PENTAIR

Pyrotenax BRAND

COMMERCIAL FIRE-RATED WIRING SYSTEMS

THERMAL MANAGEMENT SOLUTIONS | WWW.PENTAIRTHERMAL.COM

PENTAIR

BUILDING & INFRASTRUCTURE SOLUTIONS

We provide quality solutions for winter safety, comfort and performance to building and infrastructure design, construction, operation and maintenance professionals. From pipe freeze protection to maintaining fluid temperatures and melting snow, detecting leaks, heating floors, maintaining critical circuits with fire-rated and specialty cables, you can rely on Pentair Thermal Managements' solutions & services for greater safety, comfort and performance.

THE HEART OF OUR SOLUTIONS

For over 75 years, Pyrotenax brand mineral insulated products have satisfied the unique requirements of the wiring and heating industries.

Pentair Thermal Management offers a unique product—Pyrotenax brand Mineral Insulated (MI) wiring cable—for the safe operation of critical emergency circuits. These circuits are essential for the safe evacuation of buildings and to continue firefighters' efforts during an emergency. Typical fire-rated applications include wiring for fire pumps, emergency generators, firefighters' elevators and smoke extraction fans.

Other applications include the retrofitting of electrical power feeders in commercial buildings due to increased power consumption and the elimination of the effects of electromagnetic interference (caused by high current feeders) on electronic equipment.

Pyrotenax

FIRE-RATED SYSTEMS

High-rise buildings, hospitals, airports, and tunnels are locations where fires can be costly and deadly if the emergency systems in place do not operate properly. Pentair Thermal Management fire-rated cables will operate for at least 2 hours under fire conditions to allow for the continued operation of life safety equipment and the safe evacuation of the facility.

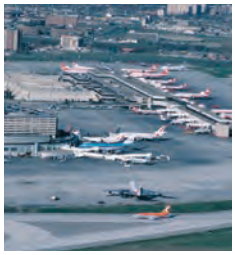
SPECIALTY WIRING SYSTEMS

Mineral Insulated cable technology for special applications include hollow conductor cable systems for high current particle accelerator applications, patented systems for eliminating electromagnetic interference, and systems for introducing utility services into a building using MI cable instead of concrete encasement of the service conductors. Historic and commercial building retrofits are typical applications where the space for electrical wiring is limited. Pentair Thermal Management non-fire-rated cables and service entrance systems are small in profile and unobtrusive, providing the perfect solution for these applications.

Pentair Thermal Management wiring systems can be found in commercial applications worldwide:

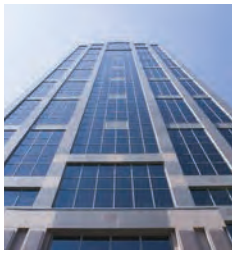
Rockefeller Center, USA • Riyadh University Hospital, Saudi Arabia • U.S. Capitol Building, USA • Stuttgart International Airport, Germany • NYC Museum of Natural History, USA • Heathrow International Airport, UK • Harvard University, USA • NYU Medical Center, USA • Montreal Metro, CA • Brussels Metro, Belgium • Pentagon Building, USA • Wing Lung Bank, Hong Kong • Yankee Stadium, USA • Buckingham Palace, UK • The White House, USA • Vienna Metro, Austria • Texas Medical Center, USA • Dublin Airport, Ireland • Los Angeles City Hall, USA • Channel Tunnel, UK

