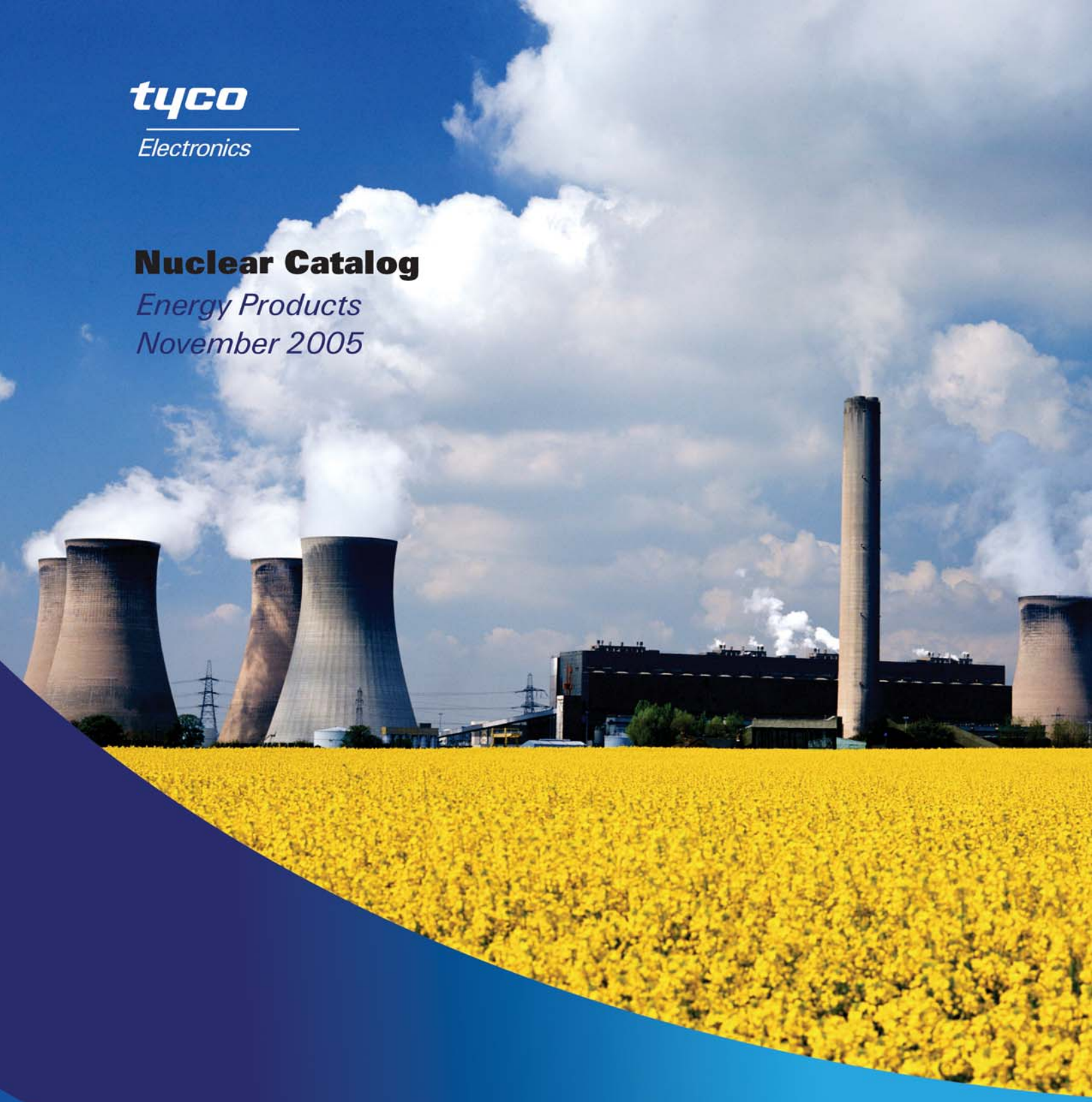
tyco
Electronics

Nuclear Catalog

Energy Products
November 2005



a vital part of your world

Class 1E (K1) Nuclear Qualified LOCA Type Tested Cable Accessories

Heat-shrinkable cable accessories

Tyco Electronics has developed a series of heat-shrinkable components and kits to help seal and insulate electrical connections in nuclear power plants. Made from heavy-wall, flame retardant, crosslinked polyolefin and precoated with a nuclear-grade adhesive, these products have been designed to withstand the radiation levels and temperatures that are possible inside the containment buildings of nuclear stations.

Tyco Electronics' nuclear power products have been designed to answer the specific needs associated with protecting many of the 200,000 connections that must be made in the construction of these plants. Tyco Electronics' nuclear accessories have been subjected to very severe LOCA/HELB tests to establish its performance for a postulated nuclear accident environment.

Qualification

Electrical connections should, as a minimum, be qualified to the same standards as the cables. Tyco Electronics' nuclear products are designed to perform in environments that are more severe than most 1E LOCA qualified cables and are tested beyond the design basis conditions of most nuclear power plants.

Nuclear environmental qualification (EQ) for products involves compliance with industry accepted standards including IEEE 323 and IEEE 383 and other international standards. The materials used in these products have been tested and proven to perform the intended function for the life of the plant (usually 40 years). Tyco Electronics uses many accepted methods to justify the life including the Arrhenius method for accelerated aging of plastics. These materials are then used individually as components, as tubings for simple splices, or in various combinations called "kits" that are designed for a more complex application.

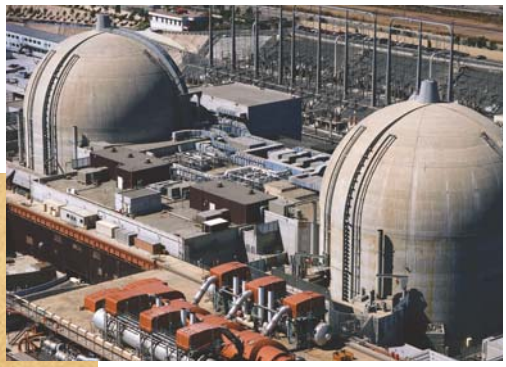
All of our 1E safety related harsh environment products are type tested in the intended use configuration and in the worst case conditions by our own or independent certified laboratories. The results of these tests are presented in Energy Division Reports (EDR) which are used for EQ purposes in our certificate of conformance/compliance.

Reformulation 2001

Tyco Electronics reformulated the compounds used for the extruded tubing, molded parts and the nuclear sealing adhesive. This was a project that started in 1999 and involved repeating all of the initial testing of the original compounds to prove that the two materials were essentially the same and could be considered similar in form, fit and function.

The products made from these new compounds were type tested to a LOCA that was as close to the original LOCA as could be attained. The results of the tests proved that the reformulated material was virtually the same as the original compound. The new LOCA test provided an opportunity to examine some changes in our product design parameters, including a 1" (25mm) seal length for smaller conductors and expanded use ranges for all sizes of the original and new compound formulation. All of these type tests are included in test reports including EDR-5336 and EDR-5389.

The new design parameters are included in the In-Line Splice Application Guide in this catalog.



Product design

Tyco Electronics' Raychem products are qualified for harsh environments in several different configurations. These designs range from very simple single conductor splices using one heat - shrink tubing, to complex kits for cable transitions using several different components. These products have been type tested to IEEE 383 and IEEE 323 specifications and are designed to be generic to cover a wide range of cable types and sizes. Note: All of Tyco Electronics' Raychem kits are sized by the substrate diameter and not the wire gauge. Wires and cables of the same gauge can have drastically different diameters, so it is critically important to determine the qualified substrate sealing diameter when selecting kits.

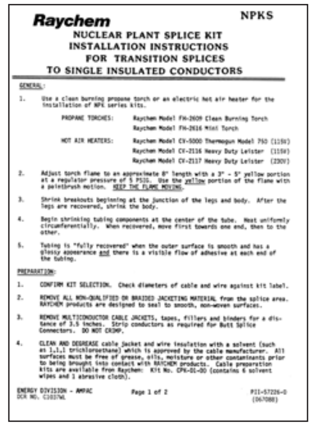
A typical "kit" is composed of heat-shrinkable tubings and molded parts. These components combine to electrically insulate and environmentally seal a cable splice in a specific configuration.

Typical Kit

There is a product label that lists the kit name, functional description, application use range (usually the cable insulation diameter range and bolt or connector size), voltage class, lot number and other internal Tyco Electronics identification numbers.

Typical Label

Also included in the kit are Product Installation Instructions which describe the installation in step by step detail.



Raychem NPKS

NUCLEAR PLANT SPLICE KIT
INSTALLATION INSTRUCTIONS
FOR TRANSITION SPLICES
TO SINGLE INSULATED CONDUCTORS

GENERAL:

1. Use a clean burning propane torch or an electric hot air heater for the installation of NPK series kits.

PROPANE TORCHES: Raychem Model FH-2609 Clean Burning Torch
Raychem Model FH-2616 Mini Torch

HOT AIR HEATERS: Raychem Model CV-5000 Thermogun Model 750 (115V)
Raychem Model CV-2116 Heavy Duty Leister (115V)
Raychem Model CV-2117 Heavy Duty Leister (230V)

2. Adjust torch flame to an approximate 8" length with a 3" - 5" yellow portion at a regulator pressure of 5 PSIG. Use the yellow portion of the flame with a paintbrush motion. KEEP THE FLAME MOVING.

3. Shrink breakouts beginning at the junction of the legs and body. After the legs are recovered, shrink the body.

4. Begin shrinking tubing components at the center of the tube. Heat uniformly circumferentially. When recovered, move first towards one end, then to the other.

5. Tubing is "fully recovered" when the outer surface is smooth and has a glossy appearance and there is a visible flow of adhesive at each end of the tubing.

PREPARATION:

1. CONFIRM KIT SELECTION. Check diameters of cable and wire against kit label.

2. REMOVE ALL NON-QUALIFIED OR BRAIDED JACKETING MATERIAL from the splice area. RAYCHEM products are designed to seal to smooth, non-woven surfaces.

3. REMOVE MULTICONDUCTOR CABLE JACKETS, tapes, fillers and binders for a distance of 3.5 inches. Strip conductors as required for Butt Splice Connectors. DO NOT CRIMP.

4. CLEAN AND DEGREASE cable jacket and wire insulation with a solvent (such as 1,1,1 trichloroethane) which is approved by the cable manufacturer. All surfaces must be free of grease, oils, moisture or other contaminants prior to being brought into contact with RAYCHEM products. Cable preparation kits are available from Raychem: Kit No. CPK-01-00 (contains 6 solvent wipes and 1 abrasive cloth).

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DCR NO. C10374L (067088)

Typical PII for NPKS

There is also a "Kit Contents List" which describes the individual components of the kit with reference letters to simplify the identification of components.

Components

Each component is labeled in a poly bag and identified with a reference letter that ties it to the kit contents list and the installation instructions.

Quality control

Tyco Electronics' Raychem Nuclear Cable Accessories are designed and manufactured under quality assurance procedures that comply with the requirements of the nuclear industry worldwide. Since 1980 Raychem (now Tyco Electronics) has used a quality assurance program that is in compliance with 10 CFR 50 Appendix B and several other national and international standards. Peer review of the design and manufacturing processes are required. Tyco Electronics facilities are audited by several independent audit committees including NUPIC.

The Tyco Electronics Energy Quality Assurance program is in compliance with the following standards:

- 10CFR50, Appx. B
- 10CFR21, NQA-1
- ANSI N45.2 (and applicable "Daughter" Standards)
- CAN3-Z299.2
- ISO-9001

The current version of our quality manual is available on the web. Simply open your web browser to: www.tycoelectronics.com and select Quality Documentation, then select Energy Division - Fuquay-Varina, North Carolina Quality System Manual, and Quality Manual Nuclear Appendix

Reformulation 2001

The entire requalification program was completed and documented under the guidance of the Tyco Electronics – Energy Division Quality Program.

Nuclear products – typical kit

QC USP Stamp

documentation

In addition to supplying base components (tubing and molded parts), Tyco Electronics designs and manufactures a wide variety of kits to seal and insulate specific connections in the plant. These kits provide the added advantage of being pre-designed to remain consistent with the type-tested designs and being pre-kitted with the exact parts necessary.

Advantages of pre-designed kits:

- Engineering details have been worked out and are documented.
- Multiple checkpoints exist in the documentation to verify proper kit selection.
- Traceability is provided and maintained.
- Complete installation instructions provide step-by-step guidance.

Description of features of nuclear kit documentation:

1. Each nuclear splice kit is boxed (for storage convenience) and distinctively labeled with the following information:
   - Kit part number ("name")
   - Kit functional description
   - Application range (wire diameters)
   - Storage level

With the above information, the installer can verify proper kit selection prior to opening the box.

2. Each kit, consisting of multiple components, is placed in a poly bag and labeled with a kit lot number. This lot number is recorded by Tyco Electronics and is used to reference the lot numbers for all components used in the kit. This kit lot number can be recorded on the termination card in the field to facilitate traceability.

3. Each component in the splice kit is separately bagged and labeled with a "key reference letter." This is a unique alphabet letter assigned to each component. The letter correlates with the reference to the component in the installation instructions. This allows the installer to easily identify the proper part during the installation sequence. Individual bagging helps to assure that cleanliness is maintained prior to installation.

4. Each kit is supplied with installation instructions specific to that kit. The instructions address cable preparation, application technique, and the specific kit installation sequence. Components are referenced in the instructions both by a description and the key reference letter.

WCSF-N cable sleeves
(For Class IE systems subject to LOCA/MSLB)

WCSF-N is a flame retardant, heavy-wall tubing designed for nuclear applications. It is rated at 1000 volts and is designed to electrically insulate, mechanically protect and environmentally seal cable splices. It is internally coated with a red sealant specially formulated to withstand the nuclear environment (uncoated tubing is available for applications that do not require environmental seals).

NPK - nuclear plant splice kit
(For Class IE systems subject to LOCA/MSLB)

NPK series kits are designed to provide an environmentally sealed and mechanically protected electrical splice insulating system. The splice kits individually splice and seal each insulated conductor and reconstitute the cable jacket over the splice area to add additional protection and reliability. NPK series kits are available for all electrical penetration splicing needs:

NPKC - Control cable
NPKP - Power cable
NPKS - Shielded instrumentation cable

NPKV - nuclear plant stub connection kit ("V")
(For Class IE systems subject to LOCA/MSLB)

The NPKV kits are designed to insulate and seal V-type stub connections to valves, limit switches, level switches, and instruments in small boxes or conduit outlet bodies where installation space is minimal. They can be used as a direct replacement for terminal blocks.

NMCK - nuclear motor connection kit
(For Class IE systems subject to LOCA/MSLB)

The NMCK product line is designed for low voltage motor terminations. Kits are available in stub, in-line, "Y" and "H" configurations. The NMCK kits feature ease of installation and removal.

NCBK - nuclear cable breakout kit
(For Class IE systems subject to LOCA/MSLB)

Nuclear cable breakout kits are designed to environmentally seal cable jackets to prevent moisture migration down the cable.

NESK - nuclear end sealing kit
(For Class IE systems subject to LOCA/MSLB)

Nuclear End Sealing Kits are designed to environmentally seal cable ends and spare conductors.

NJRT/NWRT - nuclear jacket repair and insulating tape
(For Class IE systems subject to LOCA/MSLB)

NJRT and NWRT are wraparound products which are ideal when access to the cable end is not available. Made from the same material as WCSF-N tubing, NJRT and NWRT tapes are intended to repair cable jacket damage and replace non-qualified tape on single conductor in-line splices on Class IE circuits subject to accident conditions.

NHVT - nuclear high voltage termination
(For Class IE systems non-accident)

This product provides a system for terminating and sealing all types of medium voltage (5-15 kV) cables. The NHVT has been tested for use on Class IE circuits requiring a 40-year life with 50 MRAD integrated radiation dose.

NMCK8 - nuclear motor connection kit - 8-kV
(For Class IE systems subject to HELB)

The NMCK8 kits are designed to insulate and seal connections in Class IE medium voltage motors. They are available in an in-line configuration, as well as stubs and "Y's." The NHVT kits are available to terminate any shielded field cables prior to installation of the NMCK8.

BBIT-N/HVBT-RN bus insulation products

BBIT-N is a heavy wall bus insulation tubing for use on straight or bent bars where maximum clearance reduction is required. BBIT-N is rated to ANSI/IEEE C37.20-1987 for 15-kV applications and has been tested for Class 1E insulated connections in HELB conditions.

HVBT-RN is a sealant-coated, general purpose tape used to insulate straight and bent bus bars in retrofit applications where tubing cannot be used. HVBT-RN is a "Commercial Grade" product as defined in 10 CFR part 21.3.

NTBR - Terminal Block Replacement

NTBR kits are designed to insulate and environmentally seal Class 1E wires that are relatively small (0.05" to 0.15" using WCSF-050-3/1 up to WCSF-115-9/3). Connectors are not supplied with kits but can be ordered separately through Tyco Electronics. These kits have been type tested to LOCA environments and comply with all applicable requirements of IEEE 323 and IEEE 383. Commercial products are listed on page 69.

Training

Tyco Electronics offers training classes for Raychem Nuclear Qualified products for installers, inspectors, and engineering personnel. These classes cover the basic elements of material science, heat-shrinkable polyolefin technology, specific product functions and hands-on installation. The courses are given by Tyco Electronics personnel and typically last four hours. For information on Tyco Electronics' Raychem Nuclear Qualified products, please contact the customer service department (nuclear specialist) at the numbers listed on the back cover of this book.

