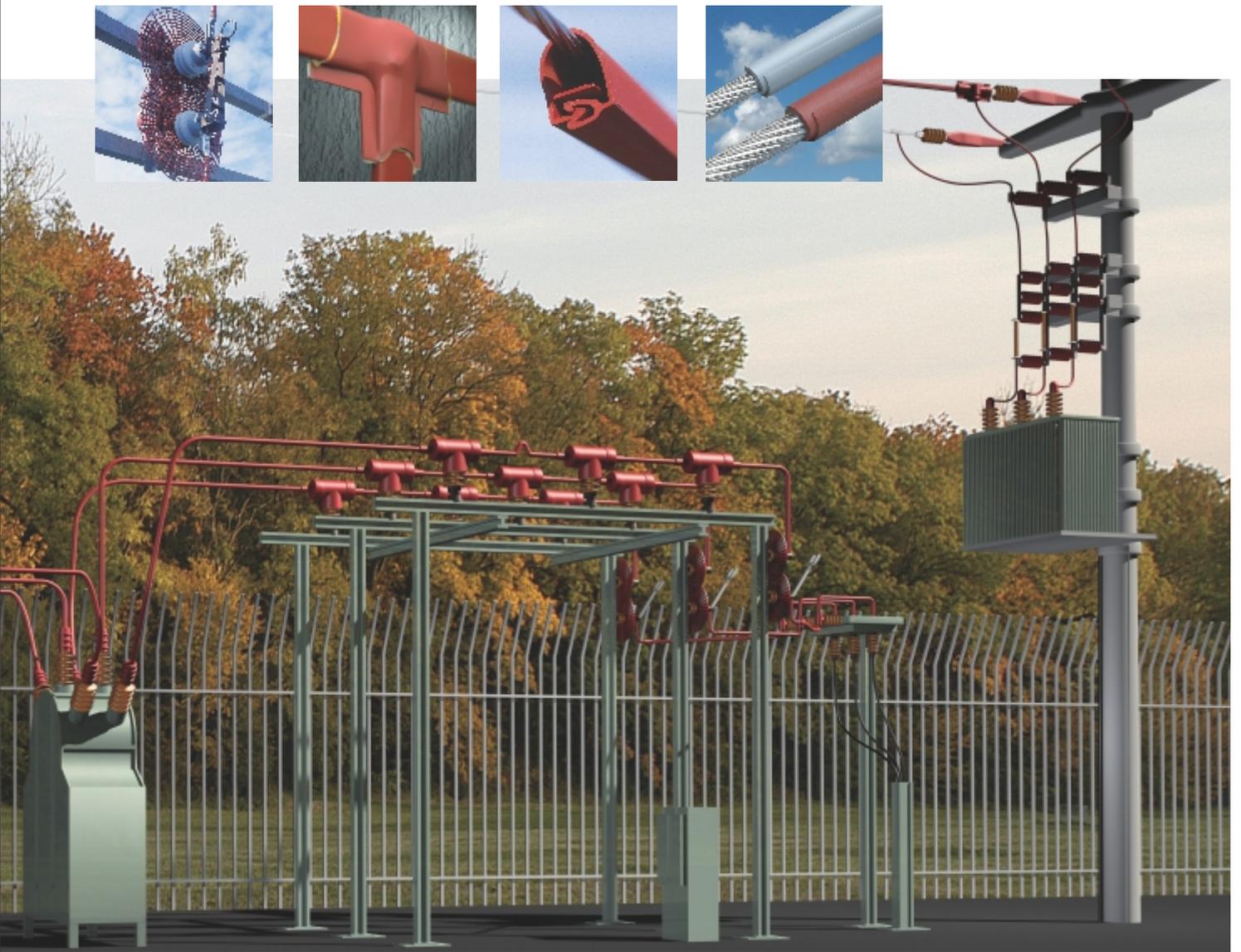


### The Raychem Raysulate Insulation Enhancement System

Network reliability is a priority for electrical utilities. Supply interruptions add to maintenance costs and affect customer service. Substation faults are particularly expensive: equipment is often damaged and difficult to repair or replace; specialized post-fault maintenance may be required, and significant customer "supply" lost. For over 30 years Raysulate products have been protecting substations and overhead distribution/transmission networks around the world by insulating vulnerable bare metalwork.