Tunnels



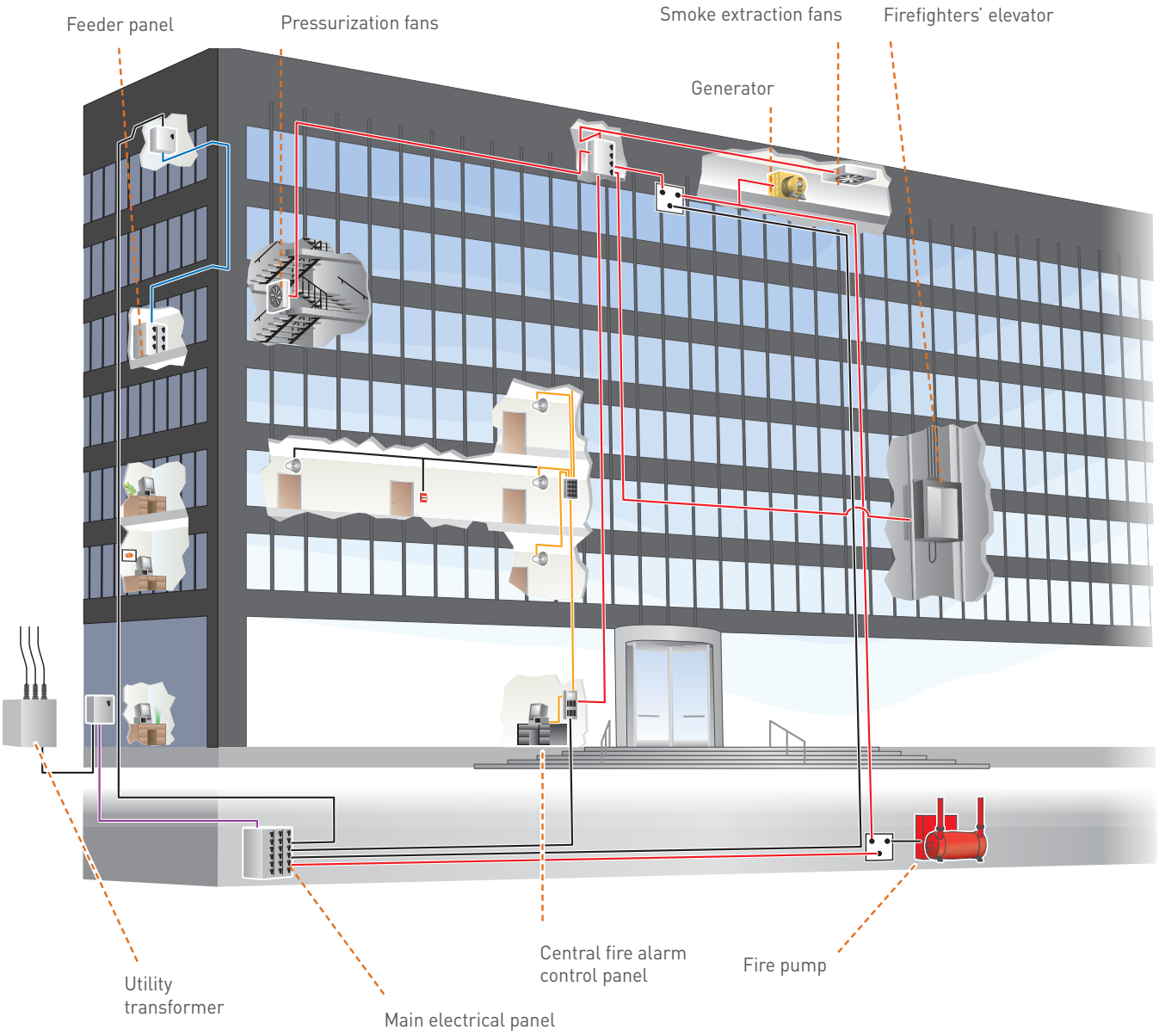
Airports

Hospitals

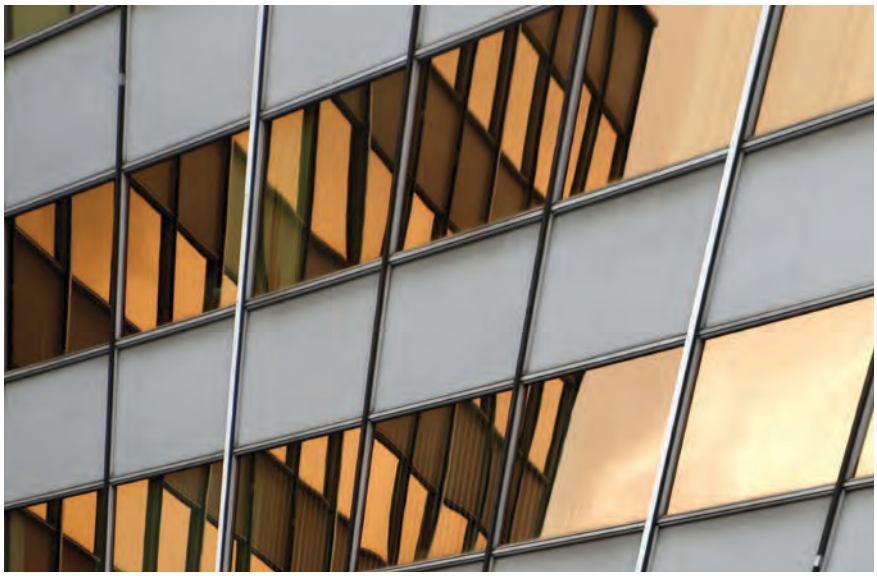


High-rise buildings

APPLICATIONS



TYPICAL WIRING SYSTEMS IN A HIGH-RISE BUILDING



FIRE-RATED CABLE SYSTEM

Power Cables

Fire Alarm Cables

For all critical life safety circuits fed by the emergency supply including: the fire pump, fire alarm system, smoke extraction fans, pressurization fans, and power for the firefighters' elevator.

SPACE SAVING CABLE SYSTEM

For the retrofitting of power feeders in locations where space is limited and difficult installation conditions exist.

SERVICE ENTRANCE CABLE SYSTEM

For the retrofit of service entrance feeders when additional power is needed and where encasement of conventional conductors in concrete is not feasible.

NORMAL POWER CABLES

Standard power feeders throughout the building.

WIRING SYSTEMS

FIRE-RATED CABLE SYSTEM

PYROTENAX SYSTEM 1850

A UL Classified/ ULC Listed 2-hour fire-rated, mineral insulated, copper-sheathed power cable for protection of critical life safety circuits.

SPACE SAVING CABLE SYSTEM

PYROTENAX SYSTEM 1850

Pyrotenax System 1850 mineral insulated, copper-sheathed wiring cable is an ideal alternative for retrofitting feeders in buildings and for ease of installation in tight spaces and difficult runs.

Space saving MI cable vs conduit & wire

SERVICE ENTRANCE SYSTEM

PYROTENAX SYSTEM 1850-SE

A UL Classified 2-hour fire-rated, mineral insulated, copper-sheathed service entrance cable system that allows service entrance conductors to be routed inside the building.

This system is designed as an alternative to concrete encasement for service conductors. Where conditions make concrete encasement difficult or impractical, Authorities Having Jurisdiction (AHJs) have accepted this system as an alternative to concrete encasement.

WIRING TECHNOLOGY

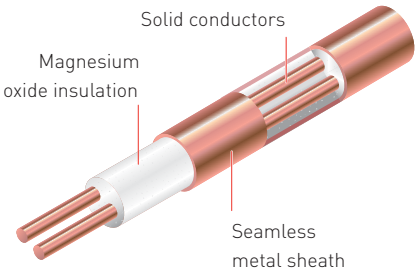
MINERAL INSULATED TECHNOLOGY

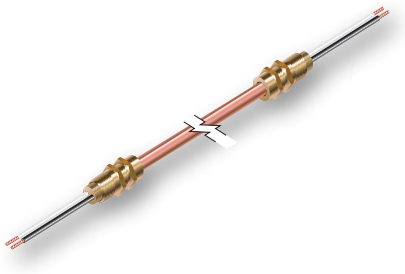
Using only inorganic materials, copper and magnesium oxide (MgO), Pyrotenax Mineral Insulated (MI) wiring cable offers a unique combination of dependability, versatility, and performance. Highly compacted magnesium oxide insulation provides exceptional temperature and electrical performance. Manufactured using a process unique to the Pyrotenax brand, this product has set the standard for fire-rated electrical cables worldwide.

Pyrotenax mineral insulated cable is listed in the NEC/CEC as "Type MI" and is available in 1, 2, 3, 4 and 7 conductor configurations in a range of sizes between 18 AWG and 500 kcmil.

Pyrotenax mineral insulated wiring cable offers unique fire survival properties as well as small size and enhanced ampacity capability.

Designed to specified length tolerances, Pyrotenax MI factory terminated cables are ideal for a wide variety of wiring applications including hazardous locations and areas where the space for electrical wiring is limited.