Typical training outline:

1. Introduction: Material Properties
2. Heat-Shrinkable Polyolefin Technology
3. WCSF Tubing
4. Use Range and Seal Length Calculations
5. Product and Kit documentation
6. Hands-On Installation of Products

There are several kits designed especially for training (referred to as PDP kits). These kits include:

PDP #		
5	NPKS Demo Kit:	NPKS-2-21B kit with cable to demonstrate a more complex splice used on a shielded twisted pair instrumentation cable.
17	NMCK Demo Kit:	NMCK-3V with sample feeder cable and motor lead for typical motor connection.
22	NPKV Demo Kit:	NPKV-2-14 with wires for small gauge (16-10 AWG) V type splice configuration.
33	NHVT Demo Kit:	A shielded 5 or 8 kV cable and a NHVT-81G for a Medium Voltage termination installation.
32	NMCK-8 Demo Kit:	An NMCK-8-1L for a Medium Voltage motor lead and an NHVT Demo Kit to demonstrate an in-line 8 kV motor connection.
57	NJRT Demo Kit:	A roll of NJRT and a cable stub to demonstrate heat-shrinkable tape.

Qualification 2001

The original Raychem Nuclear Grade products used a compound formulation created in the late 1970's. In compliance with our Quality Assurance program, the compound formulation did not deviate from the one used to qualify the products in the 20+ years of the product's lifetime. The Qualification 2001 reformulation was designed to be as close to the original formulation as possible, using more contemporary compounds. The type testing of the products produced with this new formulation was designed to be very similar to the original testing to allow Tyco Electronics to make the statement that these products are the SAME IN FORM, FIT, and FUNCTION as those that were qualified in the original test.

The following table lists examples of the ORIGINAL compound formulation of Raychem Nuclear Products and the new, similar but distinctive nomenclature for the Qualification 2001 products made with the new formulation:

Typical Example

Original Raychem Product	Qualification 2001 Raychem Product	Function
302A812-52/144	302A812-52/144-N	Cable Breakout
WCSF-050-3N	WCSF-050-3/1-3N	Heat-Shrink Coated Tubing
NMCK-2V	NMCK-2V (N)	Motor Connection Kit

The nomenclature chosen for the Qualification 2001 products was selected at the suggestion of our current customers to be similar to the original formulation products but still identifiable upon inspection. The Qualification 2001 products have different qualification reports and certificate of conformance and compliance documents which should be reviewed by the plant Environmental Qualification engineering personnel.

The Qualification 2001 project showed clearly the similarity of the parts that were manufactured with the new formulation compound and clearly provided support for the claim of equivalency in FORM, FIT, AND FUNCTION.

New Formulation Products Test Reports

EDR-5331	Analysis of heat aging data to determine aging conditions for WCSF, WBTF, and WWTF nuclear qualification testing	All extruded products- WCSF, NJRT & WBTF tapes
EDR-5332	Analysis of heat aging data to determine aging conditions for -52 molding material for nuclear qualification testing	All molded parts, end caps, and breakouts
EDR-5336	Nuclear Products Requalification 2001 Type Testing - From Wyle Report 23854	Type testing for WCSF and all kitted products except kitted products with molded reformulated end caps.
EDR-5348	Flammability Qualification Test Report: IEEE 1202 (IEEE 383)	Flame Retardency Test for new compound (Old IEEE 383 test)
EDR-5389	Nuclear products requalification testing, phase 2	Type-testing for kitted products containing molded reformulated end caps.

Original Qualification Test Reports

Report Number	Type-Test Description	Product Tested
EDR-5008	Qualification to ANSI C119.1-1974	WCSF-N
EDR-5009	Vertical Tray Flame Test to Section 2.5 of IEEE 383-1974	WCSF-N
EDR-5011	LOCA Qualification test of WCSF-N on EPR-Hypalon wire per IEEE 323	WCSF-N
EDR-5018	Life assessment including Arrhenius analysis of NHVT materials	NHVT
EDR-5021	Qualification Report Supplement for Raychem Nuclear Grade Adhesive	S1119
EDR-5022	Performance test to IEEE 48-1975	NHVT
EDR-5024	Qualification Report Supplement	GCA
EDR-5037	HELB Qualification test after heat aging and radiation	NMCK8
EDR-5040	Arrhenius heat aging performance	-52 molding material
EDR-5046	Arrhenius heat aging performance	WCSF material
EDR-5060	Evaluation and Performance of S1119 Ribbon Adhesive	S1119
EDR-5063	Arrhenius heat aging performance	BBIT material
EDR-5088	One inch seal length - non-accident	WCSF-N
EDR-5190	Performance Evaluation of Raychem Nuclear Motor Connection Kit - NMCK-8	NMCK8-V
EDR-5210	WBTF/NJRT Qualification Type test	NJRT
EDR-5258	NWRT flammability test	NWRT
EDR-5260	NMCK-V Kits. Conversion of Bonded End Caps to Molded Round End Caps	NMCK
71100, Rev. 1	Performance test after thermal and radiation aging	NHVT
Franklin Inst. F-C4033-3	LOCA Qualification test per IEEE 323 and 383 guidelines using simultaneous application of environmental parameters	WCSF-N
Wyle Laboratories 58442-1, -2 & -3	LOCA/MSLB Qualification test per IEEE 323 and 383 guidelines	1: WCSF-N 2: NCBK, NESK 3: NMCK
Wyle Laboratories 58722-1, -2 , -3, -5, -6	LOCA/MSLB Qualification test per IEEE 323 and 383 guidelines	1: NPKV 2: WCSF-N (Bolted Splice) 3: 202B811 & 821 Molded Sleeve 5: WCSF-050N 6: NPK
AT/E 1029 & 1061	LOCA Qualification test after thermal and radiation aging	NTMS

Wyle 23854 (EDR-5336/EDR-5389)

The following is a brief summary of Tyco Electronics' Raychem Requalification Test report (also referred to as EDR-5336/EDR-5389). This report documents the result of the testing done to verify that the cable accessories and components manufactured with the new compound are the same in FORM, FIT, and FUNCTION as the original formulation components. The type testing was conducted at the Wyle Laboratories in Huntsville, Alabama.

Test Sequence

1. Thermal Aging to simulate 40 years at 90˚C (878 hours at 150˚C based on Arrhenius data). Both original and new formulations were used in these thermal aged samples.
2. Radiation exposure (gamma) of 50 Mrads (500 kGray) total ambient for 40 years, up to 165 Mrads for LOCA DBE.
3. Simulated LOCA/MSLB environmental exposure with samples energized according to 600V with rated current.
4. Chemical spray continuously for 30 days (0.28M H3BO3, 0.064M Na2S2O3 buffered with NaOH to pH of 10.5).

Test Summary

1. All products were shown to be equivalent in FORM, FIT, and FUNCTION to original products.
2. Kits configured from combinations of original components with new components performed the same as kits configured with all new formulation components.
3. Reduced seal lengths of 1" (25 mm) were tested on small conductor samples. One inch seal lengths were shown to pass the entire test sequence.
4. The Use Range criteria has been expanded from 2.0 times the extruded ID of the tubing to 2.5 times except for WCSF-050.

Note: This information is provided as a summary only. Check with Tyco Electronics customer service for current revisions of all test reports when performing environmental qualification analysis.

Original Formulation Test Reports Wyle 58722

The following is a brief summary of Tyco Electronics' Raychem Environmental Qualification Test Reports 58722-1, -2, -3, -5 and -6. These reports document the results of the qualification type-testing conducted at Wyle Laboratories in Norco, California.

Test Sequence

1. Thermal Aging to simulate over 40 years of 90°C (916.75 hours at 150°C - based on Arrhenius plot), EDR-5046.

2. Radiation Exposure, 220 Mrads gamma radiation.

3. Simulated LOCA/MSLB environmental exposure with samples energized at 1000 Volts and rated current.

4. Chemical spray continuously for 30 days (6200 ppm Boron, 50 ppm Hydrazine, Trisodium Phosphate buffer to pH of 10.5).

Test Summary

1. WCSF-N, NPKV, Molded Sleeves, WCSF-050-N and NPK products met the defined acceptance criteria in qualification type-testing.

2. Products tested fully exposed to LOCA-MSLB environment including chemical spray. No protective enclosure required.

3. Product test configuration verifies insensitivity to orientation.

4. Electrical function monitored before, during and after environmental testing. All voltage withstand tests conducted at 3600 Volts a.c. for 5 minutes with samples immersed in water.

Original Formulation Test Reports Wyle 58442

The following is a brief summary of Tyco Electronics Environmental Qualification Test Reports 58442-1, -2, and -3. These reports document the results of the qualification type-testing conducted at Wyle Laboratories in Norco, California.

Test Sequence

1. Thermal Aging to simulate over 40 years at 90°C (1500 hours at 150°C - based on Arrhenius plot).

2. Radiation Exposure, 200-290 Mrads gamma radiation.

3. Simulated LOCA/MSLB environmental exposure with samples energized at 1000 Volts and rated current.

4. Chemical spray continuously for 30 days (6200 ppm Boron, 50 ppm Hydrazine, Trisodium Phosphate buffer to pH of 10.5).

Test Summary

1. WCSF-N, NMCK, NCBK and NESK products met the defined acceptance criteria in qualification type-testing.

2. Products tested fully exposed to LOCA/MSLB environment, including chemical spray. No protective enclosure required.

3. Product test configuration verifies insensitivity to orientation.

4. Electrical function monitored before, during and after environmental testing. All voltage withstand tests conducted at 3600 Volts a.c. for 5 minutes with samples immersed in water.

Tyco Electronics' nuclear cable accessory products are packaged in accordance with ANSI N45.2.2 - 1972, Level B or C as appropriate. When these products are handled and stored in accordance with these instructions, they will be adequately protected from normal physical damage and contamination while in transit (truck, rail, or air) where good commercial shipping practices are utilized and while in storage. Export packaging is covered separately.

There are no shelf life limitations for Tyco Electronics nuclear products when stored under the conditions described below. This statement does not extend the warrranty period beyond the period set forth in the Tyco Electronics Purchase Order Acknowledgement terms and conditions.

Packaging

Interior packaging consists of polyethylene bag, tie or heat-sealed, providing protection against dirt, water, salt, and other contaminants. Single-unit packaging (for an entire kit or for a single component, whichever is applicable) is normally specified by Tyco Electronics; however, certain items such as sleeving or small items may be bulk packaged at a specific quantity. The bags are placed in cardboard boxes to provide protection from physical damage. Quantities may be single unit or bulk quantities per box. Cushioning material is not required although Styrofoam or paper cushioning materials may be utilized in shipping containers to prevent shifting.

Identification

Product identification is accomplished by labeling the interior and cardboard containers. The labels provide, as a minimum: Tyco Electronics company name, product description or part number, lot control number, quantity and package date (or code). Other information useful to the user may also be provided.

Shipping & Handling

Packaging described above is for most shipping situations. Large shipments may be consolidated into large cardboard containers or palletized and shrink-wrapped. Shipping containers are marked with "Ship To" address, PO number, and Tyco Electronics order number. Additional information (such as "Storage Level," PO item numbers, special marking, etc.) may be added to containers when required. Sound material handling practices which prevent physical damage to the product packaging are sufficient for Tyco Electronics Products.

Storage

Indoor storage is recommended to avoid excessive exposure to dirt, water, salt, and other elements which may deteriorate packaging or contaminate the product. Storage temperatures should not exceed -40°F or 140°F.

Warranty

Tyco Electronics warrants that the product supplied hereunder shall be free from defects in materials and workmanship and shall conform to applicable Tyco Electronics specifications at the time of shipment. Tyco Electronics does not warrant the use by Buyer of any product or component for a particular application except as specified or approved in advance by Tyco Electronics in writing and assumes no responsibility for any field engineering or documentation prepared by Buyer. Tyco Electronics will supply replacement product for any product not conforming to the above warranty within the shorter of 18 months of the date of shipment or 12 months of the date of installation. In no event shall Tyco Electronics be liable for any incidental or consequential damages including, without limitation, removal of defective product or installation of replacement product. The foregoing warranty is in lieu of any other warranty including, without limitation, any warranty of merchantability or fitness for a particular purpose, any and all of which other warranties are hereby expressly disclaimed.

Limitation of Liablility; Indemnity

Notwithstanding any other provision herein, or in any other document or communication, (i) Seller's liability with respect to any matter or matters resulting from, or arising from, or relating to this purchase order, shall in no event exceed in the aggregate the total purchase price of the particular goods purchased hereunder from, or to which the liability results, arises or relates, and (ii) Seller shall in no event be liable to Buyer, Engineer, or any other person or entity for loss of use of Buyer's or its customer's facilities, loss of revenue, loss of use of revenue, loss of anticipated profits, cost of replacement power, or other incidental or consequential damages. By accepting delivery of the products offered, Buyer agrees that it indemnifies and holds harmless Seller against all claims, loss, damage and liability including without limitation whatever kind, directly or indirectly arising from or relating to the hazards inherent in the Buyer's or its customer's facilities.

Suitability

It shall be the responsibility of the Buyer to determine, on the basis of test reports furnished with the bid, or before fabrication, the suitability of the goods for the intended use and their compliance with applicable codes and standards.

Notification

It shall be the responsibility of the Buyer to notify Tyco Electronics within 30 days of the discovery of a product defect. Included shall be a brief statement describing the nature of the defect and the degree of urgency generated by the situation. Notification shall be written, or transmitted by Fax to the attention of the Nuclear Product Manager, Tyco Electronics.

Tyco Electronics
Energy Products
8000 Purfoy Road
Fuquay-Varina, NC 27526

Customer:
Factory order:
Purchase Order:
Date:

TO: SAMPLE ONLY WCSF New Formulation

CERTIFICATE OF COMPLIANCE/CONFORMANCE
(Certificate of Compliance when Test Reports are attached)

THIS CERTIFIES THAT THE ITEMS LISTED BELOW, WHEN INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S INSTALLATION INSTRUCTIONS:

1. Are identical, in respect to original material processing, and design basis criteria, to those products tested in the following reports:

EDR-2001*: Arrhenius Aging Report (Ref.: IEEE-383, Sec. 2.3.2), Rev.0, dated: August 10, 1978
EDR-5008*: Qualification Report (Ref.: ANSI C119.1-1974), Rev.1, dated: March 18, 1980
EDR-5009*: Flammability Qualification Report (Ref.: IEEE-383, Sec. 2.5), Rev.0, dated: March 7, 1980
EDR-5046*: Arrhenius Aging Report (Ref.: IEEE-383, Sec. 2.3.2), Rev.1, dated: January 4, 1996
Wyle Report 58442-1*: DBE Qualification Report (Ref.: IEEE-383, Sec. 2.4), Rev. 0, dated: May 15, 1980
Wyle Report 58722-2*: DBE Qualification Report (Ref.: IEEE-383, Sec. 2.4), Rev. 0, dated: November 18, 1982
Franklin Report F-C4033-3*: DBE Qualification Report (Ref.: IEEE-383, Sec. 2.4), Rev. 0, dated: January 1975

"Equivalency of the reformulated WCSF compared to the original WCSF was confirmed by the test reports:
EDR-5348*: Flammability Qualification Report [Ref: IEEE 1202 (IEEE-383)], Rev. 0, dated: February 11, 2002
EDR-5331*: Arrhenius Aging Report (Ref: IEEE-383, Sec. 2.3.2), Rev. 0, dated: September 21, 2000
EDR-5336*: DBE Qualification Report (Ref.: IEEE-383, Sec. 2.4), Rev. 3, dated: May 01, 2003
EDR-5389**: DBE Qualification Report (Ref.: IEEE-383), Rev. 0, dated: December 10, 2004

(Reports marked with one asterisk (*) comply with IEEE Standards 323-1974 and 383-1974. Report marked with two asterisks (**) comply also with IEEE Standards 323-2003 and 383-2003.The determination of suitability for specific end uses of these products is the responsibility of the purchaser.)

2. Are in conformance with the following specification:
   SCD: 37001, PPS 3010/7, Rev. B and 3012/19 Rev. C
   In conformance with the requirements of the above stated purchase order.

3. Have no shelf life limitations when stored in accordance with ANSI N45.2.2 level B or C;
   Temperature range: -40 to +140°F (-40 to +60°C)

4. And are being supplied in accordance with the Tyco Electronics, North Carolina Quality Manual, Revision AC, July 2003, which complies with 10CFR50, Appendix B, 10CFR21, NQA-1, ANSI N45.2 (and applicable "Daughter" Standards), CAN 3-Z299.2 and ISO-9001.

Records supporting this certificate are kept on file and are available for review at 8000 Purfoy Road, Fuquay-Varina, NC 27526-9349 (800-327-6996). Nuclear components are manufactured in Menlo Park, CA and in Ottobrunn, Germany facilities. All nuclear items are shipped from NC facility.

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Nuclear Quality Assurance

ITEM#	PRODUCT DESCRIPTION	LOT NUMBER	QUANTITY

NOTE: These products have not been fabricated tested or packaged with mercury or mercury compounds.
EXCEPT AS OTHERWISE EXPRESSLY AGREED BY TYCO ELECTRONICS IN WRITING, THE FOREGOING CERTIFICATE IS IN LIEU OF ANY WARRANTY OR REPRESENTATION EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, BOTH OF WHICH ARE EXPRESSLY DISCLAIMED.