### Protection from bird and animal outages

Birds and animals often enter substations and interfere with overhead lines causing faults by bridging air clearances. Outages occur especially on distribution equipment, where conductor spacings allow relatively small birds and animals to bridge phases. The Raychem Raysulate system of tubes, tapes, sheets, preformed covers and barriers provide a proven, cost-effective and easy-to-install retrofit solution to bird and animal outages.



### The complete retrofit system

Distribution equipment with bare busbars, conductors and connections is always vulnerable to having phases or phase to ground accidentally bridged. As well as the obvious problems caused to the network, such events can also endanger protected wildlife. The best solution is one where the vulnerable bare metalwork is insulated and the wildlife can roam the substations and overhead lines (OHL) without damaging themselves or the equipment.

The Raychem Raysulate Insulation Enhancement System includes product solutions for substations, overhead lines, and distribution and transmission applications. All products in the Insulation Enhancement System use the same crosslinking polymer technology that has given Raychem electrical products high performance and reliability for over 35 years.

## Substations



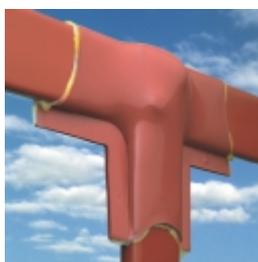
### Raychem Medium Voltage Conductor Cover “MVCC”

Raychem MVCC is a flexible cold applied wrap around insulation cover for use in short lengths on curved conductor or jumper leads. Secured with UV-stabilized cable ties it helps outage prevention caused by birds, animals and debris. Suitable for applications up to 25kV.



### Raychem High Voltage Busbar Tape “HVBT”

Raychem HVBT heat-shrinkable tape is ideal for use on complex shapes and where busbars cannot be disconnected. Raychem HVBT tape shrinks 30% longitudinally while a factory-coated hot melt adhesive flows and seals the layers of tape during installation. As with other components in the system, the adhesive does not bond to metalwork, allowing easy removal for inspection and maintenance. Available in three widths: 25mm, 50mm and 100mm.



### Raychem High Voltage Insulating Sheet “HVIS”

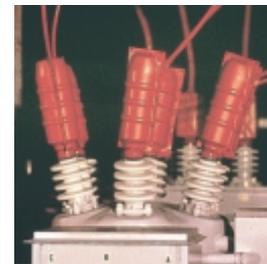
Raychem HVIS heat-shrinkable sheet shrinks 25% in both directions enabling rapid and reliable insulation of T-joints, L-joints and difficult shapes. The sheet is a two-layer laminate with a heat shrinkable backing and a hot melt adhesive. Raychem HVIS sheet is cut to size from a roll, held in place around the connection with metal clamps and shrunk with a gas torch until the adhesive flows, sealing the interfaces. Environmentally sealed joints can be made using Raychem sealing mastic.

## Substations



### Raychem Bus Connection Insulating Covers "BCIC"

A wide range of standard Raychem BCIC preformed covers is available for any substation equipment connections. Customised covers can be made simply and economically by forming one of the Raychem Raysulate materials. Standard covers can also be easily modified. Installation is easy with no need to disconnect busbars. Raychem BCIC covers are held in place with UV-stabilized plastic nuts and bolts, latches or cable ties, and be easily removed for maintenance. Suitable for applications up to 36kV.



Substation equipment is vulnerable to flashovers caused by accidental bridging of phases, or phase to earth. Usually made by birds, animals, vegetation or airborne debris, flashovers can be very expensive in terms of damage to equipment, reduced reliability and in some cases even electrocution of protected species. Almost any event of this nature can be prevented by insulating the strategically vulnerable bare metalwork with a combination of Raychem Raysulate products.



### Raychem Bus Insulator Squirrel Guard "BISG"

The Raychem BISG squirrel guard is a rigid polymeric disc that fits between the sheds of post insulators and equipment bushings. It acts as a physical barrier preventing animals, such as squirrels and possums, from bridging the phase-to-ground clearance. The animal must climb over the Raychem BISG, therefore, preventing it from touching live conductors and earth planes at the same time. Installation is quick and simple, with no need to disconnect busbars, and can even be done live. The part is sized for core diameters from 60mm to 115mm and is suitable for applications up to 36kV.