PYROTENAX MI CABLE

THE BENCHMARK OF SAFETY AND RELIABILITY

The traditional method of fire protection of electrical cables in emergency circuits (encasement of non-fire-rated cables in 2 inches of concrete) was accepted as suitable for 1-hour protection, but is hardly adequate for today's 2-hour requirement. Encasement of cables in concrete is not a listed method, and in fact Fig 19.2.7 (reproduced below) in the 2008 NFPA Fire Protection Handbook clearly shows that it is not suitable. Codes will eventually change to reflect this reality, but it will take time—meanwhile, designers be aware!

4 inches of concrete minimum for 2-hour fire resistance of a concrete slab

Dotted line: regular aggregates

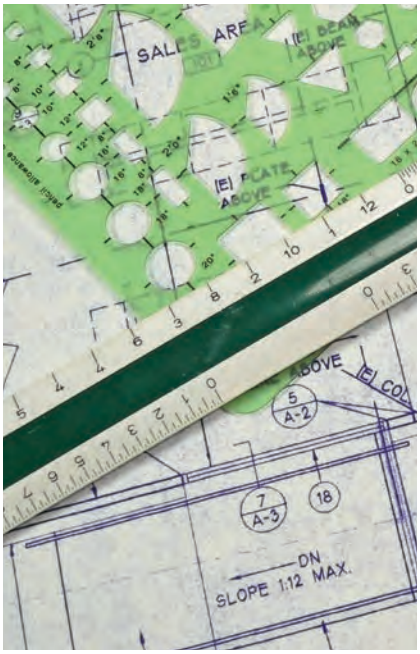
Solid line: lightweight aggregates

FM Approvals GP-1
2-Hour Fire Resistant Cable

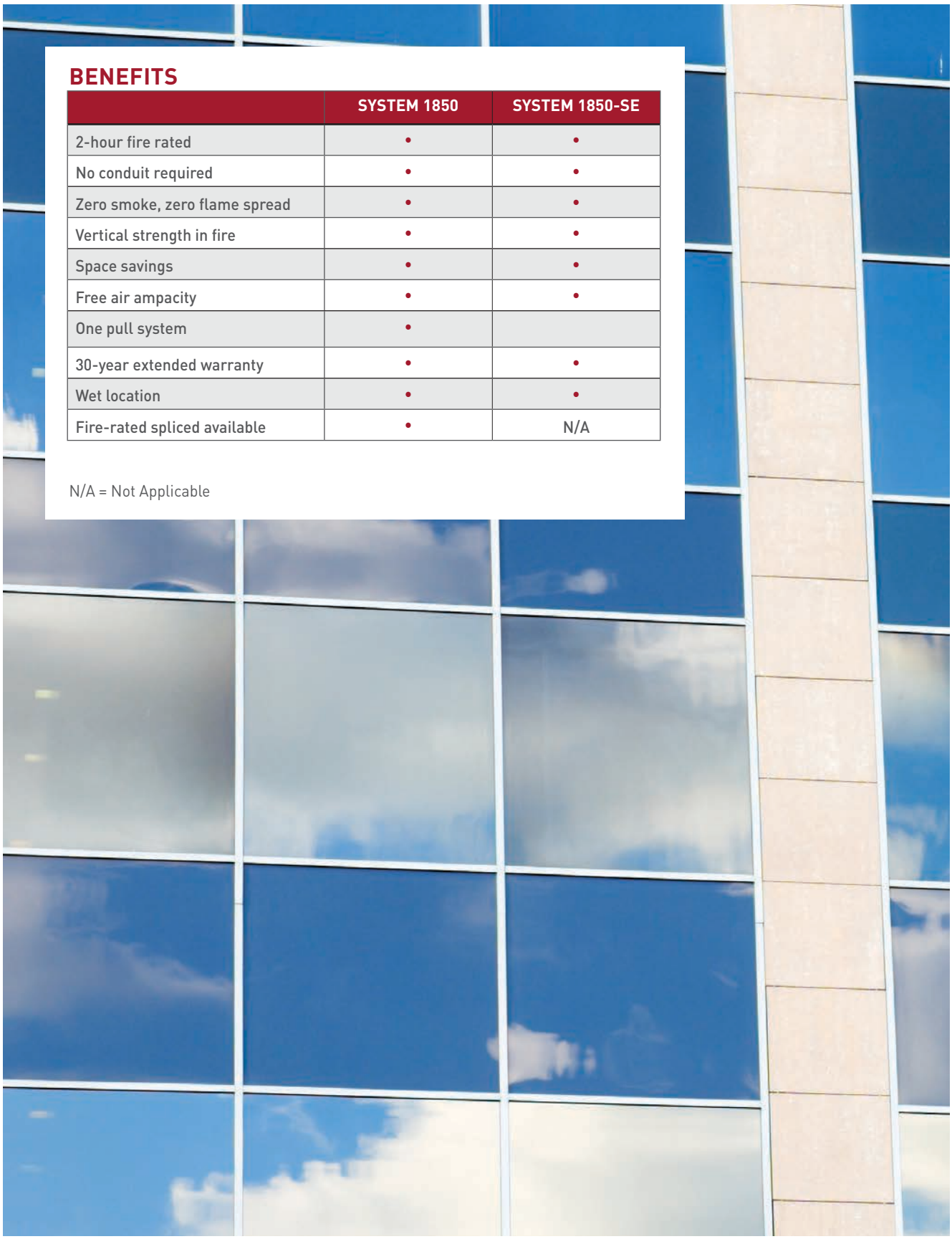
Fire-rated electrical cables are UL Classified/ULC Listed as 2-hour fire-rated if they successfully pass the ANSI/UL 2196 and ULC-S139 fire test standards, which require that circuit integrity be maintained throughout a fire test that reaches 1850°F over a two hour period, followed by the full force of a fire-fighter's hose-stream.

In 2012, Underwriters Laboratories conducted research testing on polymer-insulated fire-rated cables and found serious problems with the cable designs, so much so that based on that research they made a decision to de-certify all fire-rated cables. MI cable, being a different technology and not subject to the issues with polymer cables was quickly re-instated by UL and ULC with a new System identifier ("System 1850") in UL/ULC categories FHIT/FHITC.

You can trust Pyrotenax fire-rated cable, the original, and the best solution for protection of life safety circuits. The totally inorganic construction of unjacketed System 1850 MI cable allows for an environmentally clean electrical cable that does not burn, produce smoke, or contribute fuel when exposed to fire conditions.