Tyco Electronics
Energy Products
8000 Purfoy Road
Fuquay-Varina, NC 27526

Customer:
Factory order: RS
Purchase Order:
Date: 5/14/02

TO: SAMPLE ONLY WCSF Original Formulation

CERTIFICATE OF COMPLIANCE/CONFORMANCE
(Certificate of Compliance when Test Reports are Attached)

THIS CERTIFIES THAT THE ITEMS LISTED BELOW, WHEN INSTALLED IN ACCORDANCE WITH THE MANUFACTURER'S INSTALLATION INSTRUCTIONS:

1. Are identical, in respect to original material processing, and design basis criteria, to those products tested in the following reports:

EDR-2001*: Arrhenius Aging Report (Ref.: IEEE-383, Sec. 2.3.2), Rev.0, dated: August 10, 1978
EDR-5008*: Qualification Report (Ref.: ANSI C119.1-1974), Rev.1, dated: March 18, 1980
EDR-5009*: Flammability Qualification Report (Ref.: IEEE-383, Sec. 2.5), Rev.0, dated: March 7, 1980
EDR-5046*: Arrhenius Aging Report (Ref.: IEEE-383, Sec. 2.3.2), Rev.1, dated: January 4,1996
Wyle Report 58442-1*: DBE Qualification Report (Ref.: IEEE-383, Sec. 2.4), Rev. 0, dated: May 15, 1980
Wyle Report 58722-2*: DBE Qualification Report (Ref.: IEEE-383, Sec. 2.4), Rev. 0, dated: November 18, 1982
Franklin Report F-C4033-3*: DBE Qualification Report (Ref.: IEEE-383, Sec. 2.4), Rev. 0, dated: January 1975

(Reports asterisked (*) are in compliance with IEEE Standards 323-1974 and 383-1974. The determination of suitability for specific end uses of these products is the responsibility of the purchaser.)

2. Are in conformance with the following specification: SCD: 37001
   In conformance with the requirements of the above stated purchase order

3. Have no shelf life limitations when stored in accordance with ANSI N45.2.2 level B or C; Temperature range:-40˚F to +140˚F (-40˚C to +60˚C); and

4. Are being supplied in accordance with the Tyco Electronics, North Carolina Quality Manual, Revision AA, June 2000, which complies with 10CFR50, Appx. B, 10CFR21, NQA-1, ANSI N45.2 (and applicable "Daughter" Standards), CAN3-Z299.2 and ISO-9001.

Records supporting this certificate are kept on file and are available for review at 8000 Purfoy Road, Fuquay-Varina, NC, 27526-9349 (800-327-6996). Nuclear components are manufactured in Menlo Park, CA facility. All nuclear items shipped from NC facility.

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Nuclear Quality Assurance/Site Quality Manager

ITEM#	PRODUCT DESCRIPTION	LOT NUMBER	QUANTITY
1	WCSF-070-6N	XXXXX	50

NOTE: These products have not been fabricated, tested, or packaged with mercury or mercury compounds, except as otherwise expressly agreed by Tyco Electronics in writing. The foregoing certificate is in lieu of any warranty or representation expressed or implied, including without limitation of any warranty of merchant ability or fitness for a particular purpose, both of which are expressly disclaimed.

WCSF

Heavy-Wall, Flame-retardant Nuclear Cable Sleeves

WCSF cable sleeve is a heavy-wall, flame-retardant, heat-shrinkable tubing. It is available in uncoated and precoated with a hot-melt, radiation-resistant sealant to provide a positive environmental seal. It is designed for electrical insulating up to 1000V and general purpose sealing applications where flame retardancy, radiation resistance, and severe environmental performance are required.

WCSF cable sleeves accommodate a wide range of splicing or connection applications for Class IE and wire and cable systems. Each connection is indiviually insulated and sealed. Additionally, the sleeves can be used for a wide range of related applications including sealing, jacketing and strain relief throughout the plant.

Tubing is also supplied as components in standard splice kits for specific applications.

Heat-shrinkability of Tyco Electronics' WCSF tubing provides fast and easy installation, positive visual inspection, and a pre-engineered insulation thickness to assure consistent installation.

WCSF cable sleeves are supplied under Tyco Electronics' comprehensive Quality Assurance Program with Certified Documentation to meet industry requirements for safety related electrical equipment.

Qualification type-testing

The Raychem WCSF-N sleeves have been subjected to the following tests:

Flammability
The product has passed the IEEE 383 Flame Test at both 70,000 and 210,000 BTU/hour.

Heat aging
40 year life at 90°C established using Arrhenius method.

Radiation
Functional operability has been verified after 215 MRAD of gamma exposure.

LOCA
WCSF has been tested to LOCA/HELB profiles based on the guidelines of IEEE 323 and 383.
·40 year aging and 215 MRAD
·30 day test
·Peak temperature 218°C (425°F)
·30 day chemical spray

Tyco Electronics' environmental type-tests are valid when sleeves are used within the established ranges specified in the Product Installation and Inspection Guide. Use of the product beyond these ranges may invalidate the applicability of these test results.

Ordering information

Order by part number. Specify size and coating. Specify Type N for nuclear adhesive coating; uncoated tubing (Type U) is available if a seal is not required. Spooled, uncoated tubing is designated A/U.

Related product information

Material specifications
PPS 3010/7 (RT-1508/1) - Tubing
PPS 3012/19 (RT-1050/15) - Adhesive/Sealant

New formulation test reports

EDR-5331
EDR-5336
EDR-5348
EDR-5389

Original formulation test reports (sizes 070 - 2500)

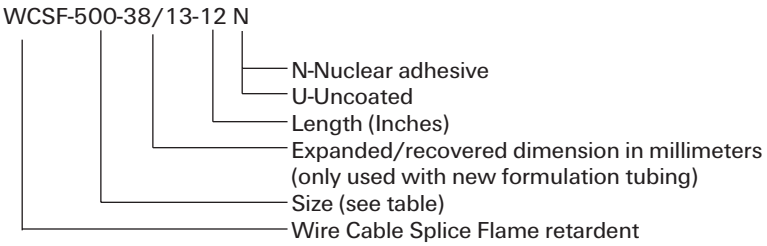
EDR-2001
EDR-5008
EDR-5009
EDR-5046
WYLE 58442-1
WYLE 58722-2

Original formulation test reports (sizes 050)

EDR-5009
EDR-5046
WYLE 58722-5

Ordering information

The new formulation Qualification 2001 WCSF tubings have expanded use ranges and different descriptions from the original formulation WCSF products. There is only one use range (the minimum and maximum qualified substrate diameter allowed for compliance with the type testing) for the new product line:



WCSF-N coated tubing USE RANGE for 1E & K1 Harsh Environments (LOCA/HELB)

New Formulation Expanded Description	As Supplied Nominal ID Inch	mm	Use Range inch	x =Standard Lengths (mm)	inch	(mm)	Note	Original Formulation Description
WCSF-050-3/1-xN	0.13	(3.3)	0.05 - 0.70	(1.3 - 2.5)	3, 6, 40	(75, 150, 1000)	1, 2, 3, 4	WSCF-050-N
WCSF-070-6/2-xN	0.25	(6.0)	0.07 - 0.18	(1.8 - 4.4)	3, 6, 40	(75, 150, 1000)	1, 2, 3	WSCF-070-N
WCSF-115-9/3-xN	0.35	(9.0)	0.115 - 0.29	(2.9 - 7.3)	3, 6, 9, 40	(75, 150, 225, 1000)	1, 2, 3	WSCF-115-N
WCSF-200-18/5-xN	0.70	(18.0)	0.20 - 0.50	(5.1 - 12.7)	6, 9, 12, 40	(150, 225, 300, 1000)	1, 2, 3	WSCF-200-N
WCSF-300-28/8-xN	1.1	(28.0)	0.31 - 0.75	(7.9 - 19.0)	6, 9, 12, 40	(150, 225, 300, 1000)	1, 3	WSCF-300-N
WCSF-500-38/13-xN	1.5	(38.0)	0.53 - 1.25	(14 - 32)	6, 9, 12, 40	(150, 225, 300, 1000)	1, 3	WSCF-500-N
WCSF-650-50/17-xN	2.0	(50.0)	0.70 - 1.63	(18 - 41)	6, 9, 12, 40	(150, 225, 300, 1000)	1, 3	WSCF-650-N
WCSF-1000-76/26-xN	3.0	(76.0)	1.1 - 2.5	(28 - 64)	12, 18, 40	(300, 450, 1000)	1, 3	WSCF-1000-N
WCSF-1500-114/38-xN	4.5	(114.0)	1.7 - 3.8	(43 - 97)	12, 18, 40	(300, 450, 1000)	1, 3	WSCF-1500-N
WCSF-2500-177/63-xN	7.0	(177.0)	2.8 - 6.3	(70 - 159)	12, 18, 40	(300, 450, 1000)	1, 3	WSCF-2500-N

1. Bolt pads are required where the hardware may have sharp corners/edges and always if the use range is at least twice the tubing's minimum use range diameter. Recommended bolt pad is EPPA-109N sized as needed.
2. These tubings can be used as splice insulation sleeves and are qualified with 1" seal length. All others require 2" seal length.
3. Both original formulation WCSF and qualification 2001 formulation tubings have been type tested to these use ranges.
4. When used as a shim or small wire jacketing, the use range of WCSF-050-N is 0.50 - 0.10 inch (1.3 - 2.5mm).

When used as a splice sealing sleeve for bolted splices, the use range for the WCSF sizes listed below should not exceed the following values:

Description	Use Range (inches - mm)
WCSF-070-6/2-xN	0.07 - 0.14 (1.8 - 3.6)
WCSF-115-9/3-xN	0.115-0.23 (2.8 - 5.8)
WCSF-200-18/5-xN	0.20-0.40 (5.1 - 10.2)
WCSF-300-28/8-xN	0.31 - 060 (7.9 - 15.2)

General instructions

The use of WCSF tubing to seal electrical connections in nuclear plants is dependent on its proper selection and installation. This guide specifies the capabilities and limitations for the selection of tubing, including installation and inspection of the tubing.

1. WCSF tubing can be identified by the letters "WCSF", on the back outer surface and the presence of a red sealant coating on the inner surface. There is a lot number on the outer surface for traceability.

2. Qualification type tests are valid when the tubing is used in accordance with the instructions and the application ranges included in this document. Use of the product outside the published use ranges may invalidate the applicability of the qualification type tests.

3. Tyco Electronics products are designed to seal on qualified cable insulations. It is the responsibility of our customers to insure that the critical environmental sealing surfaces are qualified (by the cable manufacturer). Several cable constructions utilize a non-qualified, sacrificial jacket for mechanical protection. It is imperative that Tyco Electronics nuclear qualified splicing products are installed such that the environmental seal is made on a qualified substrate.

Physical	Test method	Requirement
Tensile strength (tubing)	ASTM D412	1200 psi min
Ultimate Elongation (tubing)	ASTM D412	250% min
Heat aging (200 hr at 175°C, 1600 hr at 150°C) (tubing)	ASTM D2671, Sec. 83.2 D412	Tensile 1000 psi min, elongation 100% min
Radiation (50 MRADS after 200 hr at 175°C) (tubing)	ASTM D412 & ASTM E1027	Tensile 800 psi min, elongation 50% min
Radiation (200 MRADS) (tubing)	IEEE 323-1974	Functional operability
Heat shock (4 hr at 225°C) (tubing)	ASTM D2671	No dripping, flowing or cracking
Low temperature flexibility (tubing) (4 hr at -55°C)	ASTM D2671	No cracking
Low temperature flexibility (adhesive) (4 hr at -40°C)	ASTM D2671	No cracking
Adhesive Peel strength (WCSF/WCSF) (adhesive)		10lb/inch min.
Specific gravity (tubing/adhesive)	ASTM D792	1.35 max/.97 max g/cm^3
Electrical		
Dielectric strength (tubing)	ASTM D149	200 volts/mil (min) @ nominal wall .100" 350 volts/mil (min) @ nominal wall 0.060"
Volume resistivity (tubing)	ASTM D257	1 x 10E13 Ohm cm min
Chemical		
Corrosive effect (16 hr at 135°C) (tubing)	ASTM D2671	No corrosion
Water absorption (24 hr at 23°C) (tubing)	ASTM D570	0.5% max
Flame retardancy (tubing)	ICEA S-19-81, Sec. 6.19.6, 5th Edition Massive vertical tray test, Sec. 2.5 (IEEE 1202-1991)	Self extinguishing in less than 1 minute No propagation

Application Guide

Introduction

WCSF tubings are heat-shrinkable, flame-retardant, flexible polyolefin tubings specially formulated and tested to withstand the particular environment found in nuclear generating stations. The tubings may be supplied in either "coated" or "uncoated" form. When coated, the suffix "N" is added to the part designator indicating that the entire inner surface of the tubing is covered with a sealant that is designed to form an environmental seal under normal, and Design Basis Event (DBE) conditions. Uncoated tubings carry the suffix "U."

The WCSF series of tubings is rated to 1000 volts. The tubings have been type-tested and have demonstrated a 40-year service life at 90°C continuous operating temperature, by Arrhenius analysis. Customers should review all type testing and qualification reports.

The purpose of this guide is to present all of the information required to select, install, and inspect the WCSF series of tubings for use on single-conductor, in-line splices only.

Qualification type-testing

Tyco Electronics has performed environmental qualification type-testing with WCSF-N tubing in accordance with the guidelines of IEEE Std. 323 and IEEE Std. 383, to enable the user to qualify WCSF-N for use on class IE electrical systems subject to accident conditions at nuclear generating facilities. Tyco Electronics' qualification type-tests are valid when the tubing is used in accordance with the guidelines and the application ranges included in this document. Use of the product outside the published use ranges may invalidate the applicability of the qualification tests.

The qualification status of Tyco Electronics' nuclear products is conditional on the substrate materials being capable of maintaining physical and seal integrity under the same conditions to which the Tyco Electronics materials are type-tested. It is also required that the cable substrates to which Tyco Electronics products are applied be clean and degreased and be suitable sealing surfaces (woven jackets or braids, for example, are unacceptable sealing surfaces).

Tyco Electronics maintains a quality assurance/ quality control program in accordance with 10CFR50 Appendix B. Lot numbers are assigned to all nuclear components to enable complete traceability of our products.

Selection of Tubing

The general design philosophy of heat-shrinkable cable splices is to provide adequate insulation over the exposed conductor and connection hardware with a material that provides mechanical protection and an environmental seal. The wire and cable splice should perform as well as the cable in the conditions anticipated in nuclear power plant areas that are subject to Design Basis Event environments. To comply with the designs of the products that were type tested for Class 1E and K1 harsh environments, the following criteria shall be met in the design of Tyco Electronics' Raychem heat-shrinkable cable splices:

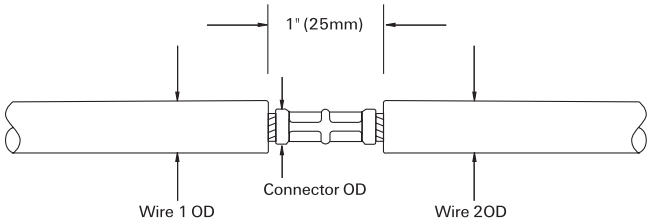
1. Tubings shall be used within the published "use range" minimum and maximum diameter when sealing on qualified substrates.
2. Connectors and other hardware (bolts, nuts, and lugs) shall be sized not to exceed the maximum diameter use range for a given tubing. Connectors and hardware do not have to stay within the minimum diameter of use range.
3. Splices shall be designed to provide type-tested seal length on the qualified substrate after installation. This is either 1.0" (25 mm) for WCSF-200-18/5-xN and below or 2.0" (50 mm) for WCSF-300-28/8-xN and larger tubings. This criteria is true for shims as well.

For general single conductor wire to wire splices, the tubing is selected by determining the outside diameter of the qualified insulation (substrate) on each wire and the actual or effective diameter over the crimp or bolted connection hardware. The diameters of the substrate and the connector or connection hardware must fall within the "use range" of the WCSF-N tubing selected for the splice. After the correct size of tubing is selected, the length of the splice must be determined. The length of the splice is calculated by adding the connector length (with any exposed conductor included) plus two times the required seal length plus an allowance for longitudinal or linear shrinkage of the tubing. For WCSF-050-3/1-N, WCSF-070-6/2-N, WCSF-115-9/3-N, and WCSF-200-18/5-N, the tubings have been type tested with a 1" or 25 mm seal length; tubings WCSF-300-28/8-N and larger were tested with a 2" (50mm) seal length.