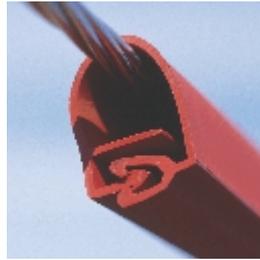
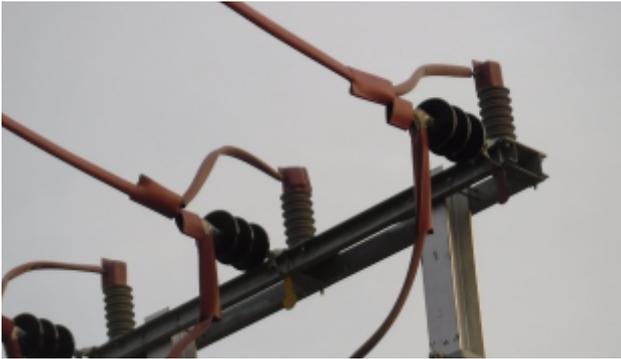


## Overhead Lines



### Raychem Bird Protection Caps "BCIC"

The Raychem BCIC bird cap protects birds and other animals from live conductors on insulator crossarms. The flexible polymer means that most configurations of conductor attachment are easily accommodated. Installation is very simple, and tool free, some versions can be installed on an energized line. Suitable for applications up to 36kV.



### Raychem Medium Voltage Line Cover "MVL"

Raychem MVLC is a cold applied retrofit cover that insulates OHL against flashovers caused by birds, intermittent tree contact and clashing conductors. Installation is made from one position, even with an energized line, by driving it along the conductor by hand for up to 20 meters, or by an automated tool for longer distances.

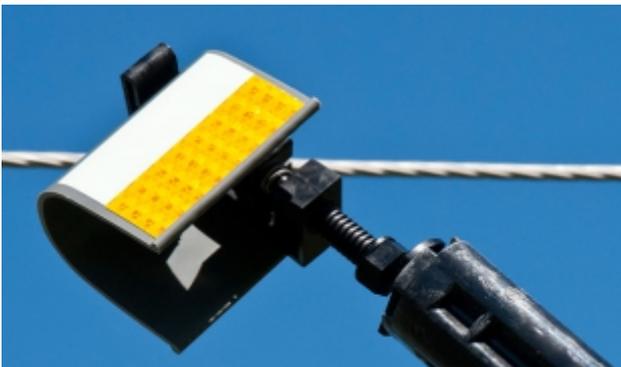
Raychem MVLC can be used in many other applications normally up to 36kV. For increased insulation levels, 40kV and above, information is available upon request.



### Overhead Line Deadend Cover

One of Raychem's Raysulate wide range of BCIC preformed covers to insulate any bare metal overhead lines fittings that could be bridged phase to phase or phase to ground by large birds.

The Raysulate range of covers are simple to install, can be field cut to overcome any unusual or problem geometries and is compatible with all heat shrink or existing materials. Suitable for wood pole or metal tower overhead line applications.



### Bird Flight Diverter (AFD)

The Raychem AFD is designed to make birds aware of power lines sooner than bare conductor alone therefore helping birds avoid often devastating collisions. The AFD is RFI free up to 69kV and incorporates high visibility prismatic reflecting strips that allow birds to see it in low light or foggy conditions. The AFD is easily installed with a shearbolt fixing that controls the clamping force required to correctly attach to the power line. The AFD can be installed live with a 'hot-stick'

## Pollution/Heavy Wetting



### Raychem High Voltage Creepage Extenders "HVCE"

Raychem HVCE creepage extenders represent a long term solution to pollution flashovers by making a permanent addition to the creepage distance. This increases flashover voltage, reduces leakage current and surface electrical stress. Creepage extenders also improve the insulator shape and increase the strike distance. Heat-shrinkable creepage extenders are flexible polymeric skirts, coated internally with a track-resistant mastic for bonding to the insulator. These are available to fit insulators and bushings up to 500kV, with shed diameter 80mm to over 390mm.

Wrap around Raychem HVCE-WA creepage extenders are cold applied. There is no need to disconnect to install. These are available to fit insulators and bushings up to 500kV with shed diameter 175mm to over 600mm.