FEATURES



BENEFITS

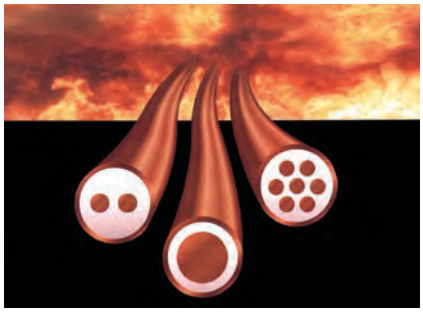
	SYSTEM 1850	SYSTEM 1850-SE
2-hour fire rated	•	•
No conduit required	•	•
Zero smoke, zero flame spread	•	•
Vertical strength in fire	•	•
Space savings	•	•
Free air ampacity	•	•
One pull system	•	
30-year extended warranty	•	•
Wet location	•	•
Fire-rated spliced available	•	N/A

N/A = Not Applicable

REASONS TO CHOOSE PENTAIR THERMAL MANAGEMENT WIRING SYSTEMS

FIRE RATED

It is critical that circuits involving life safety and firefighting efforts remain operable during an emergency. These circuits provide power for emergency equipment, fire pumps, pressurization fans and fire alarm systems. Pyrotenax fire-rated cables are designed to operate for at least 2 hours under fire conditions to allow for the continued operation of life safety equipment and the safe evacuation of the facility.

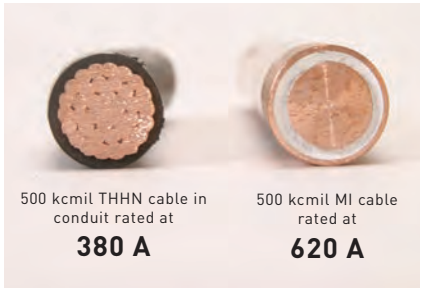


SINGLE CONDUCTOR ADVANTAGES

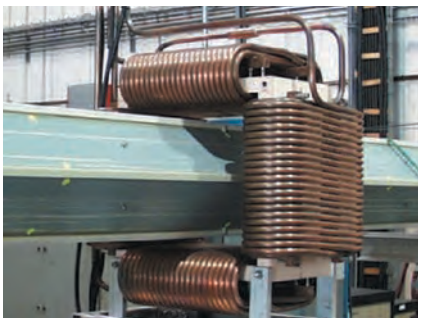
Single conductor Pyrotenax MI cables require no conduit, allowing for as much as 80% space savings over conduit and wire. In addition, the NEC and CEC allow bundled single-conductor MI cable to be operated at higher ampacities, resulting in significant savings in materials and installation costs, especially in short runs.

FREE AIR RATING

The inorganic construction of Pyrotenax MI wiring cables means that there is virtually no aging of the cable. This allows Pyrotenax MI wiring cables to operate at higher ampacities than conventional wiring, resulting in significant cost savings in materials and installation (especially in shorter runs).



SERVICES AND SUPPORT



FIELD AND TECHNICAL SUPPORT

With years of experience, Pentair Thermal Management field service engineers are highly qualified to offer field support, advice, and training at all stages of a project. Backed by expert factory engineering support, the service is available worldwide.

EXPERTISE IN LIFE SAFETY CIRCUITS

Pentair Thermal Management has been at the forefront in the development of life safety wiring systems for many years. Our engineering expertise is frequently called upon to consult on critical applications, create technical product standards and to revise national and local codes. Our specialists can help you with your specification needs as well.

UNIQUE SOLUTIONS

The construction of Pyrotenax MI wiring cable lends itself to a variety of applications that would be difficult or impossible to solve otherwise. Examples include using the MI cable sheath and a compensator to eliminate magnetic fields around the MI cables, as well as using hollow conductors to allow circulation of coolant to limit temperature rise at high current densities in particle accelerator applications.

ISO Certification
Pentair Thermal Management maintains an ISO 9001:2008 registered Quality Management System and 14001:2004 Environmental Management Systems at its MI cable manufacturing facility. The Quality Management System covers all manufacturing and business processes and the Environmental Management Systems ensures sound environmental performance.

Certified System SAI GLOBAL ISO 9001 Quality

Certified System SAI GLOBAL ISO 14001 Environmental

Six Sigma
Understanding and satisfying the needs of our customers is important to Pentair Thermal Management. We have a customer-focused, data-driven Six Sigma program to continuously improve the quality and delivery of our products, services, and business processes.

On Time Delivery
Pentair Thermal Management consistently meets customer demands for product delivery. We strive to ship product from stock on the day the order is placed and for 100% on time delivery of all custom manufactured products.

WEB SERVICES AND SOFTWARE

VISIT WWW.PENTAIRTHERMAL.COM

Pentair Thermal Management is a world leader in heat-tracing, fire-rated and specialty wiring and sensing solutions for the oil & gas, power, food & beverage, chemical, water and other process industries, as well as for the commercial and residential construction markets. Visit our web site to download, print, browse product information, or submit a question.

ON-LINE TECHNICAL SUPPORT

On our interactive frequently asked questions and answers (FAQ) page, you'll find questions broken down by markets and product lines. If your question does not appear, simply submit a new question. A Pentair Thermal Management technical expert will answer your question and post it to the web site.

ON-LINE DESIGN TOOL

The online **Voltage Drop Calculator** allows you to estimate the voltage drop for Pyrotenax MI cable, and to determine the appropriate size of cable to use.

DOWNLOAD CABLE SIZING SOFTWARE

PyroSizer software aids in the design of critical circuits that utilize Pyrotenax MI copper cable. Enter basic project conditions on the "Project Default Parameters" screen and then simply apply these parameters to the entire project to minimize keying, and speed up design.

PENTAIR THERMAL MANAGEMENT NORTH AMERICAN OPERATIONS

BEFORE YOU BUY, WEIGH THE FACTS:

Greater selection

Offering the most complete product line of proven heating technologies to better satisfy your unique needs.

More innovation

As a world leader in heating cable technologies, design optimization, construction, and control and monitoring systems, we invented many of today's industry standards.

More manufacturing experience

Quality-driven manufacturing processes, combined with years of manufacturing self-regulating and mineral-insulated cables gives you products proven to be the most reliable.

FOR PROVEN FIRE-RATED SOLUTIONS, LOOK TO THE LEADER.