WCSF-N Coated Tubing Description	**As Supplied (Expanded) Nominal I.D. Inches *mm***	**Application Use Range Inches *mm***	**K Factor to Determine Shim O.D. Inches *mm***	**(See Description) x = Std. Lengths Inches *mm***
WCSF-050-3/1-xN*	0.13 *3.3*	0.05 - 0.07 (0.10)* *1.3 - 1.8 (2.5)**	0.012 *7.8*	3, 6, 40 *75, 150, 1000*
WCSF-070-6/2-xN	0.25 *6.0*	0.07 - 0.18 (0.14)** *1.8 - 4.4 (3.6)***	0.044 *28.1*	3, 6, 40 *75, 150, 1000*
WCSF-115-9/3-xN	0.35 *9.0*	0.11 - 0.29 (0.23)** *2.8 - 7.3 (5.8)***	0.068 *42.0*	3, 6, 9, 40 *75, 150, 225, 1000*
WCSF-200-18/5-xN	0.70 *18.0*	0.20 - 0.50 (0.40)** *5.1 - 12.7 (10.2)***	0.120 *76.0*	6, 9, 12, 40 *150, 225, 300, 1000*
WCSF-300-28/8-xN	1.1 *28.0*	0.31 - 0.75 (0.60)** *7.9 - 19.0 (15.2)***	0.270 *173*	6, 9, 12, 40 *150, 225, 300, 1000*
WCSF-500-38/13-xN	1.5 *38.0*	0.53 - 1.25 *14.0 - 32.0*	0.456 *298*	6, 9, 12, 40 *150, 225, 300, 1000*
WCSF-650-50/17-xN	2.0 *50.0*	0.70 - 1.63 *18.0 - 41.0*	0.558 *366*	6, 9, 12, 40 *150, 225, 300, 1000*
WCSF-1000-76/26-xN	3.0 *76.0*	1.10 - 2.50 *28.0 - 64.0*	0.796 *521*	12, 18, 40 *300, 450, 1000*
WCSF-1500-114/38-xN	4.5 *114.0*	1.70 - 3.80 *43.0 - 97.0*	1.136 *728*	12, 18, 40 *300, 450, 1000*
WCSF-2500-117/63-xN	7.0 *177.0*	2.80 - 6.30 *70.0 - 159.0*	1.816 *1158*	12, 18, 40 *300, 450, 1000*

* When used as a shim or small wire jacketing, the use range of WCSF-050-N is 0.05 - 0.10 inch (1.3 - 2.5mm).
** Maximum use range over bolted splices/connections.

Example 1: Qualified wire with crimped connector:



Step 1: OD of Qualified Substrate of Wire 1: 0.20" (5 mm)
OD of Qualified Substrate of Wire 2: 0.20" (5 mm)
OD of Connector (before crimping): 0.10" (3 mm)

Step 2: Select tubing that has use range to accommodate both connector and wires: In this example, both WCSF-115-9/3-N and WCSF-200-18/5-N would work; however, WCSF-115-9/3 can be used with a 1" (25 mm) seal length. Note that the OD of the connector is below the use range minimum for both tubings; this is acceptable since the tubing is not making a seal on this surface.

Step 3: Calculate the length of tubing required:

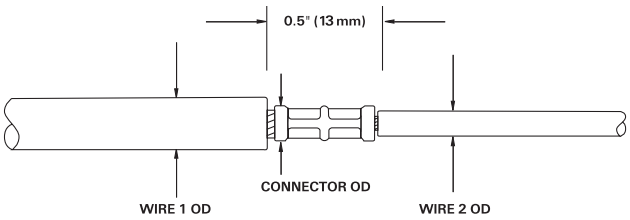
Using WCSF-115-9/3 N (inches will be used for simplicity)

Seal Length: 1" for each side
Connector exposed area 1"
Length Shrinkage 10% max.

$$\text{Total Seal Length} = \frac{1''+1''+1''}{0.9} = 3.33''$$

Seal Length = 3.33" minimum, recommended at least 4" cut from standard 6" tube.

Example 2: Two different size qualified wires with crimped connector:



Step 1: OD of Qualified Substrate of Wire 1: 0.19" (5 mm)
OD of Qualified Substrate of Wire 2: 0.07" (2 mm)
OD of Connector (before crimping): 0.10" (3 mm)

Step 2: Select tubing that has use range to accommodate both connector and wires:

In this case, there is no tubing that will cover the use range of both Wire 1 and Wire 2. A shim tubing that will fit the smaller Wire 2 is first selected and the outside diameter of this installed shim tubing is calculated with the following formula :

$$\text{Tubing OD} = \sqrt{(OD_{substrate})^2 + K_{Tubing}}$$

Where:

Tubing OD = the Outside Diameter of the recovered shim tubing

$OD_{substrate}$ = the Outside Diameter of the smaller cable.

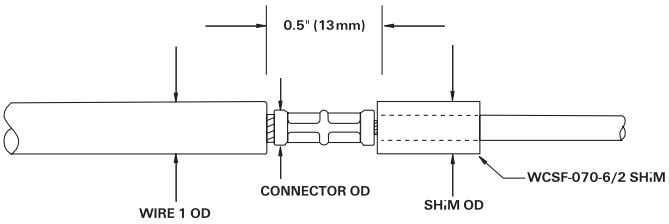
K_{Tubing} = the factored cross sectional area of the tubing given in the Use Range Table (Page 27)

Units can be in inches or mm, but the appropriate value of K selected from the table must be consistent with the units chosen.

In this example, WCSF-070-6/2 will work for Wire 2 since the diameter is within the use range of 0.07" - 0.18". Using the formula above, the OD over this tubing after it is installed on Wire 2 is calculated as follows:

$$\text{Tubing OD} = \sqrt{(0.07_{substrate})^2 + 0.044}$$

Tubing OD = **0.22**"



The shim length should be at least 1.11" long to comply with the seal length parameters. 1" minimum seal length 10% longitudinal shrinkage.

After installation of the shim, the cables have effective diameters of

OD of Qualified Substrate of Wire 1:	0.19"
OD over SHIM on Wire 2:	0.22"
OD of Connector (before crimping):	0.10"

From these data, we can select WCSF-115-9/3 N tubing and satisfy all of the use range criteria.

Step 3: Calculate the length of tubing required:

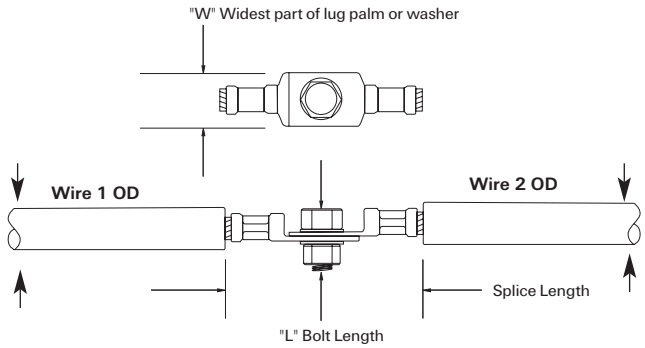
Using WCSF-115-9/3 N (inches will be used for simplicity)

Seal Length:	1" for each side
Connector exposed area	0.5"
Length Shrinkage	10% max.

$$\text{Total Seal Length} = \frac{1" + 1" + 0.5"}{0.9} = 2.78"$$

Seal Length = 2.78" minimum, recommended at least 3" cut from standard 6" tube.

Example 3: Qualified wire with bolted hardware connection:



Step 1: Measure the effective diameter over the bolted connection by using a string to measure the largest part of the connection and dividing by pi (3.14) to determine the diameter, or as an approximation, use the following formula:

$$\text{Diameter}_{\text{effective}} = 0.36 \times W + 0.64 \times L$$

Where:

W = Largest width dimension of lug pad or largest washer
L = Bolt length including bolt head (this is not the commercial bolt size; it must be measured)

OD of Qualified Substrate of Wire 1:	0.21"
OD of Qualified Substrate of Wire 2:	0.21"
Length of bolt "L"	0.85"
Width of Lug Pad "W"	0.75"

$$\text{Diameter}_{\text{effective}} = 0.36\ (0.75") + 0.64\ (0.85")$$

$$\text{Diameter}_{\text{effective}} = 0.81"$$

In this case, there is no tubing that will cover the use range of both the Effective Diameter of the bolted connection and Wire 1 and 2. A tubing that will fit the wires is first selected and the outside diameter of this installed "shim" tubing is calculated as before:

$$\text{Tubing OD} = \sqrt{(OD_{substrate})^2 + K_{Tubing}}$$

OD substrate = 0.21" so use WCSF-200-18/5, K = 0.120

(The shim length should be at least 2.25" long to comply with the seal length parameters.)

$$\text{Tubing OD} = \sqrt{(0.21"_{substrate})^2 + 0.120}$$

Tubing OD = 0.41"

There is no tubing that has a use range that can accommodate both the shimmed wires and the larger diameter of the bolted connection, so another shim must be installed over the first shim. The new cable diameter can be calculated in the same manner using the tubing OD as the new OD substrate as follows:

OD substrate = 0.41" so use WCSF-300-28/8, K = 0.270

$$\text{Tubing OD} = \sqrt{(0.41"_{\text{substrate}})^2 + 0.270}$$

Tubing OD = 0.66"

Step 2: Select tubing that has use range to accommodate both connector and wires:

OD of Qualified Substrate of Wire 1:	SHIMMED TO 0.66"
OD of Qualified Substrate of Wire 2:	SHIMMED TO 0.66"
Length of bolt "L"	0.85"
Width of Lug Pad "W"	0.75"
Diameter effective	0.81"

Now the wires and the effective bolted connection diameter are within the use range of one tubing, WCSF-500-38/13-N which should be installed to overlap the outer shims on wires 1 and 2 and over the bolted connection. The bolted connection should be covered with a fiberglass bolt pad, EPPA-109N-1 before the WCSF-500-38/13 N is installed, to eliminate the sharp edges of the bolts and lugs.

When two shims are necessary, the larger diameter outer shim should be cut at least 2.25" long to comply with seal length criteria. The smaller diameter inner shim should be cut a minimum 0.5" longer than the outer shim. The outer shim should be installed centered over the inner shim.

The splice sealing sleeve must be long enough to provide proper seal length and must overlap the outer shim(s) by at least 0.25"

Step 3: Calculate the length of sealing sleeve tubing required

Outer Shim length:	2.25" on each side = 4.50"
Centering outer shim over inner shim = 0.25" in from end of inner shim:	0.25" on each side = 0.50"
sealing sleeve overlap at ends of outer shim	0.25" on each side = 0.50"
Connector length:	3.0"
Length shrinkage;	10% max

$$\text{Seal length} = \frac{4.50 + 0.50 + 0.50 + 3}{0.9} = 9.44"$$

9.44" minimum, recommended at least 12.0" standard length.

Installation Guidelines

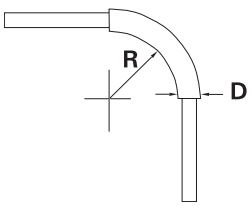
1. Clean all qualified substrates with solvents and materials approved by the cable manufacturer before installing Tyco Electronics' Raychem products. All non-qualified materials (such as braided materials or extra jackets) should be removed from the qualified substrate in the splice area.

2. When directed to do so, place all components on cables BEFORE installing crimps or other connection methods. Follow all steps of the installation instructions. Generally, shims are installed before other components and are aligned at the end of the cable insulation to be shimmed, unless otherwise directed. Where two shims are used, the inner shim should be a minimum of 0.50" longer than the outer shim.

3. Fiberglass bolt pads (EPPA-109N) are recommended for all bolted connections, including screws and nuts. They are also recommended where the hardware may have sharp corners/edges and always if the use range is at least twice the tubing's minimum use range diameters. Some kits are supplied with uncoated tubing type bolt pads. Again, follow the instructions provided with the kit.

4. Do not bend the splice when it is warm or hot. Heat-shrinkable tubings are mechanically weak when warmed during the heating process and can be punctured by the connection hardware if bent when warm.

5. Tyco Electronics' Raychem Nuclear products should not be bent (when cool) to a radius smaller than 5 times the outside diameter (D) of the installed product.
   IMPORTANT: Do not violate the cable manufacturer's bend radius criteria.



6. Generally, when shrinking tubings start at any called out dimension and shrink to the opposite end (such as shims) OR for long splice tubings, start in the center and work to one end, then the other.

7. Shrink tubings by heating on ALL sides, including the back side away from the installer. It is a common problem to underheat tubings, especially the side away from the installer; therefore, the installer should concentrate the heat source on the back side of the tubing.

8. Heat sources for installation of heat-shrink tubings include most industrial hot-air guns (best for general Nuclear Product use and small tubings) and clean burning propane torches. Contact a Tyco Electronics representative for installation product suggestions.

Inspection Guidelines

1. Tubing is fully recovered when it conforms to the substrate and has no flat sides or wrinkles. Tubing should be evenly heated and should have equal wall thickness all the way around the splice. If flat sides or wrinkles are felt with the hand (when the tubing is comfortable to feel), it is underheated. Underheated tubing can be corrected by re-heating all the way around.

2. The tubing **may** appear glossy when recovered but this is not an absolute criteria of proper installation. The sealant **may** be visible flowing from the end of the tubing and should be visible in the larger tubing sizes (larger than WCSF-200-18/5-N), but it is not always visible in the smaller sizes. The tubing is installed correctly if it conforms to the substrate and has no flat spots or wrinkles.

3. Overheating is evidenced by severe scorching or blistering. If the damage cannot be removed by solvent cleaning, the product should be replaced.

Nuclear Braided Sleeving

Selection Guide

1. Braided sleeving is a fiberglass sleeve that is used in Tyco Electronics' splice kits to protect the outer WCSF-N tubing from sharp edges and to keep the connection area free of sealant.

2. Braided sleeving has been tested for Class IE service subject to accident conditions, such as a LOCA or HELB, when used with WCSF-N tubing.

3. Braided sleeving is not intended to provide electrical insulation but rather should be used in with WCSF-N to provide the sealing and insulation of the connection.

Test Reports:
Wyle 58722-2,
EDR-5336

Description	As-supplied diameter (inches)	Nominal thickness (in)	Use range min. (in)	Use range max. (in)
EPPA-109N-1	0.5	0.03	0.5	0.9
EPPA-109N-2	0.9	0.03	0.9	1.7
EPPA-109N-3	1.4	0.03	1.4	2.8
EPPA-109N-4	2.3	0.03	2.3	4.0

NESK

Class 1E (K1) Nuclear Qualified LOCA Type Tested End Sealing Kits

NESK (Nuclear End Sealing) kits are a combination of an end cap and a support tubing that is used to seal spare or unused conductors. NESK kits have been type-tested 1E service inside containment to LOCA conditions.

NESK kit components are made from a cross-linked flame retardant polyolefin material that is very similar to the compound used in the WCSF tubing, but it is modified to allow the parts to be molded into shape.

Qualification

Test Reports: EDR-5331, EDR-5332, EDR-5336, EDR-5348, EDR-5389

Original Compound Test Reports: EDR-5009, EDR-5040, EDR-5046, Wyle 58442-2

NESK Installed

Kit Description

Original Formulation	Use Range (in)	Length (in)	Kit Description New Formulation
NESK-01-L	0.05 – 0.10	3	NESK-01-L(N)
NESK-01	0.11 – 0.16	3	NESK-01(N)
NESK-02	0.13 – 0.21	3	NESK-02 (N)
NESK-03	0.20 – 0.32	3	NESK-03(N)
NESK-04	0.30 – 0.50	3	NESK-04(N)
NESK-05	0.37 – 0.56	6	NESK-05(N)
NESK-06	0.50 – 0.90	6	NESK-06(N)
NESK-07	0.75 – 1.15	6	NESK-07(N)
NESK-08	1.00 – 1.80	9	NESK-08(N)
NESK-09	1.50 – 3.00	9	NESK-09(N)

Nuclear End Caps

Tyco Electronics can provide end caps to seal cables that are not exposed to LOCA conditions. These end caps are suitable for 1E cables in non-accident environments. The description of these caps includes the –52/144 description which stands for the Nuclear Grade Molding compound –52 and the adhesive coating /144.

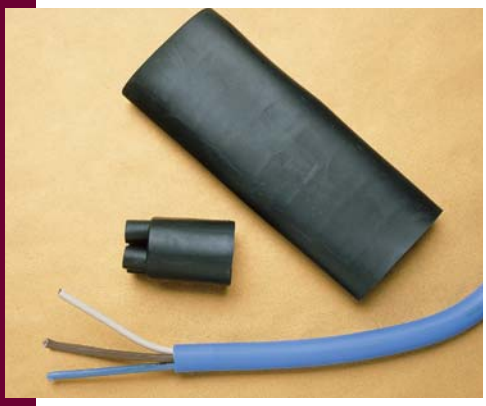
Qualification

Test Reports: EDR-5332, EDR-5336, EDR-5389

Original Compound Test Reports: EDR-5040, EDR-5058, EDR-5065, Wyle 58442-2

Nuclear Grade End Cap Use Range (not for LOCA)

Old Formulation	Use Range (in)	New Formulation
101A011-52/144	0.08 – 0.16	101A011-52/144-N
101A021-52/144	0.13 – 0.26	101A021-52/144-N
101A031-52/144	0.18 – 0.36	101A031-52/144-N
101A041-52/144	0.25 – 0.55	101A041-52/144-N
101A052-52/144	0.37 – 0.78	101A052-52/144-N
101A062-52/144	0.45 – 0.95	101A062-52/144-N
101A073-52/144	0.71 – 1.50	101A073-52/144-N
101A083-52/144	0.90 – 1.90	101A083-52/144-N
101A094-52/144	1.50 – 3.20	101A094-52/144-N



NCBK

Class 1E (K1) Nuclear Qualified LOCA Type Tested Cable Breakouts

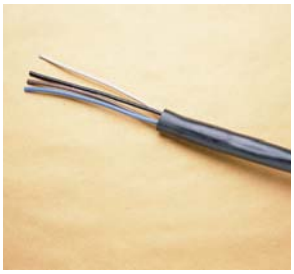
NCBK (Nuclear Cable Breakouts) kits are a combination of a cable breakout and a reinforcing tubing that is used to provide an environmental seal between the cable jacket and the individual wires of multiconductor cables. NCBK kits have been type-tested for 1E service inside containment to LOCA conditions. NCBK kit components are made from a cross-linked flame retardant polyolefin material that is very similar to the compound used in the WCSF tubing, but it is modified to allow the parts to be molded into shape.