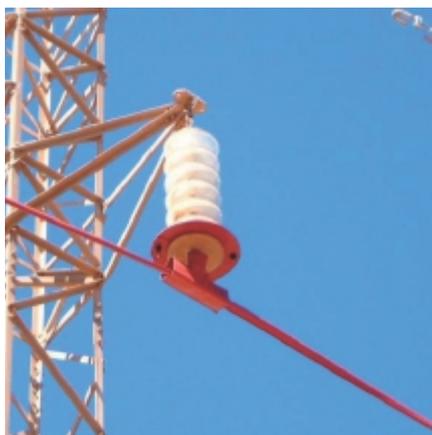
### Raychem High Voltage Booster Sheds "HVBS"

Raychem HVBS booster sheds are loose fitting polymeric collars for insulators and bushings, which are spaced from the porcelain skirt by short pegs and from the core by tongues. Booster sheds increase the diameter of the bushing in several places and break up long cascades of contaminated water to prevent "heavy wetting" flashovers, which can occur during live-line washing or torrential rain. Available to fit insulator core diameters from 160mm to 770mm. suitable for applications up to 500kV.

### System Application

By using a combination of products distribution towers can be protected from flashovers and outages caused by birds. Targeting the most troublesome sections of OHL can reduce the number of incidents and save protected wildlife.

Regardless of the application it is possible to create a Raysulate solution for any accidental contacts or bridging problem.



## Indoor Equipment

### Recommended clearances

Tests on busbars insulated with Raychem BBIT/BPTM tubing have shown significant reductions in air clearance over conventional air-insulated systems. The most important requirements for the minimum spacing of the busbars is that the system must be free from audible corona at the AC Withstand test voltage and also withstands the Impulse test voltage. The possible air clearances are based on practical testing on a range of busbar sizes and configurations.

The detailed clearance reductions and the application ranges for each of the products are listed in the data sheets.

The Raychem Raysulate Insulation Enhancement System is widely used for electrical insulation needs on enclosed buswork and for connections in switch-gear and electrical equipment. The insulation products provide a highly flexible system for all shapes and sizes of conductor.

### Medium Voltage System



### Low Voltage System

The Raychem Raysulate Insulation Enhancement System also has an equivalent LV range of products. Coloured in black and suitable up to 1kV.



### Clearance reduction

The tables indicate the clearance reductions that are possible using Raychem BBIT tubing. These are derived from BIL, AC withstand, DC withstand and discharge extinction tests. These clearances should not be adopted without testing by the user. Sharp electrodes and unusual geometries may require wider clearances.

#### Round busbars (BBIT)

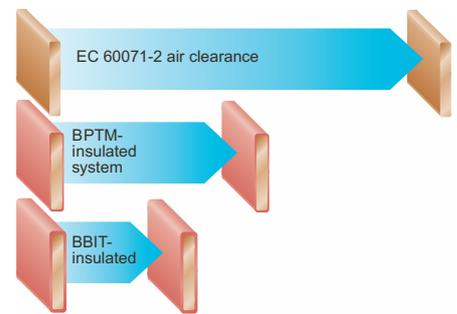
Rated voltage (kV)	Phase-phase (mm)	Phase-ground (mm)	IEC 60071-2 air clearance (mm)
12	30	40	120
17.5	45	60	160
24	60	90	220
36	100	160	320

#### Rectangular busbars (BBIT)

Rated voltage (kV)	Phase-phase (mm)	Phase-ground (mm)	IEC 60071-2 air clearance (mm)
12	35	45	120
17.5	55	65	160
24	70	100	220
36	140	190	320

### Raychem "BBIT/BPTM" busbar insulation tubing

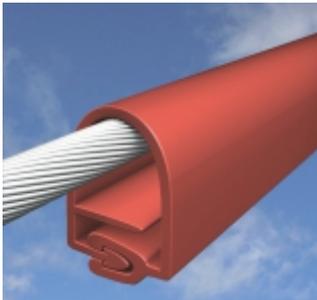
Raychem BBIT/BPTM heat-shrinkable tubings are suitable for use on long runs of rectangular or round busbars. These tubes shrink down to 40% of their original diameter and, due to excellent flexibility, conform tightly to a wide range of sizes. Raychem BBIT/BPTM tubing slides easily into place, even around several bends and on awkward shapes. Wall thickness is controlled by the heat-shrink process. Available to suit sizes of busbars from 5mm to over 250mm. Raychem BPTM is suitable for applications up to 25kV and Raychem BBIT up to 36kV.