Visit our web site at **WWW.PENTAIRTHERMAL.COM** or contact us at **1-800-545-6258**.

DESIGN GUIDES

This section provides design guides for the Pentair Thermal Management commercial wiring products. Each design guide is also available in .pdf format on our web site at www.pentairthermal.com.

CONTENTS

SYSTEM 1850 FIRE-RATED CABLE SYSTEM

This section provides an overview of general circuit design considerations and installation guidelines for Pyrotenax Fire-Rated Cables. For additional information, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258. Also, visit our web site at www.pentairthermal.com.

CONTENTS

INTRODUCTION

Pentair Thermal Management Pyrotenax System 1850 mineral insulated (MI) wiring cables meet the relevant requirements of the U.S. National Electrical Code (NEC), the National Fire Alarm Code, the Canadian Electrical Code (CEC), and the Canadian National Building Code for fire protection of emergency power feeders and fire alarm circuits. The codes stipulate that a reliable source of power is required to operate all critical life safety circuits necessary to provide time for a safe evacuation of building occupants and to allow emergency crews to effectively control the fire. Fire-resistance ratings of 1-hour or 2-hours are required depending on national and local codes, the type of circuit, and the environment.

Typical Applications

Pentair Thermal Management fire-rated wiring cables meet the most stringent requirements for 2-hour fire rating, allowing for the highest degree of fire protection for emergency back-up power supply systems, emergency equipment, and fire alarm systems. In the event of a fire, electrical power and communication is preserved for critical life safety circuits. These critical circuits provide power for:

- Fire pumps – to maintain pressure in the sprinkler system
- Firefighters' elevators
- Smoke dampers and pressurization fans – to maintain smoke-free areas for egress
- Smoke extraction fans
- Emergency lighting and exit signs
- Fire alarm and voice communication systems

Typical Locations

Typical locations requiring emergency power feeders include:

- High-rise buildings
- Hospitals and other institutions
- Historic buildings
- Tunnels and subways
- Airports, stadiums, hotels, banks, etc.

Pyrotenax System 1850 Fire-Rated Mineral Insulated Cable

System 1850 2-hour fire-rated MI cable offers a unique combination of dependability, versatility, and permanence while withstanding continuous operating temperatures as high as 250°C (482°F) and intermittent exposure temperatures as high as 1010°C (1850°F).

Featuring "zero smoke, zero flame spread, zero fuel contribution" and up to 80% space savings compared to conventional conduit and wire systems, System 1850 MI cable is the preferred choice for many specifiers. The ease with which this tough cable can be pulled into difficult runs with tight corners makes it an ideal choice for many applications. System 1850 MI cable may be installed in virtually any location: outdoors, submersed, or buried with a protective over-jacket. The cable can be bent, twisted, or pulled, and can withstand mechanical abrasion while remaining fully functional.

System 1850 MI cable is 2-hour fire-rated to ANSI/UL 2196 / ULC-S139 fire test standards, which utilize the ASTM E-119 time-temperature curve. The test requires that cables remain operational after exposure to temperatures up to 1010°C (1850°F) for two hours followed by the full force of a firefighter's hose stream. System 1850 MI cable passes this rigorous circuit integrity test without additional mechanical protection.

CABLE CONSTRUCTION

Pyrotenax System 1850 MI cables are manufactured using only inorganic materials, copper and magnesium oxide. This construction is inherently tough, yet allows the cable to be bent and molded to fit into tight spaces. In addition, the totally inorganic construction of unjacketed System 1850 MI cable allows for an environmentally clean electrical cable that does not burn, produce smoke, or contribute fuel when exposed to fire conditions.

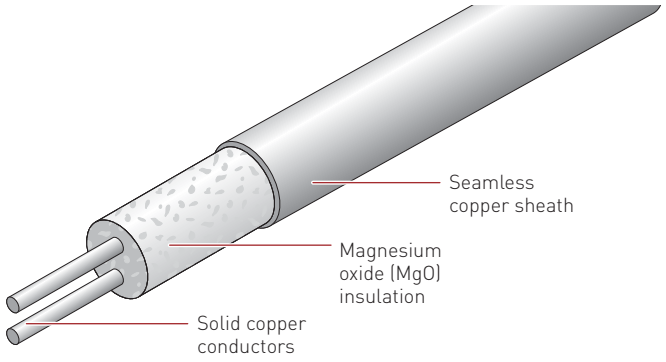


Fig. 1 System 1850 MI cable construction

For superior corrosion protection, an optional polymer jacket is available and is suitable for use in temperatures as low as –40°C (–40°F).

CONFIGURATIONS

System 1850 fire-rated MI cables are available in a range of sizes and conductor configurations for power feeders and in twisted pair configurations for fire alarm circuits.

Approvals and Certifications

PYROTENAX SYSTEM 1850 MI CABLE

Pyrotenax System 1850 MI cables meet the requirements of the circuit integrity fire test, ANSI/UL 2196 (ULC-S139 in Canada), and are UL Listed and CSA Certified in North America.

The details of this system appear in the online UL and ULC Fire Resistance Directories as Electrical Circuit Integrity System (FHIT and FHITC) System No. 1850. Mineral insulated wiring cables are also Classified by Factory Mutual (FM) as a 2-hour fire-resistive cable.

Factory terminated MI cable sets are approved for both nonhazardous locations and hazardous locations. For specific approval information, see the product data sheets in the Technical Data section.

OUTSIDE NORTH AMERICA

Pyrotenax fire-rated fire alarm and power cables are also available for use outside North America, and are LPCB certified to BS EN 60702-1, BS 6387 Categories C, W, and Z, BS EN 50267-2-1, BS EN 50200, BS 8434-2 and BS 5839-1 for standard and enhanced grades of cable. These products carry the CE Mark and are approved to local standards. Contact Pentair Thermal Management for information on our range of cables certified for use worldwide.

FIRE ALARM CIRCUITS

The following general guidelines relate to the design and installation of fire alarm circuits utilizing Pyrotenax System 1850 MI cables.

Pyrotenax System 1850 Fire Alarm Circuit Design Considerations

Fire alarm systems should only be designed by professionals familiar with generally accepted design practices. The information provided below relates specifically to designs using Pentair Thermal Management fire alarm cables and must be followed, along with all relevant local codes and standards, to ensure that the systems are designed properly. For additional information, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

CABLE SIZING

Primarily data and signal communications, these circuits are low voltage and low current, utilizing 18 AWG and 16 AWG conductors.