Qualification Test Reports

EDR-5331
EDR-5332
EDR-5336
EDR-5348
EDR-5389

Original Compound Test Reports

EDR-5009
EDR-5040
EDR-5046
Wyle 58442-2



NCBK Installed

Kit Description Old Formulation	Number of Legs	Cable Jacket Diameter Range (in)	Individual Wire (leg) Diameter Range (in)	Kit Description New Formulation
NCBK-02-03	2	0.42 – 0.53	0.11 – 0.20	NCBK-02-03(N)
NCBK-02-05A	2	0.53 – 1.16	0.18 – 0.34	NCBK-02-05A(N)
NCBK-02-06A	2	0.70 – 1.84	0.30 – 0.56	NCBK-02-06A(N)
NCBK-02-07	2	1.65 – 2.85	0.55 – 1.00	NCBK-02-07(N)
NCBK-03-04A	3	0.37 – 0.50	0.10 – 0.20	NCBK-03-04A(N)
NCBK-03-05A	3	0.34 – 1.20	0.18 – 0.34	NCBK-03-05A(N)
NCBK-03-06A	3	0.71 – 1.74	0.27 – 0.50	NCBK-03-06A(N)
NCBK-03-08	3	1.56 – 2.60	0.54 – 0.98	NCBK-03-08(N)
NCBK-04-03	4	0.53 – 0.92	0.12 – 0.22	NCBK-04-03(N)
NCBK-04-04	4	0.76 – 1.22	0.19 – 0.34	NCBK-04-04(N)
NCBK-04-05	4	1.16 – 1.89	0.30 – 0.54	NCBK-04-05(N)
NCBK-04-06	4	1.84 – 2.86	0.54 – 0.98	NCBK-04-06(N)
NCBK-05-01	5	0.53 – 0.93	0.11 – 0.20	NCBK-05-01(N)

Nuclear Cable Breakouts

Nuclear Cable Breakouts

Tyco Electronics can provide cable breakouts to seal cables that are not exposed to LOCA conditions. These breakouts are suitable for 1E cables in non-accident environments. The description of these breakouts includes the –52/144 description which stands for the Nuclear Grade Molding compound (52) and the adhesive coating (144). For accident environments, breakouts must be used with WCSF Tubing

Qualification Test Reports

EDR-5332
EDR-5336
EDR-5389

Original Compound Test Reports

EDR-5040
EDR-5O58
EDR-5065
Wyle 58442-2

Nuclear Cable Breakout Use Range

Description Original Formulation	Number of Legs	Cable Jacket Diameter Range (in)	Individual Wire (leg) Diameter Range (in)	Description New Formulation
302A720-52/144	2	1.86 – 3.40	0.81 – 1.50	302A720-52/144-N
302A812-52/144	2	0.42 – 0.78	0.10 – 0.27	302A812-52/144-N
302A823-52/144	2	0.63 – 1.16	0.18 – 0.46	302A823-52/144-N
302A834-52/144	2	1.00 – 1.84	0.30 – 0.76	302A834-52/144-N
302A845-52/144	2	1.60 – 2.90	0.54 – 1.35	302A845-52/144-N
602A212-52-02/144	2	0.42 – 0.86	0.06 – 0.12	602A212-52-02/144-N
403A134-52/144	3	0.42 – 1.74	0.27 – 0.68	403A134-52/144-N
403A145-52/144	3	1.48 – 2.50	0.53 – 1.08	403A145-52/144-N
403A211-52/144	3	0.36 – 0.73	0.10 – 0.27	403A211-52/144-N
403A222-52/144	3	0.62 – 1.19	0.17 – 0.43	403A222-52/144-N
403A232-52/144	3	1.00 – 1.86	0.39 – 0.74	403A232-52/144-N
403A242-52/144	3	1.23 – 2.40	0.56 – 1.08	403A242-52/144-N
602A212-52-03/144	3	0.42 – 0.86	0.06 – 0.12	602A212-52-03/144-N
502A812-52/144	4	0.50 – 0.92	0.10 – 0.22	502A812-52/144-N
502A823-52/144	4	0.75 – 1.38	0.18 – 0.41	502A823-52/144-N
502A834-52/144	4	1.15 – 2.10	0.30 – 0.54	502A834-52/144-N
502A845-52/144	4	1.83 – 3.34	0.53 – 0.98	502A845-52/144-N
602A212-52-04/144	4	0.42 – 0.86	0.06 – 0.12	602A212-52-04/144-N
602A114-52/144	5	0.98 – 1.62	0.16 – 0.30	602A114-52/144-N
602A212-52/144	5	0.42 – 0.86	0.06 – 0.12	602A212-52/144-N
602A312-52/144	5	0.54 – 1.05	0.10 – 0.22	602A312-52/144-N
703A155-52/144	6	1.53 – 2.80	0.31 – 0.64	703A155-52/144-N
803A155-52/144	7	1.53 – 2.80	0.31 – 0.64	803A115-52/144-N
902A014-52/144	8	1.19 – 1.71	0.19 – 0.40	902A014-52/144-N

NPKC

Class 1E (K1) Nuclear Qualified
LOCA Type Tested In-Line Control Cable Splice Kits

NPKC kits are designed to insulate and environmentally seal multiconductor power cables with 2 to 12 conductors. The insulated conductors are connected with a compression connector (not supplied with kit) and then insulated with WCSF-N tubing. The jacket of the multiconductor cable is then reconstructed with WCSF-N tubing and a cable breakout, where necessary. These kits have been type tested to LOCA environments and comply with all applicable requirements of IEEE 323 and IEEE 383.

These configurations were also requalified and are now supplied with components manufactured from the new compound formulation. The most common kit sizes and configurations are listed in the following tables. Factory engineers can design other cable splice configurations. Contact your local Tyco Electronics sales representative for assistance with your application.

Qualification Test Reports
EDR-5331
EDR-5332
EDR-5336
EDR-5348
EDR-5389

Original Compound Test Reports
EDR-5009
EDR-5040
EDR-5046
Wyle 58722-2
Wyle 58722-6

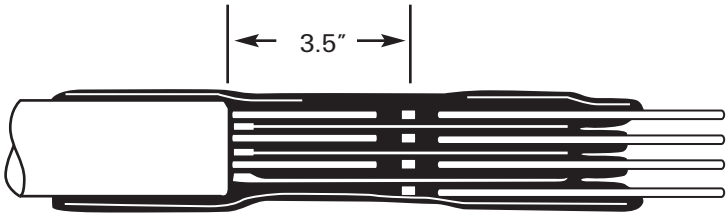
NPKC In-Line Splice

Kit Description Original Formulation	Number of Conductors	Cable Jacket OD Range – (in)	Insulated Wire OD Range – (in)	Max Conn. OD-Length (in.)	Kit Description New Formulation
NPKC-2-31A	2	0.31 – 0.60	0.11 – 0.20	0.20 x 1.2	NPKC-2-31A(N)
NPKC-3-31A	3	0.31 – 0.60	0.11 – 0.23	0.20 x 1.2	NPKC-3-31A(N)
NPKC-4-31A	4	0.31 – 0.60	0.11 – 0.23	0.20 x 1.2	NPKC-4-31A(N)
NPKC-5-31A	5	0.31 – 0.60	0.11 – 0.23	0.20 x 1.2	NPKC-5-31A(N)
NPKC-7-31A	7	0.53 – 1.0	0.11 – 0.23	0.20 x 1.2	NPKC-7-31A(N)
NPKC-9-31A	9	0.53 – 1.0	0.11 – 0.23	0.20 x 1.2	NPKC-9-31A(N)
NPKC-12-31A	12	0.53 – 1.0	0.11 – 0.23	0.20 x 1.2	NPKC-12-31A(N)

NPKC

Class 1E (K1) Nuclear Qualified
LOCA Type Tested Control Cable Transition Splice Kits

Tyco Electronics' Raychem Nuclear products can be used to provide an environmental seal when making a transition from one cable type to another. The following kits are used to transition between multiconductor cable and individual conductors.



NPKC Transition Splice

Kit Description Original Formulation	Number of Conductors	Cable Jacket OD Range – (in)	Insulated Wire OD Range – (in)	Max Conn. OD-Length (in.)	Kit Description New Formulation
NPKC-2-21A	2	0.31 – 0.60	0.11 – 0.20	0.23 x 1.2	NPKC-2-21A(N)
NPKC-3-21A	3	0.31 – 0.60	0.11 – 0.20	0.23 x 1.2	NPKC-3-21A(N)
NPKC-4-21A	4	0.31 – 0.60	0.11 – 0.20	0.23 x 1.2	NPKC-4-21A(N)
NPKC-5-21A	5	0.31 – 0.60	0.11 – 0.20	0.23 x 1.2	NPKC-5-21A(N)
NPKC-7-21A	7	0.53 – 1.00	0.13 – 0.20	0.23 x 1.2	NPKC-7-21A(N)
NPKC-9-21A	9	0.53 – 1.00	0.11 – 0.20	0.23 x 1.2	NPKC-9-21A(N)
NPKC-12-21A	12	0.53 – 1.00	0.13 – 0.20	0.23 x 1.2	NPKC-12-21A(N)

NPKC Terminal Block Replacement Kits

1. NPKC kits are designed to insulate and environmentally seal control cable splices that are single conductor in-line, WYE, or H configurations. These kits have been designed to replace terminal block connections.
2. All kits are designed for Class IE service inside containment subject to accident conditions such as LOCA or HELB.
3. Qualification type-tests are valid when kits are used within the specified range shown in the tables below. Use of the product beyond these ranges may invalidate these tests.

Single Conductor In-Line Bolted

Kit Description Original Formulation	Wire O.D. Range (in)	Max. Bolt Size (DxL**)	Installed Dimensions	Kit Description New Formulation
NPKC-1-12A*	0.11 - 0.23	#10 x 5/16	1/2 D x 7 L	NPKC-1-12A(N)*
NPKC-1-12B	0.20 - 0.40	1/4 x 3/8	3/4 D x 9 L	NPKC-1-12B (N)

Wye Splices, Bolted

Kit Description Original Formulation	Number of Wires	Max Bolt Size (DxL**)	Installed Dimensions	Parallel Wire O.D. Range	1/C O.D. Range	Kit Description New Formulation
NPKC-3-42A*	3	#10 x 1/2	3/4 D x 6 L	0.11 - 0.20	0.11 - 0.20	NPKC-3-42A(N)*
NPKC-3-42B	3	5/16 x 3/4	1 D x 6 L	0.18 - 0.34	0.14 - 1.0	NPKC-3-42B (N)

H Splices Bolted

Kit Description Original Formulation	Number of Wires	Max. Bolt Size (DxL**)	Installed Dimensions	Wire O.D. Range	Kit Description New Formulation
NPKC -4-62A*	4	#10 x 1/2	1 D x 6 L	0.10 - 0.20	NPKC -4-62A(N)*
NPKC - 4-62B	4	5/16 x 3/4	1 D x 6 L	0.18 - 0.34	NPKC - 4-62B (N)

** For thin insulation on penetration or device leads with diameters between 0.05 and 0.10, WCSF-050-3/1-N should be used in conjunction with the referenced kit. WCSF-050-3/1-40N (40 inch length) is also available for field cutting.*

***(D x L) Bolt Length not including head.*

NPKP

Class 1E (K1) Nuclear Qualified
LOCA Type Tested In-Line Power Cable Splice Kits

NPKP kits are designed to insulate and environmentally seal multiconductor power cables with two or three conductors. The insulated conductors are connected with a compression connector (not supplied with kit) and then insulated with WCSF-N tubing. The jacket of the multiconductor cable is then reconstructed with WCSF-N tubing and a cable breakout, where necessary. These kits have been type tested to LOCA environments and comply with all applicable requirements of IEEE 323 and IEEE 383.

These configurations were also requalified and are now supplied with components manufactured with the new compound formulation. The most common kit sizes and configurations are listed in the tables below. Factory engineers can design other cable splice configurations. Contact your local Tyco Electronics sales representative for assistance with your application.

Qualification Test Reports
EDR-5331
EDR-5332
EDR-5336
EDR-5348
EDR-5389

Original Compound Test Reports
EDR-5009
EDR-5040,
EDR-5046
Wyle 58722-2
Wyle 58722-6

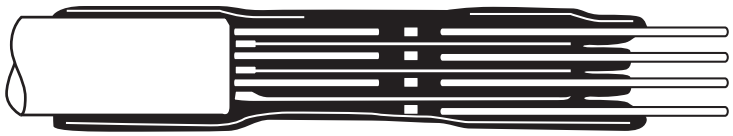
NPKP In-Line Splice

Kit Description Original Formulation	Number of Conductors	Cable Jacket OD Range – (in)	Insulated Wire OD Range – (in)	Max Conn. OD-Length (in.)	Kit Description New Formulation
NPKP-2-31A	2	0.53 – 1.00	0.20 – 0.40	0.40 x 1.2	NPKP-2-31A(N)
NPKP-3-31B	3	0.53 – 1.00	0.20 – 0.40	0.40 x 1.2	NPKP-3-31B(N)
NPKP-3-31C	3	0.70 – 2.00	0.31 – 0.60	0.60 x 2.0	NPKP-3-31C(N)

NPKP

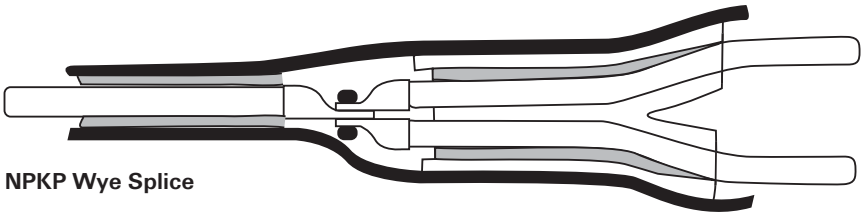
Class 1E (K1) Nuclear Qualified
LOCA Type Tested Power Cable Transition Splice Kits

Tyco Electronics' Raychem Nuclear products can be used to provide an environmental seal when making a transition from one cable type to another. The following kits are used to transition between multiconductor cable and individual conductors:



NPKP Transition Splice

Kit Description Original Formulation	Number of Conductors	Cable Jacket OD Range (in)	Insulated Wire OD Range (in)	Max Conn. OD-Length (in.)	Kit Description New Formulation
NPKP-3-21B	3	0.77 – 1.3	0.31 – 0.50	0.50 x 4.0	NPKP-3-21B(N)
NPKP-3-21E	3	0.77 – 1.3	0.27 – 0.40	0.40 x 3.0	NPKP-3-21E(N)



NPKP Wye Splice

Kit Description Original Formulation	Parallel Wires Dia. Range (in)	Single Wire Dia. Range (in)	Crimped or Bolted	Max Conn. Length (in)	Max Bolt Size (Std Bolt Size)	Tang Width	Kit Description New Formulation
NPKP-2-41A	0.10 - 0.20	0.31 - 0.60	Crimped	2.0	N/A	N/A	NPKP-2-41A(N)
NPKP-2-41B	0.18 - 0.34	0.31 - 0.60	Crimped	3.0	N/A	N/A	NPKP-2-41B(N)
NPKP-2-41E	0.18 - 0.34	0.20 -0.40	Crimped	3.0	N/A	N/A	NPKP-2-41E(N)
NPKP-3-41D	0.53 - 0.98	0.75 - 1.3	Crimped	3.0	N/A	N/A	NPKP-3-41D(N)
NPKP-3-42A	0.31 - 0.52	0.31 - 0.60	Bolted	3.6	5/16 x 3/4*	0.44 - 0.88	NPKP-3-42A(N)

Note: The above product selection guide is for standard kits in typical plant configurations. For custom applications or configurations, please contact your local Tyco Electronics Sales Representative.

** Bolt length not including head.*

NPKS

Class 1E (K1) Nuclear Qualified
LOCA Type Tested In-Line Instrumentation Cable Splice Kits

NPKS kits are designed to insulate and environmentally seal instrumentation cables splices, i.e. shielded twisted pairs. The insulated conductors are connected with a compression connector (not supplied with kit) and then insulated with WCSF-N tubing. The jacket of the multiconductor cable is then reconstructed with WCSF-N tubing and a cable breakout where necessary. These kits have been type tested to LOCA environments and comply with all applicable requirements of IEEE 323 and IEEE 383.

These configurations were also requalified and are now supplied with components manufactured with the new compound formulation. The most common kit sizes and configurations are listed in the following tables. Factory engineers can design other cable splice configurations. Please contact your local Tyco Electronics sales representative for assistance with your application.