## Solutions for electrified railway systems

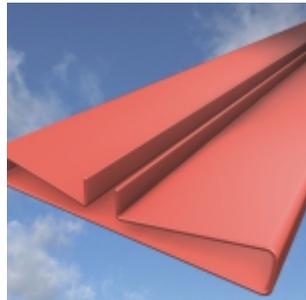


Raychem RPG has used its experience from utilities and substations to provide a range of specialist cold applied retrofit products that can help prevent flashovers, outages and circuit breaker operations on the rail network. By insulating either the live equipment or earth planes from problems caused by wildlife, vegetation or airborne debris at areas of reduced clearance network reliability can be improved. The range of covers, barriers and sheets are easily installed and are suitable for 25kV applications.



### Raychem Medium Voltage Line Cover "MVLC"

Provides insulation for catenary, droppers and associated conductors against contact with trees, birds, wildlife or even vandalism. Simple fast wraparound installation. Flame Retardant version available rated up to 40kV.



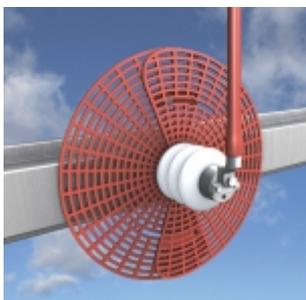
### Raychem "I" Beam Insulation Cover "IBIC"

Prevents accidental bridging between "I" section steelwork and live catenary or associated equipment by wildlife. Installation is clip-on, tool-free and fast.



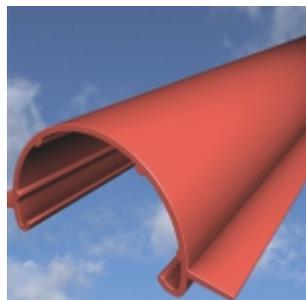
### Raychem "BCIC" Insulating Cover

A preformed cover designed to insulate the dropper connector where the contact wire is protected by MVLC.



### Raychem Bus Insulator Squirrel Guard "BISG"

Can be mounted horizontally or vertically on any MV insulator or bushing to prevent wildlife bridging phase to ground. Designed to eliminate accidental flashover on trackside substations and all associated equipment.



### Raychem Under Bridge Arm Cover "UBAC"

A range of covers to insulate the end fitting of horizontal insulators in tunnels and under bridges.



### Raychem Rigid Red Barrier Board, 3mm "RRBB"

A tough insulating board that can be secured to the underside of structures to insulate them from live equipment where there are reduced clearances. Raychem RRBB can be easily cut, drilled or formed on site to allow fitting to complex structures.

## Technical Data

### Medium-Voltage Products\*

#### Test and Performance Data

Material Properties	Test method	Requirements	BBIT BPTM	BCIC HVIS	CITM	BCAC, HVCE-WA, HVBT, OLIT	HVCE	MVLC	BISG RRBB
<b>Electrical</b>									
Volume resistivity	ASTM D-257, IEC 93	ohm-cm min	1.0x10 <sup>13</sup>	1.0x10 <sup>13</sup>	1.0x10 <sup>13</sup>	1.0x10 <sup>13</sup>	1.0x10 <sup>13</sup>	1x10 <sup>13</sup>	1x10 <sup>13</sup>
Dielectric constant	ASTM D-150, IEC 250	max	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Dielectric strength	ASTM D-149, IEC 243	V/mil at 1.3mm min.						550	
		V/mil at 1.5mm min.	500						
		V/mil at 2mm min.	450	330		330	250		
		V/mil at 2.5mm min.	400						380
V/mil at 3mm min.	350			350					
<b>Thermal</b>									
Thermal endurance	IEEE 1-1969, IEC 216	min.	105°C	105°C	110°C	105°C**	110°C	105°C	
Accelerated aging for 168 hours	ISO 188	Tensile strength	1450 psi	1450 psi	2160 psi	1450 psi	1100 psi	1450 psi	2450 psi
		Ultimate elongation	300%	300%	300%	300%	300%	100%	25%
		Aging Temp.	120°C	120°C	120°C	120°C	120°C	150°C	120°C
<b>Chemical</b>									
Flammability	ANSI C37.20	Pass	Pass	Pass		Pass			
Water absorption	ISO/R 62, procedure A	1% max. after 14 days at 23°C	Pass	Pass	Pass	Pass	Pass	Pass	Pass
Low-temperature flexibility	ASTM D-2671, procedure C	No cracking after 4 hr	Pass -40°C	Pass -40°C	Pass -40°C	Pass -40°C	Pass -40°C	Pass -20°C	Pass -40°C
Corrosion	Copper Mirror, ASTM D-2671, procedure B	Passed visual inspection after 16 hr		Pass 150°C		Pass 150°C		Pass 135°C	
<b>Physical</b>									
Tensile strength	ASTM D-638, ISO 37	psi (min )	1450 <4 mm, 1150 >4 mm	1450	2160	1450	1150	1450	2450
Ultimate elongation	ASTM D-638, ISO 37	% min	300	300	400	300	300	200	25

Note: Blank spaces indicate that property was not measured during product qualification.