Cable sizing should be in accordance with the fire alarm system manufacturers' recommendations.

CABLE TERMINATION AND SPLICES

When using Pyrotenax System 1850 shielded twisted-pair cables, the drain wire is connected to the metallic inner shield. At each junction box, the drain wires are connected together, but not grounded; the shield drain wire is only grounded at one point in the circuit.

System 1850 MI Cable

System 1850 MI fire alarm cables are approved as a complete system only when used with the appropriate Pyrotenax termination and splice kits. The use of nonapproved components may compromise the reliability of the system and will invalidate approvals and warranties.

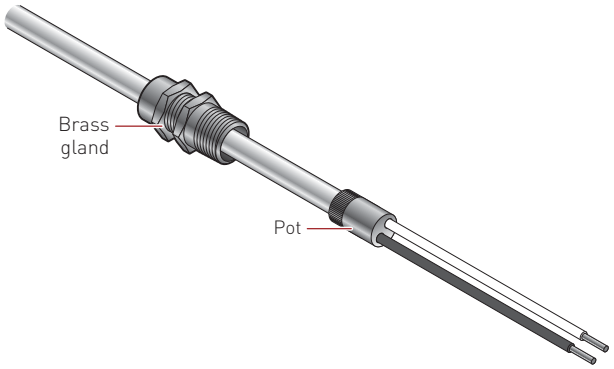


Fig. 2 System 1850 MI cable termination

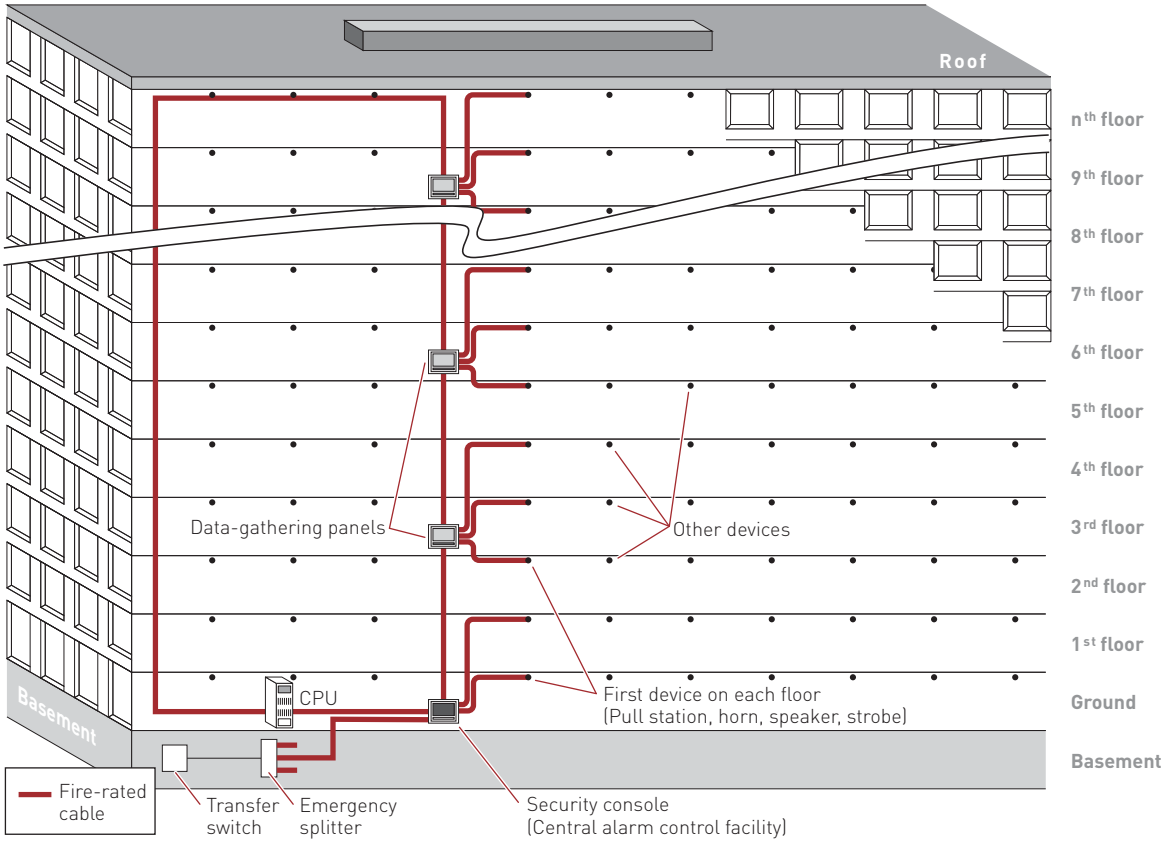


Fig. 3 Typical fire alarm system

Installation Guidelines

These installation guidelines apply to Pyrotenax System 1850 MI cables only. When installing a system, refer to the requirements in the UL/ULC Fire Resistance Directory and the appropriate System 1850 data sheets, or installation instructions shipped with the product, and available on the Pentair Thermal Management web site at www.pentairthermal.com.

SUPPORTING FIRE ALARM CABLE

It is important that all support components are made of appropriate materials, such as copper, steel, stainless steel, and concrete. Low melting point or combustible materials such as aluminum, brass, plastic, lead, wood, etc. are not acceptable.

System 1850 MI Cable

System 1850 MI cables may be directly mounted on noncombustible surfaces such as concrete or masonry, or supported by steel rod and channel (trapeze) systems. UL/ULC listing requirements for fire-rated cables stipulate support spacing at certain intervals; refer to the installation instructions shipped with the product and available on the Pentair Thermal Management web site, www.pentairthermal.com.