Qualification Test Reports
EDR-5331
EDR-5332
EDR-5336
EDR-5348
EDR-5389

Original Compound Test Reports
EDR-5009
EDR-5040
EDR-5046
Wyle 58722-2
Wyle 58722-6

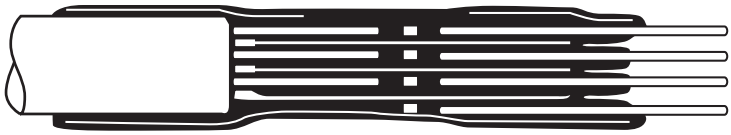
NPKS In-Line Splice

Kit Description Original Formulation	Number of Conductors	Cable Jacket OD Range (in)	Insulated Wire OD Range (in)	Max Conn. OD-Length (in.)	Kit Decscription New Formulation
NPKS-2-31A	2	0.31 – 0.60	0.07 – 0.14	0.14 x 1.2	NPKS-2-31A(N)
NPKS-2-31B	2	0.31 – 0.60	0.11 – 0.19	0.23 x 1.2	NPKS-2-31B(N)
NPKS-3-31A	3	0.31 – 0.60	0.07 – 0.14	0.14 x 1.2	NPKS-3-31A(N)
NPKS-3-31B	3	0.31 – 0.60	0.11 – 0.23	0.23 x 1.2	NPKS-3-31B(N)
NPKS-4-31A	4	0.31 – 0.60	0.07 – 0.14	0.14 x 1.2	NPKS-4-31A(N)
NPKS-4-31B	4	0.31 – 0.60	0.11 – 0.23	0.23 x 1.2	NPKS-4-31B(N)

NPKS

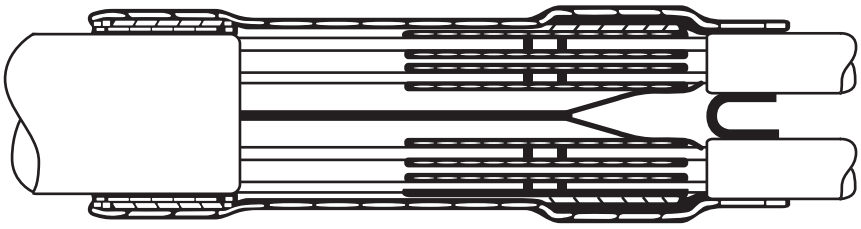
Class 1E (K1) Nuclear Qualified
LOCA Type Tested Instrumentation Transition Splice Kits

Tyco Electronics' Raychem Nuclear products can be used to provide an environmental seal when making a transition from one cable type to another. The following kits are used to transition between multiconductor instrumentation cable and individual conductors.



NPKS Transition Splice

Kit Description Original Formulation	Number of Conductors	Cable Jacket OD Range (in)	Insulated Wire OD Range (in)	Max Conn. OD-Length (in.)	Kit Description New Formulation
NPKS-2-21A	2	0.31 – 0.60	0.07 – 0.12	0.14 x 1.2	NPKS-2-21A(N)
NPKS-2-21B	2	0.31 – 0.60	0.11 – 0.20	0.23 x 1.2	NPKS-2-21B(N)
NPKS-3-21A	3	0.31 – 0.60	0.07 – 0.12	0.14 x 1.2	NPKS-3-21A(N)
NPKS-3-21B	3	0.31 – 0.60	0.11 – 0.20	0.23 x 1.2	NPKS-3-21B(N)
NPKS-4-21A	4	0.31 – 0.60	0.07 – 0.12	0.14 x 1.2	NPKS-4-21A(N)



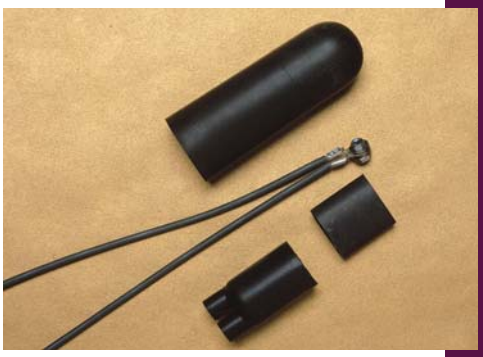
1 STQ to 2STP Cables

Kit Description Original Formulation	Number of Conductors	Cable Jacket OD Range (in)	Insulated Wire OD Range (in)	Max Conn. OD-Length (in.)	Kit Description New Formulation
NPKS-4-41A	4	0.31 – 0.60 (STQ)	0.07 – 0.14	1.2	NPKS-4-41A(N)
		0.19 - 0.34 (STP)	0.07 - 0.14	1.2	

Note: The above product selection guide is for standard kits in typical plant configurations. For custom applications or configurations please contact your local Tyco Electronics Area Sales Representative.

NPKV

Class 1E (K1) Nuclear Qualified
LOCA Type Tested Small Conductor "V" -Stub Splice Kits



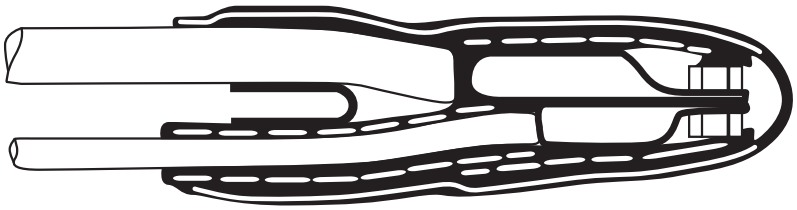
NPKV kits are designed to insulate and environmentally seal small diameter (0.05" – 0.34") wires in small enclosures typically found in valves, limit switches, small motors, and other areas where the connection space is limited. The insulated conductors are typically connected with a ring lug terminal and screws and nuts (compression connectors can also be used) then insulated and sealed with a combination of nuclear grade breakouts, tubings and molded end caps. Connection hardware is not supplied with the kit. These kits have been type-tested to LOCA environments and comply with all applicable requirements of IEEE 323 and IEEE 383.

These configurations were also requalified and are now supplied with components manufactured with the new compound formulation. The most common kit sizes and configurations are listed in the tables. Factory engineers can design other cable splice configurations. Please contact your local Tyco Electronics Sales representative for assistance.

Qualification Test Reports:
EDR-5331
EDR-5332
EDR-5336
EDR-5348
EDR-5389

Original Compound Test Reports:
EDR-5040
EDR-5046
Wyle 58722-1

NPKV installed



NPKV drawing

Kit Description Original Formulation	Number of Conductors	Wire OD Range (in)	Max. Lug Tang Width	Max Bolt Size (Std Bolt Size)	Kit Description New Formulation
NPKV-2-16	2	0.06 – 0.12	0.36	#10 x 1/2 *	NPKV-2-16(N)
NPKV-2-14	2	0.11 – 0.20	0.45	1/4 x 1/2 *	NPKV-2-14(N)
NPKV-2-10	2	0.11 – 0.34	0.60	5/16 x 3/4 *	NPKV-2-10(N)
NPKV-3-16	3	0.06 – 0.12	0.36	#10 x 1/2 *	NPKV-3-16(N)
NPKV-3-14	3	0.10 – 0.20	0.45	1/4 x 1/2 *	NPKV-3-14(N)
NPKV-3-10A	3	0.18 - 0.34	1.0	5/16 x 3/4*	NPKV-3-10A (N)
NPKV-4-14	4	0.10 – 0.20	0.50	1/4 x 1/2 *	NPKV-4-14(N)
NPKV-4-10	4	0.18 – 0.34	1.0	5/16 x 3/4 *	NPKV-4-10(N)

Notes:
1. A compression parallel connector may replace the bolted connection for any kit.
2. The above product selection guide is for standard kits in typical plant configurations. For custom applications or configurations contact your local Tyco Electronics Sales Representative.

** Bolt length not including head.*

NMCK

Class 1E (K1) Nuclear Qualified
LOCA Type-Tested Motor Connection Kits

NMCK kits are designed to insulate and environmentally seal Class 1E cable connections at 1000 volt motors. Each kit contains components to insulate three phases for a typical bolted lug connection inside the motor connection box. Connection hardware is not supplied with the kit. These kits have been type tested to LOCA environments and comply with all applicable requirements of IEEE 323 and IEEE 383.

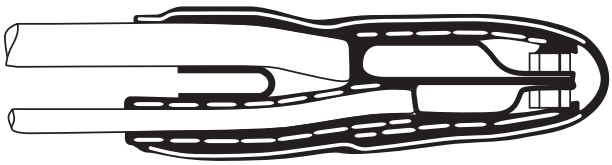
These configurations were also requalified and are now supplied with components manufactured with the new compound formulation. The most common kit sizes and configurations are listed in the tables below. Factory engineers can design other cable splice configurations. Please contact your local Tyco Electronics Sales Representative for assistance with your application.

Qualification Test Reports:

EDR-5331 EDR-5348
EDR-5332 EDR-5389
EDR-5336

Original Compound Test Reports:

EDR-5009 EDR-5260
EDR-5040 Wyle 58722-1
EDR-5046 Wyle 58722-2

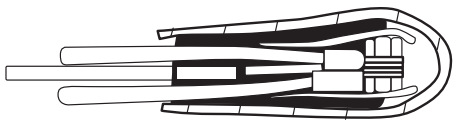


Stub configuration 2 wire per phase

1E LOCA Motor Connection Kit (3 Phase) Single Feeder to Motor Lead:

Kit Description Original Formulation	Feeder Wire OD Range (in)	Motor Wire OD Range (in)	Max. Lug W x L (in)	Max Bolt Size (Std Bolt Size)	Nominal Installed Dimensions (L x D inch)	Kit Description New Formulation
NMCK-1V	0.10 – 0.20	0.10 – 0.20	0.38 x 2.0	#10 x 5/16 *	4 x .75	NMCK-1V(N)
NMCK-2V	0.18 – 0.34	0.11 – 0.34	0.60 x 3.0	5/16 x 1/2 *	5 x 1	NMCK-2V(N)
NMCK-3V	0.30 – 0.60	0.20 – 0.60	0.95 x 4.8	1/2 x 7/8 *	6 x 1.5	NMCK-3V(N)
NMCK-4V	0.55 – 1.04	0.31 – 1.04	1.6 x 6.5	5/8 x 1-1/4 *	8 x 2	NMCK-4V(N)
NMCK-5V	0.81 – 1.5	0.53 – 1.50	2.75 x 8.0	5/8 x 1-1/2 *	14 x 2.75	NMCK-5V(N)

**L = Bolt length, not including head*



Stub configuration 3 wire per phase

1E LOCA Motor Connection Kit V Type Parallel Feeder to Motor Lead:
NMCK Motor connection kits are also available for parallel feeders to a single motor lead. These kits are similar in construction to the NMCK V series but have a three finger breakout to accommodate the parallel feeder and single motor lead. These kits have been type tested to LOCA environments and comply with all applicable requirements of IEEE 323 and IEEE 383.

These configurations were also requalified and are now supplied with components manufactured with the new compound formulation. The most common kit sizes and configurations are listed in the following tables. Factory engineers can design other cable splice configurations. Please contact your local Tyco Electronics Sales Representatives for assistance with your application.

Kit Description Original Formulation	Feeder Wire OD Range (in)	Motor Wire OD Range (in)	Max. Lug W x L* (in)	Max Bolt Size (Std Bolt Size)	Nominal Installed Dimensions (L x D inch)	Kit Description New Formulation
NMCK-3-52AA	0.10 – 0.20	0.10 – 0.20	0.60 x 2.0	1/4 x 1/2*	6 x 1	NMCK-3-52AA(N)
NMCK-3-52BB	0.18 – 0.34	0.18 – 0.34	1.02 x 4.0	1/4 x 3/4 *	6 x 1.5	NMCK-3-52BB(N)
NMCK-3-52DD	0.27 – 0.50	0.13 – 0.23	0.50 x 3.0	3/8 x 3/4 *	8 x 2	NMCK-3-52DD(N)
NMCK-3-52EE	0.27 – 0.50	0.20 – 0.50	0.50 x 3.0	3/8 x 3/4 *	8 x 2	NMCK-3-52EE(N)
NMCK-3-52FF	0.53 – 0.98	0.20 – 0.98	1.90 x 6.0	1/2 x 1-1/2*	8 x 2	NMCK-3-52FF(N)

**L = Bolt length, not including head*

NMCK In-Line Single Feeder Motor Connection Kit:

1E LOCA Motor Connection Kit In-Line Single Feeder to Motor Lead:
NMCK Motor connection kits are also available for In-Line connections to a single or parallel feeder to a motor lead.

Qualification Test Reports:
EDR-5331
EDR 5336
EDR 5348
EDR-5389

Original Compound Test Reports:
EDR-5009
EDR-5046
EDR 5260
Wyle 58722-2

NMCK In-Line Splice

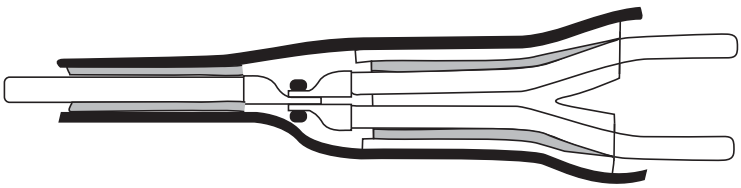
Kit Description Orignial Formulation	Feeder Cable OD Range (in)	Motor Lead OD Range (in)	Max. Lug W x L (in)	Max Bolt Size (Std Bolt Size)	Nominal Installed Dimensions (L in.)	Kit Description New Formulation
NMCK-0L-35-00	0.11 – 0.40	0.11 – 0.40	0.40 x 2.0	#10 x 5/16 *	9	NMCK-0L (N)
NMCK-1L-35-00	0.20 – 0.60	0.20 – 0.60	0.71 x 2.7	1/4 x 1/2 *	12	NMCK-1L (N)
NMCK-2L-35-00	0.31 – 1.30	0.31 – 1.30	0.95 x 5.0	1/2 x 7/8*	15	NMCK-2L (N)
NMCK-3L-35-00	0.77 – 2.00	0.77 – 2.00	1.60 x 6.5	5/8 x 1-1/4*	21	NMCK-3L (N)
NMCK-4L-35-00	1.35 – 3.00	1.35 – 3.00	2.51 x 7.0	5/8 x 1-1/2*	24	NMCK-4L (N)

**L = Bolt length, not including head*

NMCK Y Splice

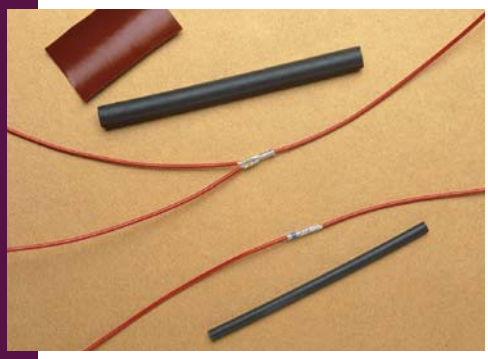
Qualification Test Reports:
EDR-5331
EDR-5332
EDR 5336
EDR 5348
EDR-5389

Original Compound Test Reports:
EDR-5009
EDR-5040
EDR-5046
Wyle 58722-2
Wyle 58722-6



Kit Description Original Formulation	Feeder Wire OD Range (in)	Motor Wire OD Range (in)	Max. Lug W x L (in)	Max Bolt Size (Std Bolt Size)	Nominal Installed Dimensions (L in.)	Kit Description New Formulation
NMCK-3-42A	1.10 - 2.00	0.30 – 0.56	1.90 x 7.4	1/2 x 1-1/2 *	15	NMCK-3-42A (N)
NMCK-3-42B	1.65 – 3.00	0.60 – 1.00	2.51 x 8.4	1/2 x1-1/2 *	15	NMCK-3-42B (N)
NMCK-3-42C	0.77 – 1.30	0.30 – 0.56	1.30 x 3.9	1/2 x 1 *	9	NMCK-3-42C (N)
NMCK-3-42D	0.77 – 1.30	0.54 – 0.93	1.60 x 6.5	1/2 x 1-1/2 *	15	NMCK-3-42D (N)

**L = Bolt length, not including head*



NTBR

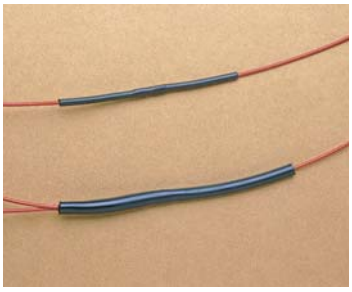
Class 1E (K1) Nuclear Qualified
LOCA Type Terminal Block Replacement Kits

NTBR kits are designed to insulate and environmentally seal Class 1E wires that are relatively small (0.05" to 0.15" using WCSF 050-3/1 up to WCSF-115 –9/3). Connectors are not supplied with kits but can be ordered separately from Tyco Electronics. These kits have been type tested to LOCA environments and comply with all applicable requirements of IEEE 323 and IEEE 383.

These configurations use WCSF 050 3/1 as a sealed environmentally qualified electrical connection. Combinations of single wires to single wires, single wires to two wires, or two wires crimped to two wires were tested using a mastic block of S1119 adhesive instead of the normal two leg breakout on the two wire side for sealing. All of these configurations passed direct exposure to LOCA conditions; however, it is recommended that these splices be installed in an enclosure. The NTBR kit is designed to replace small terminal blocks in penetrations or other terminal block cabinets.