\*Each product's voltage rating will be displayed with its selection information.

\*\*Properties measured on backing material only. HVBT and OLIT have a 70°C maximum continuous operating temperature limit.

### Low-Voltage Products

#### Test and Performance Data

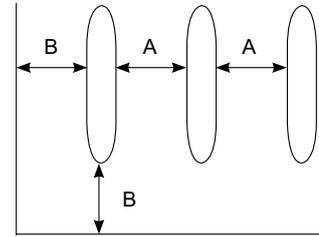
Material properties	Test method	LVIT, LVBT, LVBC
<b>Electrical</b>		
Volume resistivity	ASTM D-257, IEC 93	1x10 <sup>13</sup> ohm-cm minimum
Dielectric constant	ASTM D-150, IEC 250	6.0 maximum
Dielectric strength	ASTM D-149, IEC 243	330 V/mil at 2.5 mm
<b>Thermal</b>		
Thermal endurance	IEEE 1-1969, IEC 216	105°C minimum
Accelerated aging	ISO 188	168 hr at 150°C
	Tensile strength	1600 psi minimum
	Ultimate elongation	200% minimum
<b>Chemical</b>		
Flammability	ICEA-S-19-81	Pass
Water absorption	ISO/R 62, procedure A	0.5% maximum after 14 days @ 23°C
Low-temperature flexibility	ASTM D-2671, procedure C	No cracking after 4 hr at -40°C
<b>Physical</b>		
Tensile strength	ASTM D-638, ISO 37	1750 psi minimum
Ultimate elongation	ASTM D-638, ISO 37	350% minimum

## Technical Data

This table indicates clearance differences for rectangular busbars without and with various Raysulate electrical insulation products. These spacings are derived from BIL, AC-withstand, DC-withstand, and discharge-extinction tests on a limited number of busbar configurations insulated with Raysulate electrical insulation products.

Due to the wide range of possible busbar geometries, these spacings should not be adopted without actual testing by the user. Sharp electrodes and unusual geometries will require wider spacings.

Note: Phase-to-phase distances are reduced more than phase-to-ground distances because it is assumed that each phase is insulated.



### Selection Information: dimensions in inches (millimeters)

System Voltage kV	BIL kV	Uninsulated clearance (indoor)		BBIT clearance (indoor)		BPTM, HVBT, and HVIS Clearance (indoor)	
		A*	B**	A*	B**	A*	B**
15	95	7.5 (190)	5.0 (125)	2.2 (55)	2.6 (65)	3.4 (85)	4.2 (105)
25	125	10.5 (265)	7.5 (190)	2.8 (70)	4.0 (100)	4.5 (115)	6.0 (150)
35	150	12.5 (320)	9.5 (240)	5.6 (140)	7.5 (190)	6.5 (165)	8.0 (200)

\*Phase-to-phase

\*\*Phase-to-ground

### Recommended Guide Specification

Please Feel Free To Use The Following in Your Design Specification:

Insulation for energized bus components and connections shall consist of tubing, tape, and sheets that are factory-engineered to meet applicable switchgear performance requirements.

All insulation components shall be fabricated from flexible, crosslinked, heat-shrinkable polymeric materials formulated to provide high dielectric strength, adequate thermal endurance at bus operating temperatures, and tracking and erosion resistance.

The insulation materials shall contain no halogen compounds and be compatible with other commercial, factory-installed bus insulation materials.

Materials shall be installable at temperatures as low as -40°F Adhesive coatings on tape and sheet products shall not adhere to metal surfaces, thus permitting easy re-entry to the connections.

The insulation supplier shall furnish technical data to document design and performance to these requirements and functional testing of the complete insulation system in accordance with ANSI/IEEE C37.20-1987.