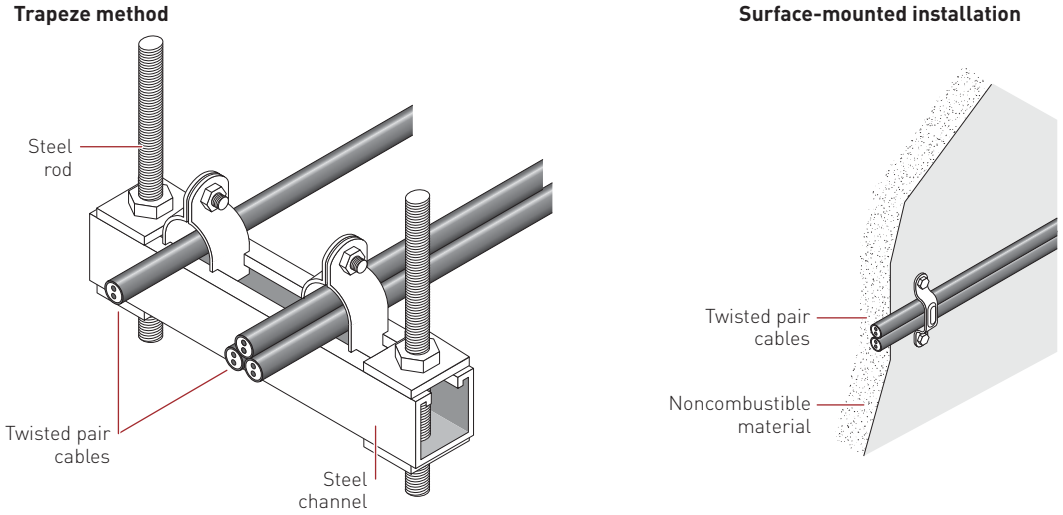


Fig. 4 Typical fire alarm installations for System 1850 MI cable

SEISMIC CONSIDERATIONS

In areas where there is a risk of seismic activity, precautions must be taken where the cable crosses expansion joints and at termination points. For more information, see Appendix: Pyrotenax MI Cable Expansion and Vibration (H57613).

TERMINATING FIRE ALARM CABLE

Pyrotenax System 1850 MI cable

Details on terminating Pyrotenax System 1850 MI cables can be found in the installation instructions provided with each System 1850 MI fire alarm cable termination kit. Factory terminated System 1850 MI cable sets are available. For details on terminated cable sets, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

CONNECTING FIRE ALARM CABLE

Pyrotenax System 1850 MI Cable

For Pyrotenax System 1850 MI cables, the termination gland is a brass fitting available in standard NPT sizes 1/2", 3/4", I", or 1-1/4" size, depending on the cable diameter.

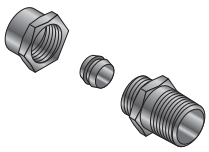


Fig. 5 Brass gland

Gland size information for each specific cable is available from the product data sheets in the Technical Data section. When tightened with the recommended torque, 25 ft-lbs for all gland sizes, this gland simultaneously seals the enclosure and grips the cable through a brass compression sleeve.

CRITICAL POWER CIRCUITS

The following general guidelines relate to the design and installation of critical power circuits utilizing Pyrotenax System 1850 cables.

Circuit Design Considerations

Critical power circuit systems should only be designed by professionals familiar with generally accepted design practices. The information provided below relates specifically to designs using Pyrotenax power cables and must be followed, along with all relevant local codes and standards, to ensure that the systems are designed properly. For further information, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

CABLE SIZING

System 1850 MI cable size is based on circuit breaker size, which in turn is based on load calculations. Special rules apply for motors, including fire pumps, where cable size is based on 125% of full load current. Use the ampacity tables specified in the electrical code to determine the cable size. If the calculated voltage drop exceeds the specified limits, a larger cable size must be chosen.

Multiconductor MI cables have the same ampacity ratings as cable in conduit or other multiconductor cable types. However, the NEC and CEC allow full "free air" ampacity for unjacketed single conductor MI cables configured according to Fig. 6 as long as a space of 2.15 cable diameters is maintained between bundles.

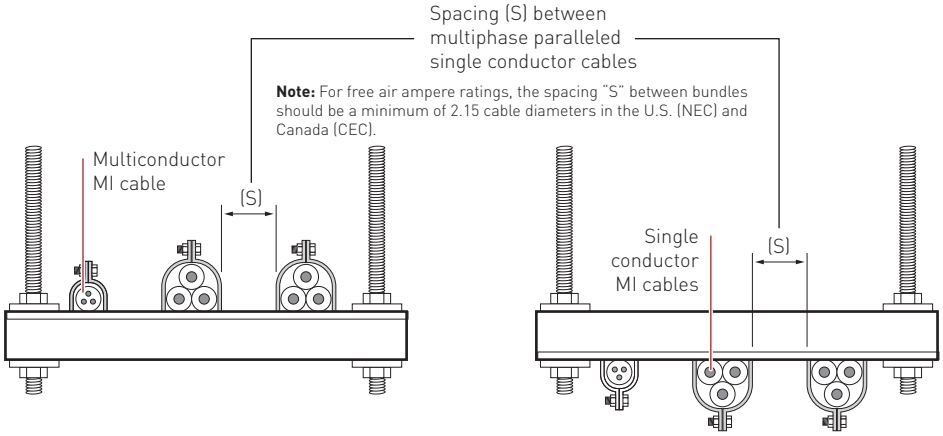


Fig. 6 Spacing of bundled conductors

Although unjacketed single conductor MI cable is unaffected by any temperature increase resulting under the installation conditions shown in Fig. 6, the termination may need to be "sized-up" to keep it within its temperature limits in accordance with electrical code requirements. Refer to the installation instructions shipped with the product for details on sizing up MI cable terminations.

VOLTAGE DROP

Voltage drop calculations are based on calculated load, not circuit breaker rating.

For conventional cables, simple formulas are used to determine if the cable size listed in the ampacity tables meets the required voltage drop limits. While these formulas can be applied to System 1850 MI cable, voltage drop values specific to the characteristics of MI cable can be calculated using any of the following:

- An equation based on the run length, the conductor current, and the circuit voltage is provided in Appendix: Pyrotenax MI Voltage Drop Calculations (H57611)
- A quick voltage drop calculator is available on the Pentair Thermal Management web site, www.pentairthermal.com
- PyroSizer MI cable sizing software is available on the Pentair Thermal Management web site, www.pentairthermal.com, or through your Pentair Thermal Management representative

EQUIPMENT BONDING

The copper sheath of System 1850 MI cables meets North American code requirements for the equipment grounding conductor. The brass gland completes the grounding path from the cable sheath to the equipment. For single conductor cables, the ground path includes a nonferrous brass plate, as shown in Fig. 7 (in Canada, brass plates are required only for ampacities over 200 A).