Qualification Test Reports

EDR-5331
EDR-5336
EDR-5348



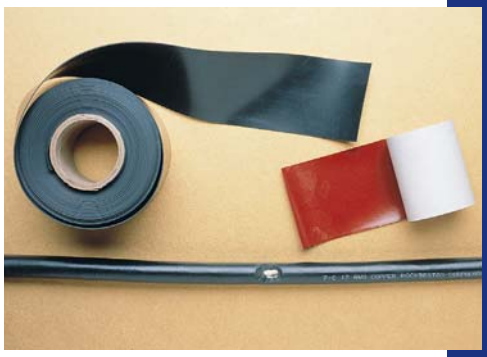
NTBR installed

1E LOCA Terminal Block Replacement Kit

New Kit Description	Single Wire OD Range (in)	2 Wire OD Range (in)	Connector Dimensions OD x L (in)	Terminations Per Kit
NTBR-A-1-1(N)	0.05 - 0.07	N/A	0.10 x 1	10 splices
NTBR-A-1-2(N)	0.07 - 0.18	0.05 – 0.08	0.18 x 1	10 splices
NTBR-A-2-2(N)	N/A	0.05 – 0.08	0.18 x 1	6 splices
NTBR-B-1-1(N)	0.07 - 0.18	N/A	0.18 x 1	6 splices
NTBR-B-1-2(N)	0.115 - 0.29	0.07 – 0.13	0.29 x 1	6 splices
NTBR-B-2-2(N)	N/A	0.07 – 0.13	0.29 x 1	6 splices

NWRT Nuclear Grade Heat-Shrinkable Tape

Class 1E (K1) Nuclear Qualified
LOCA Type-Tested Heat-Shrinkable Tape



NWRT is a flame retarded, cross-linked polyolefin heat-shrinkable tape that is designed for electrical connections on Class 1E (K1) circuits in LOCA environments. NWRT is a kit composed of WWTF flame retardant and heat-shrinkable insulation tape and the same sealant used in WCSF in a rolled form, called S1119. The sealant is wrapped around the cable insulation and bare conductor or crimped connection area (bolted connections should not be used with NWRT). The WWTF tape is wrapped and shrunk down to complete the sealed connection. NWRT is ideal for use on jacket or insulation damaged areas of cable where it is impossible to place heat-shrink tubing such as WCSF.

NWRT can be used as moisture sealing and repair on damaged wires or cable having diameters ranging from 0.07" to 0.4" and can be used over crimped connections of the same use range. For wires or cables larger than 0.40", NJRT tape is recommended.

NWRT is supplied under Tyco Electronics' comprehensive Quality Assurance program with certified documentation to meet industry requirements for safety related electrical equipment:

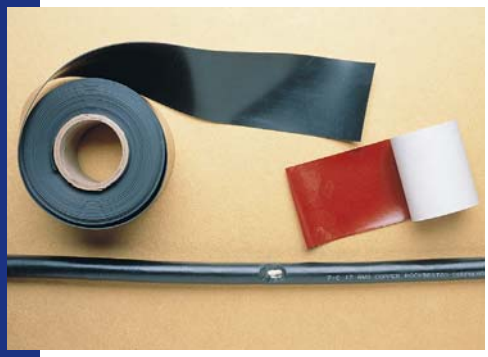
Qualification Report
EDR-5046
EDR-5258
EDR-5021

Flammability
Passed ICEA S-19-81 Sec. 6.19.6

NWRT installed

Ordering Information

Description	Width	Cable OD Range	# Rolls -Length /roll range per kit	Wall thickness Supplied/Recovered
NWRT-1	0.5"	0.07" – 0.4"	2- 10' WWTF Tape 1 - 5' S1119 Sealant	0.012 /0.02 WWTF N/A for S1119



NJRT Nuclear Grade Heat-Shrinkable Tape

Class 1E (K1) Nuclear Qualified
LOCA Type-Tested Heat-Shrinkable Tape

NJRT is a flame retarded, cross-linked polyolefin heat-shrinkable tape that is designed for electrical connections on Class 1E (K1) circuits in LOCA environments. NJRT is a kit composed of WBTF flame retardant and heat-shrinkable insulation tape and the same sealant used in WCSF in a rolled form, called S1119. The sealant is wrapped around the cable insulation and bare conductor or crimped connection area (bolted connections should not be used with NJRT). The WBTF tape is wrapped and shrunk down to complete the sealed connection. The NJRT is ideal for use on jacket or insulation damaged areas of cable where it is impossible to place heat-shrink tubing such as WCSF.

NJRT can be used as moisture sealing and repair on damaged wires or cable having diameters larger than 0.4" and can be used over crimped connections of the same use range. For wires or cables smaller than 0.4", NWRT tape is recommended.

NJRT is supplied under Tyco Electronics comprehensive Quality Assurance program with certified documentation to meet industry requirements for safety related electrical equipment.

Flammability
Passed ICEA S-19-81 Sec. 6.19.6

Qualification Reports
EDR-5336
EDR-5331
EDR-5021

NJRT installed

Ordering Information

Description	Tape Width	OD range	# Rolls-Length /roll per kit	Wall thickness (in.) Supplied/Recovered
NJRT-1N	1.0"	> 0.4"	8- 25' WBTF Tape 16 - 5' S1119 Sealant	0.025 /0.035 WBTF N/A for S1119
NJRT-2N	2.0"	> 1.0"	4- 25' WBTF Tape 4 - 5' S1119 Sealant	0.025 /0.035 WBTF N/A for S1119

NHVT

Nuclear High Voltage Terminations for 1/C Shielded Cables 5-15kV

NHVT after installation

NHVT kits are designed to properly terminate and environmentally seal shielded medium voltage (also referred to as high-voltage) indoor power cables rated up to 15kV. These kits are used for several shield configurations such as copper tape, drain wire, and other common metallic shielding systems. The termination uses Raychem Stress Control Tubing for electrical stress mitigation at the semi-con shield termination, nuclear grade sealants and the Raychem Non-Tracking tubing on the outer surface to provide a sealed IEEE 48 Class 1 termination. NHVT terminations are used in medium voltage motors (up to 15 kV), at penetrations, inside switchgear, and at transformer connections.

NHVT kits have been qualification type-tested for Class 1E circuits with limited harsh environmental exposure (HELB conditions as described in EDR 5037). **Note: These terminations are not qualified to LOCA conditions.**

Test Reports

EDR-5018
EDR-5021
EDR-5022
EDR-5037
EDR-5060
EDR-5063
Report 71100, Rev. 1

Kit Description	Nominal Conductor Size 5 kV – AWG/kcmil	Nominal Conductor Size 8 kV AWG/kcmil	Min. Insulation OD inch (mm)	Min. Lug OD inch (mm)	Max. Jacket OD inch (mm)
NHVT-80G	#4 -1/0	#4 - 1/0	0.42 (10)	0.34 (9)	0.80 (20)
NHVT-81G	2/0 - 250	#1 - 4/0	0.59 (15)	0.47 (12)	1.10 (28)
NHVT-82G	250 - 400	4/0 - 500	0.80 (20)	0.65 (16)	1.40 (36)
NHVT-83G	500 - 750	500 - 750	1.02 (26)	0.90 (23)	1.75 (44)
NHVT-84G	750 - 1500	750 - 1250	1.15 (29)	1.00 (25)	2.10 (53)
NHVT-85G	1500 - 2000	1250 - 2000	1.55 (39)	1.40 (35)	2.60 (66)

Kit Description	Nominal Conductor Size15 kV – AWG/kcmil	Min. Insulation OD inch (mm	Min. Lug OD inch (mm)	Max. Jacket OD inch (mm)
NHVT-151G	#2 -2/0	0.59 (15)	0.47 (12)	1.10 (28)
NHVT-152G	2/0 - 250	0.80 (20)	0.65 (16)	1.40 (36)
NHVT-153G	350 - 500	1.02 (26)	0.90 (23)	1.75 (44)
NHVT-154G	500 - 1000	1.15 (29)	1.00 (25)	2.10 (53)
NHVT-155G	1250- 2000	1.73 (44)	1.70 (43)	3.40 (86)

NHVT Conversion Chart

New NHVT Kit	Comparable Old Kit	
5/8kV	5kV	8kV
NHVT-80G	NHVT-I-A/01-0-00	NHVT-I-A-0-00
NHVT-81G	NHVT-I-A/01-1-00	NHVT-I-A-1-00
NHVT-82G	NHVT-I-A/01-2-00	NHVT-I-A-2-00
NHVT-83G	NHVT-I-A/01-2-88	NHVT-I-A-2-88
NHVT-84G	NHVT-I-A/01-3-88	NHVT-I-A-3-88
		NHVT-1-A-3-00
NHVT-85G	NHVT-I-A/01-4-00	NHVT-I-A-4-00
15kV	**15kV**	
NHVT-151G	NHVT-I-B-1-00	
NHVT-152G	NHVT-I-B-2-00	
NHVT-153G	NHVT-I-B-2-88	
	NHVT-I-B-3-00	
NHVT-154G	NHVT-I-B-3-88	
NHVT-155G	NHVT-I-B-4-00	
	NHVT-I-B-4-88	

The old NHVT kit descriptions have been simplified. Use the conversion chart to compare old descriptions with new descriptions and check the application ranges.

MOD-3-NHVT

3/C modification kits for use with Tyco Electronics' Raychem NHVT 1/C nuclear medium voltage terminations, (5-15kV)

The MOD-3-NHVT kits are designed to trifurcate 3/C cables into three 1/C cables by adding rejacketing tubing to the phase conductors and a sealing breakout boot to the crotch area of the 3/C cable. Once installed, the three 1/C cables are then terminated with standard 1/C NHVT kits.

To determine the correct MOD-3-NHVT kit, first select three NHVT single-conductor terminations. Then use the Selection Table below to choose the correct kit. If the diameters of your cable fall outside the MOD-3-NHVT use range, contact your local Tyco Electronics Sales Representative.

Test Reports
EDR-5331
EDR-5332
EDR-5336
EDR-5348
EDR-5389

MOD-3-NHVT dimensions in inches *(millimeters)*

Catalog Number	Min Insulation diameter inch *(mm)*	Max insulation shield diameter inch *(mm)*	3/C cable jacket diameter range inch *(mm)*
MOD-3A-NHVT	0.42 *(14)*	1.05 *(27)*	1.25-3.00 *(31-76)*
MOD-3B-NHVT	0.70 *(18)*	1.75 *(44)*	2.30-4.65 *(58-118)*
MOD-3C-NHVT	1.02 *(26)*	2.0 *(50)*	2.30-4.65 *(58-118)*

Selection table

For this 1/C Kit	Use this MOD-3- NHVT kit
NHVT-80G	MOD-3A-NHVT
NHVT-81G	MOD-3B-NHVT
NHVT-82G	MOD-3B-NHVT
NHVT-83G	MOD-3C-NHVT
NHVT-84G	MOD-3C-NHVT
NHVT-85G	MOD-3C-NHVT
NHVT-151G	MOD-3B-NHVT
NHVT-152G	MOD-3B-NHVT
NHVT-153G	MOD-3C-NHVT
NHVT-154G	MOD-3C-NHVT
NHVT-155G	MOD-3C-NHVT

Ground Clamp Accessory Kit

The GCA kit is a solderless connector system for metallic-tape shielded power cables. The GCA clamp is a constant force spring that is installed without tools by simply wrapping it around the cable over the ground strap. The clamp is supplied in kit form along with a solder-blocked, tinned copper braid that is sized to match the cable shield ampacity.

The GCA kit is designed to maintain solid contact with the cable shield during normal full load or short circuit conditions. The tool-free design eliminates possible cable damage from soldering heavy gauge strap to a thin cable shield. The GCA kit also provides a distributed contact area which minimizes overheating at the shield connection point.

The GCA Kit is intended for use with Nuclear High Voltage Terminations (NVHT). It is comprised entirely of metallic components, and specific nuclear environmental testing is not considered applicable.

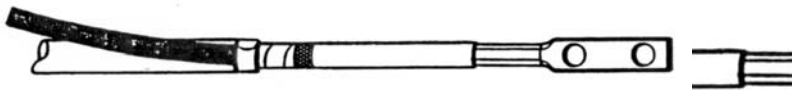
Test Reports

EDR-5024

This product has not been tested by Tyco Electronics to the special environmental requirements for use on Class IE circuits subject to accident conditions.

GCA kit inches *(millimeters)*

Kit Description	Cable shield OD inch *(mm)*	Braid Length inch *(mm)*	Equivalent Braid AWG
GCA-824-1N(G1-MOD)	0.40 - 1.35 *(10 - 34)*	24 *(610)*	8 AWG
GCA-860-1N(L1-MOD)	0.40 - 1.35 *(10 - 34)*	60 *(1500)*	8 AWG
GCA-624-2N(G2-MOD)	1.10 - 2.25 *(28 - 57)*	24 *(610)*	6 AWG
GCA-660-2N(L2-MOD)	1.10 - 2.25 *(28 - 57)*	60 *(1500)*	6 AWG
GCA-424-3N(G3-MOD)	1.65 - 3.50 *(42 - 89)*	24 *(610)*	4 AWG
GCA-460-3N(L3-MOD)	1.65 - 3.50 *(42 - 89)*	60 *(1500)*	4 AWG



NMCK8

5-8 kV Motor Connection Kits

NMCK8-V Stub or V Type Kit

NMCK8-V kits are designed to insulate and environmentally seal Medium Voltage cable connections at motors with a stub or V configuration. Each kit contains components to insulate three phases for a typical bolted lug connection inside the motor connection box. These kits have been type-tested for 1E (K1) circuits in harsh environments according to the reports listed below. Tyco Electronics' NHVT kits should be used to terminate shielded cables and are not supplied with NMCK8 kits. Connection hardware is not supplied with kit.

Original Qualification Test Reports

EDR-5009
EDR-5037
EDR-5040
EDR -5046
EDR-5063
EDR-5190
EDR-5260
Wyle 58772-1

Test Reports

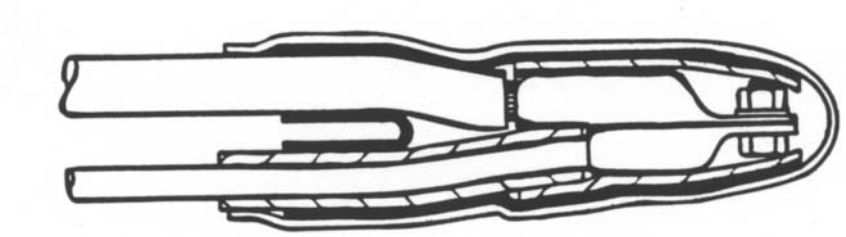
EDR-5331 EDR-5332
EDR-5336 EDR-5348
EDR-5389

These original qualification test reports used previous compound formulations for the WCSF material based parts. EDR-5336/EDR-5389 have shown the new compound formulation parts to be identical in form, fit, and function to the parts used in the listed reports. The kits listed in the selection guide use new Qualification 2001 based Molded Parts and WCSF tubing.

Stub Type NMCK8-V kits	New Kit Descriptions	
Selection Criteria	**NMCK8-4V (N)**	**NMCK8-5V(N)**
Shielded Cable Insulation OD	0.30 - 0.87	0.64 – 1.31
Non Shielded Cable OD	0.54 – 1.00	0.81 – 1.50
Motor Lead Diameter	0.31 – 1.00	0.53 – 1.50
Maximum Bolt (Std size)	1/2 x 1.0*	1/2 x 1.50*
Maximum Lug (W x L x barrel OD)	1** x 6 x 0.81	2.5** x 7 x 1.44
Completed Length x Diameter	8 x 2.2	12 x 3.0
Slipback space	5.0 + Connection length	7.0 + Connection length
Original Kit Description	NMCK8-4V	NMCK8-5V

Note: L = Bolt length, not including head*
*** Or washer width, if wider than lug tang*

NMCK8 Stub or V Type



NMCK8

5-8 kV In-Line Motor Connection Kits

NMCK8-L Type In-Line

NMCK8-L kits are designed to insulate and environmentally seal Medium Voltage cable connections at motors with an in-line configuration. Each kit contains components to insulate three phases for a typical bolted lug connection inside the motor connection box. Tyco Electronics' NHVT kits should be used to terminate shielded cables and are not supplied with NMCK8 kits. Connection hardware is not supplied with kit. These kits have been type tested for 1E (K1) circuits in harsh environments according to the reports listed:

Qualification Test Reports

EDR-5021
EDR-5037
EDR-5060
EDR-5063

NMCK8 In-Line Type

Kit Descriptions

Selection Criteria	NMCK8-1L	NMCK8-2L
Shielded Cable Insulation OD	0.53 – 1.10	0.83 – 1.50
Non Shielded Cable OD	0.70 – 1.26	1.03 – 1.60
Motor Lead Diameter	0.41 – 1.26	0.79 – 1.60
Maximum Bolt (Std size)	1/2 x 1.0*	1/2 x 1.25*
Maximum Lug Width- Connection Length	1.26** x 9.0	1.80** x 9.0

** Bolt length not including head*
*** Or washer width, if wider than lug tang*

NMCK8

5-8 kV Motor Connection Kits

NMCK8-Y Type Motor Connection Kits

NMCK8-Y kits are designed to insulate and environmentally seal Medium Voltage cable connections at motors with an In-Line configuration. Each kit contains components to insulate three phases for a typical bolted lug connection inside the motor connection box. Tyco Electronics' NHVT kits should be used to terminate shielded cables and are not supplied with NMCK8 kits. Connection hardware is not supplied with kit. These kits have been type tested for 1E (K1) circuits in harsh environments according to the reports listed below:

Original Qualification Test Reports

EDR-5021
EDR-5034
EDR-5037
EDR-5040
EDR-5060
EDR-5063

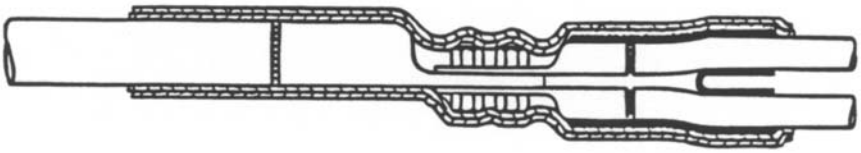
Test Reports

EDR-5332
EDR-5336
EDR-5389

These test reports used previous compound formulations for the WCSF material based parts. EDR-5336/EDR-5389 has shown the new compound formulation parts to be identical in form, fit, and function to the parts used in the listed reports. The kits listed in the selection guide use new Qualification 2001 WCSF based Molded Parts.

	New Kit Descriptions	
Selection Criteria	**NMCK8-1Y(N)**	**NMCK8-2Y(N)**
Shielded Cable Insulation OD	0.53 – 1.10	1.22 – 1.75
Non Shielded Cable OD	0.70 – 1.26	1.44 – 1.96
Motor Lead Diameter	0.37 – 0.56	0.75 – 1.0
Maximum Bolt (Std size)	1/2 x 1.25*	1/2 x 1.50*
Maximum Lug Width- Connection Length	1.80** x 9.0	1.80** x 10.0
Slip back spaces	20 + Connection length	23 + Connection length
Original Kit Description	NMCK8-1Y	NMCK8-2Y

** Bolt length not including head*
*** Or washer width, if wider than lug tang*



NMCK-8

HVBT-RN

Heat-Shrinkable Insulating Tape for Bus Bars and 5-15 kV

HVBT-RN is a medium voltage heat-shrinkable tape that is used to insulate straight or bent bus bars. The versatile tape can be used to cover irregular geometries which are not well suited for a tubing.

HVBT-RN can also be used as insulation for cable to bus connections in switchgear or transformers where the relatively smaller cable and bolts used to connect the lug to the bus create an irregular geometry. (Kits are available as HVBT-CBC on next page for this application). These connections are first wrapped with Copper Mesh to smooth out the geometry and then insulated with HVBT-RN.

HVBT-RN has been shown to tolerate irradiation to 50 megarads and has been tested to an accelerated aged condition of 40 years at 90˚ C. **Note: This product has not been typed tested to LOCA conditions**. Commercial dedication is required for use on Class 1E systems.

Qualification Test Reports

UVR-8023
EDR-5154
EDR-5259

HVBT Installed

Description	Width	Length per roll
HVBT-1-RN	1″	25′
HVBT-2-RN	2″	25′
HVBT-4-RN	4″	25′

HVBT-CBC

Cable to Switchgear or Transformer Bus Connections 5-15 kV

HVBT-CBC is a medium voltage heat-shrinkable tape that is used as insulation for cable to bus connections in switchgear or transformers where the relatively smaller cable and bolts used to connect the lug to the bus create an irregular geometry. These connections are first wrapped with copper mesh to smooth out the geometry and then insulated with HVBT-RN.

The heat-shrinkable material in the HVBT-CBC kit has been shown to tolerate irradiation to 50 megarads and has been tested to an accelerated aged condition of 40 years at 90˚C. **Note: This product has not been typed tested to LOCA conditions**. Commercial dedication is required for use on Class 1E systems.

Qualification Test Reports
UVR-8023
EDR-5154
EDR-5259

HVBT –with copper mesh

HVBT –CBC Installed

Description	Tape Width	#Rolls - Length/roll per kit
HVBT-CBC	2"	1 - 25' HVBT-2-RN 3 - 5' copper mesh

BBIT-N

Heat-Shrinkable Insulating Tubing for Bus Bars 5-15 kV

BBIT-N is a medium voltage heat-shrinkable tubing that is used to insulate straight or slightly bent bus bars. BBIT-N is used to insulate exposed bus to prevent accidental flashover or to minimize clearance distance between two phases or phase and ground. BBIT-N is rated to the Switchgear specification ANSI/IEEE C37.20-1987.

BBIT-N has been shown to tolerate irradiation to 50 megarads and has been tested to an accelerated aged condition of 40 years at 90˚ C.
Note: This product has not been type tested to LOCA conditions. It has been type tested for class 1E insulated connections.

Qualification Test Reports
EDR-5037
EDR-5063

Description	Diameter Use Range (in)	Standard Package
BBIT-N-25/10-A/U	0.41 – 0.78	65′ reel/box
BBIT-N-40/16-A/U	0.66 – 1.26	60′ reel/box
BBIT-N-65/25-A/U	1.03 – 1.96	50′ reel/box
BBIT-N-100/40-A/U	1.65 – 3.14	50′ reel/box

GELCAP

Motor Connection Kit 600V

GelCap motor connection insulator kits quickly and conveniently insulate, seal, and protect stub splice connections up to 600V. Each kit contains components to insulate three phases for a typical bolted lug connection inside the motor connection box. Connection hardware is not supplied with kit. These kits are UL and CUL Listed to 105˚C. Simply push the cap on and snap the clamp closed. Installation in seconds and removal is just as quick.

The specially formulated cap material provides excellent abrasion resistance, insulation value, and UV resistance. The GelCap kits feature revolutionary PowerGel sealing gel that provides excellent moisture seal over a wide temperature range (-40˚C to +105˚C). PowerGel sealing gel also pulls away easily and cleanly making motor change-outs much faster.

Test Reports
EDR-5334
UL LISTED
CUL LISTED

Installation Instruction
PII-55152
PII-55148

c UL US LISTED

Select kit by feeder wire size

Kit Description	Feeder Wire Range	Max. Lug Total Length (in)	Max. Lug Barrel Length (in)	Max Bolt Dimensions (Width, Length)	Cap Length (inch)
GELCAP-1*	#16 - 10 AWG	1.0	0.5	0.375, 0.500	2.8
GELCAP-2	#8 – 2 AWG	2.0	1.0	0.625, 1.00	3.5
GELCAP-3	#2 – 4/0 AWG	3.0	1.5	0.850, 1.30	6.0
GELCAP-4	250 – 500 MCM	5.0	2.0	1.100, 1.85	8.1

**GelCap-1 contains one cap with a phase separator to allow all three phases to go into one cap. All other kits contain one cap per phase.*

GELWRAP

Wrap-around Splice Cover 1000V

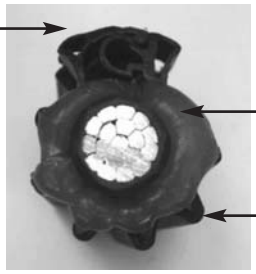
GelWrap splice cover kits quickly insulate and seal connections up to 1000V. GelWrap splice covers are equally well suited for direct buried applications as well as overhead applications. The wrap-around design is ideal for jacket damage repair. Connection hardware is not supplied with kit. These kits have been tested to ANSI C119.1-1986 for insulated underground connections.

Simply wrap the sleeve around the cable and snap it closed. The unique design is a combination of gels and elastomers to achieve great connector and cable range taking. PowerGel sealing gel completely encapsulates the connection preventing moisture intrusion or corrosion. There is no mixing or curing involved. Installation takes only a matter of seconds. Other lengths and sizes may be available upon request.

Test Reports

EDR-5343	GelWrap 18/4
EDR-5356	GelWrap 33/10

Snap-lock made of impact resistant polypropylene provides secure installation. Latch is geometrically designed to provide easy installation, even when wearing insulated gloves.



Silicone gel is a high dielectric strength insulation that completely encapsulates the connection. The result is an excellent water seal. PowerGel sealing gel is specially formulated for high temperature environments.

Elastomer cover material combines outstanding tear strength, abrasion resistant, and chemical resistance with excellent flexibility and range-taking.

Kit Description	Sleeve Length (in)	Conductor Size AWG (mm^2)	Maximum Connector Opening inch (mm)	General Use Diameter Range inch (mm)
GELWRAP-18/4-100	4.0	#12 – 4/0 (4 – 95)	1.0 (25)	0.15 – 0.70 (4 – 18)
GELWRAP-18/4-150	6.0	#12 – 4/0 (4 – 95)	3.0 (76)	0.15 – 0.70 (4 – 18)
GELWRAP-18/4-200	8.0	#12 – 4/0 (4 – 95)	5.0 (127)	0.15 – 0.70 (4 – 18)
GELWRAP-18/4-250	10.0	#12 – 4/0 (4 – 95)	7.0 (178)	0.15 – 0.70 (4 – 18)
GELWRAP-33/10-150	6.0	#2-500 (35-240)	2.0 (51)	0.40-1.30 (10-33)
GELWRAP-33/10-200	8.0	#2-500 (35-240)	4.0 (100)	0.40-1.30 (10-33)
GELWRAP-33/10-250	10.0	#2-500 (35-240)	6.0 (150)	0.40-1.30 (10-33)

For other sizes or applications, a minimum seal length is required on each side of connector opening or jacket damage. Use these guidelines for minimum seal distance:
GELWRAP-18/4 Series 1.5 (38mm)
GELWRAP-33/10 Series 2.0 (51mm)

Product Performance

Testing	Test Conditions
ANSI C119.1 - 1986	1000V insulated underground
Chemical Resistance	Fluid immersion, 168 hours @ 23°C, 75% elongation retention minimum - 10W-40 motor oil - 10% hydrochloric acid - 15% sodium chloride - 20% sodium hydroxide - ETX 60280 antifreeze (1000 hours)
Accelerated Aging	1000 hours at 135°C - 93% retention tensile strength - 82% retention elongation at break

CFTS
Cabinet Feed-Through Seals

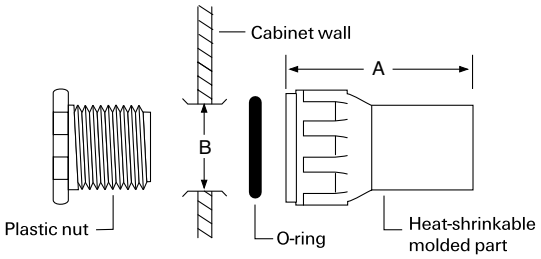
These heat-shrinkable boot feedthroughs provide a watertight and fumetight seal where cables enter connection boxes, bulkheads, or other enclosures. CFTS seals are suitable for environments that have existing periodic pressure and/or temperature differentials.

The heat-shrinkable portion of the seal is coated with a thermoplastic adhesive that seals around the cable. An O-ring creates the water/air seal at the cabinet entry. The rigid plastic portion of the CFTS protects the cable from abrasion or cut-through. Five sizes cover cable diameters from 0.20 to 2.40 .

Test Reports
EDR-5212

Installation Instructions
PII-51057

Use CFTS with maximum cabinet thickness of 0.20 inch (5mm).



Catalog number	Cable diameter (min. – max.) (mm)	A - Length of molded part (mm)	B - Clearance (knockout) hole size (mm)
CFTS-1	0.20 – 0.40 (5–10)	2.75 (70)	1.0 (25)
CFTS-2	0.25 – 0.65 (6–17)	2.75 (70)	1.0 (25)
CFTS-3	0.55 – 1.00 (14–25)	3.75 (95)	1.325 (35)
CFTS-4	0.80 – 1.45 (20–37)	4.50 (114)	2.0 (51)
CFTS-5	1.45 – 2.40 (37–61)	7.00 (178)	3.5 (89)

MCK-5

Motor Connection Kits 5kV
Qualified to meet IEEE-404 AC withstand and impulse requirements

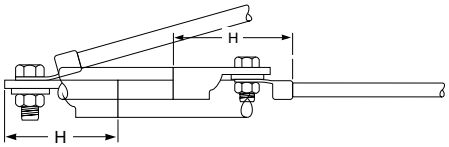
MCK-5 kits are designed to insulate and environmentally seal bolted splice connections at 5kV motors. Each kit contains components to insulate three phases for a typical bolted lug connection inside the motor connection box. Connection hardware is not supplied with kit. All kits are rated to National Electric Code, Article 310-38 ampacities for 90˚C rated feeder cable.

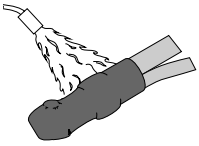
The MCK-5 series provides fast installation, easy reentry, high abrasion resistance, and environmental sealing. These heat-shrink kits are industry proven. The Type V kit is designed to splice the stub or butt configuration that is commonly used where there is insufficient room to make in-line connections. The Type L kit is used where space permits in-line connections.

Test Reports
EDR-5010

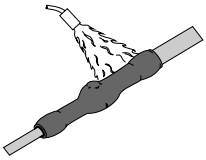
Installation Instruction
Type L PII-54730
Type V PII-54731

Motor Connection Kit (3 Phase) 5kV





Type V
Stub configuration



Type L
In-line configuration

Selection information (dimensions in inches/millimeters)

Catalog number	Motor feeder size (AWG/kcmil)	Bolt length (max.)	Connection length (max.) H (mm)	Kit Length (nominal) (mm)
MCK (1000 V)				
Type V (stub)				**Cap**
MCK-1V	#14–#10	0.375	2.0 (51)	2.5 (64)
MCK-2V	#12–#4	0.75	2.5 (64)	3.4 (86)
MCK-3V	#2–4/0	1.0	3.5 (89)	4.5 (114)
MCK-4V	250–500	1.5	5.5 (140)	6.5 (165)
Type L (in-line)				**Sleeve**
MCK-1L	#8–4/0	1.25	5.0 (127)	9.0 (229)
MCK-2L	250–1000	1.5	8.0 (203)	12.0 (305)
****MCK-5 (5 kV)***				
Type V (stub)				**Cap**
MCK-5-1V	#8–#2	1.0	5.0 (127)	7.5 (191)
MCK-5-2V	#1–250	1.5	6.0 (152)	8.5 (216)
MCK-5-3V	300–750	1.5	7.0 (178)	9.5 (241)
****Type L (in-line)***				**Sleeve**
MCK-5-1L	#8–250	1.0	6.0 (152)	12.0 (305)
MCK-5-2L	300–1000	1.5	7.0 (178)	14.0 (356)

Note: · Shielded cable must be terminated before installing MCK-5 (use Raychem HVT-80-G/SG terminations). For additional information contact your Tyco Electronics sales representative.

Selection Information (dimensions in inches (millimeters))

Wire Size	Stud Size	Max. Insul. Diameter	PIDG KYNAR Insulated	PLASTI-GRIP KYNAR Insulated
22-16 Red Stripe	6	.125 3.18	53407-1	—
	8		53408-1	—
	10		53409-1	—
	1/4 (6.35)		53410-1	—
	5/16 (7.94)		53411-1	—
16-14 Blue Stripe	6	.150 3.81	53415-1	—
	8		53417-1	—
	10		53418-1	—
	1/4 (6.35)		53419-1	—
	5/16 (7.94)		53420-1	—
	3/8 (9.53)		53421-1	—
	1/2 (12.70)		53422-1	—
12-10 Yellow Stripe	6	.230 5.84	53423-1	—
	8		53424-1	—
	10		53425-1	—
	1/4 (6.35)		53426-1	—
	5/16 (7.94)		53427-1	—
	3/8 (9.53)		53428-1	—
8 Red Stripe	10	.380 9.65	—	53978-1
	1/4 (6.35)		—	53943-1
	3/8 (9.53)		—	53944-1
6 Blue Stripe	10	.436 11.07	—	53975-1
	1/4 (6.35)		—	53946-1
	3/8 (9.53)		—	53947-1
4 Yellow Stripe	3/8 (9.53)	.515 13.08	—	53950-1
	1/2 (12.70)		—	53951-1
2 Red Stripe	3/8 (9.53)	.560 14.22	—	53953-1
	1/2 (12.70)		—	53954-1

For additional information, contact your Tyco Electronics representative and request catalog number 82038 or email to: energy-nuclear@tycoelectronics.com.

PIDG KYNAR Insulated
Withstands 259 megarads radiation and LOCA simulation

PLASTI-GRIP KYNAR Insulated
Withstands 259 megarads radiation and LOCA simulation

The line of Tyco Electronics AMP Radiation Resistant/150°C Pre-insulated Terminals and Splices include terminals and splices of the well known PIDG and PLASTI-GRIP terminal designs.

Radiation Resistant Terminals are made of fine grade, high conductivity copper with bright tinplating and feature polyvinylidene fluoride (PVF2) insulation for high resistance to radiation and solvents.

These PIDG terminals meet the performance requirements of MIL-T-7928. They were also tested by Tyco Electronics and an independent test facility and have fulfilled all requirements including radiation testing to 200 MRADs, operating temperature range from 65°C to 150°C and resistance to steam and various chemical solvents. The PIDG, PVF2 product meets all of the nuclear industry criteria for "commercial grade" products.

Tyco Electronics AMP Radiation Resistance/150°C Terminals are designed and engineered to successfully withstand extreme vibration, shock and structure stresses, and other conditions which can adversely affect the critical circuit requirements in complex equipment.

The matching Tyco Electronics AMP tooling precisely crimps all terminations. This uniformity increases reliability and also serves as a built-in quality control factor.