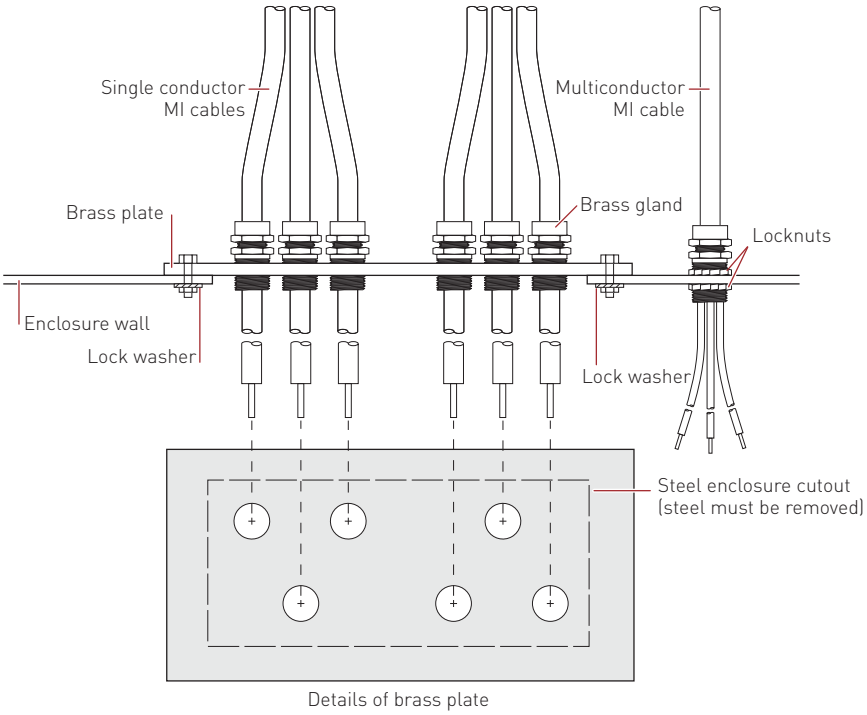


Fig. 7 Equipment bonding using brass plate

SHORT CIRCUIT CAPABILITY

The following graphs give the maximum allowable short circuit currents for System 1850 MI cables. The first is based on the cable only. The cable will survive if the short circuit currents shown are not exceeded; however, the terminations could be damaged. The second graph provides the maximum short circuit current to avoid damage to terminations.

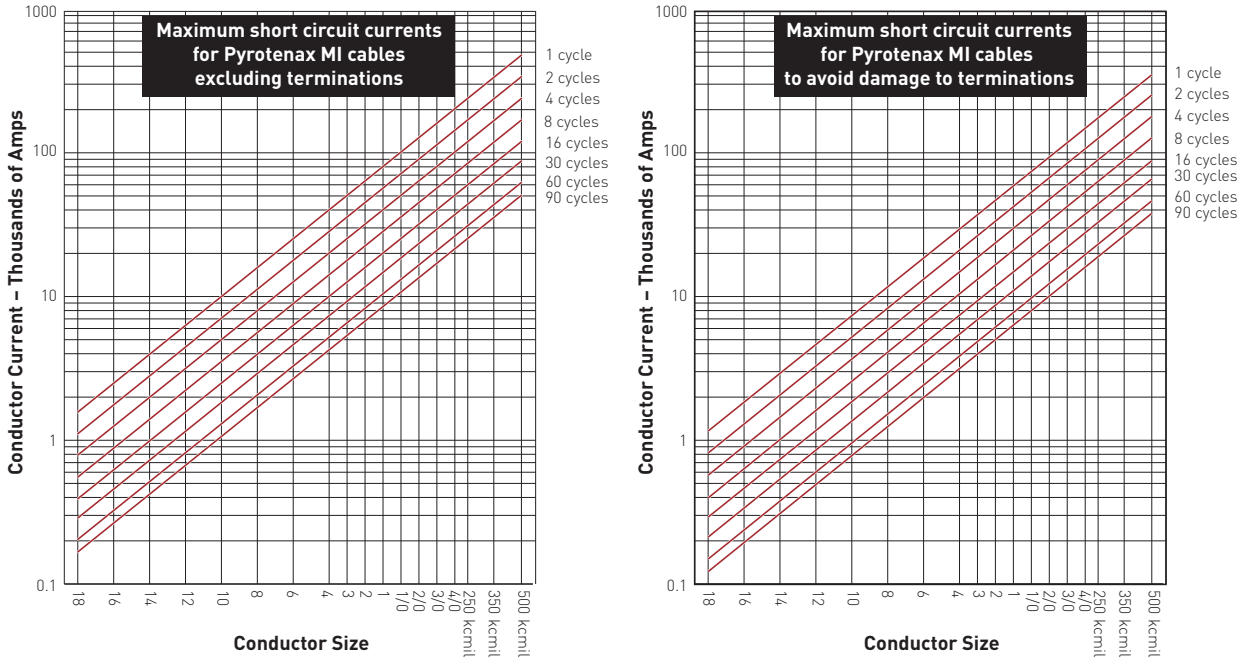


Fig. 8 Short circuit currents

EXPANSION AND VIBRATION

In applications subject to expansion or vibration, take precautions to prevent mechanical damage to System 1850 MI cable. See Appendix: Pyrotenax MI Cable Expansion and Vibration (H57613) for details.

CORROSION AND COPPER-ARMORED CABLES

In most applications, System 1850 MI cables can be used without any additional protection against corrosion. However, in applications where the cable may be exposed to corrosives, such as when the cable is directly buried or embedded in concrete, additional protection in the form of a polymer jacket is required. Refer to Appendix: Copper Sheathed Cable and Corrosion (H57614) for more information on corrosion and copper-armored cables.

CABLE TERMINATION AND SPLICES

System 1850 MI cables are approved as a complete system only when used with the appropriate Pyrotenax termination and splice kits. The use of nonapproved components will compromise the reliability of the system and will invalidate approvals and warranties.

Two types of termination kits are available: Pyropak kits for all single and multiconductor cables, and QuickTerm kits for #6 AWG and larger single conductor cables. The QuickTerm kits include a special connector to splice the solid MI conductor to a flexible tail (flexible tail not supplied).

Factory terminated System 1850 MI cable sets are available in a range of sizes and lengths. For details on terminated cable sets, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

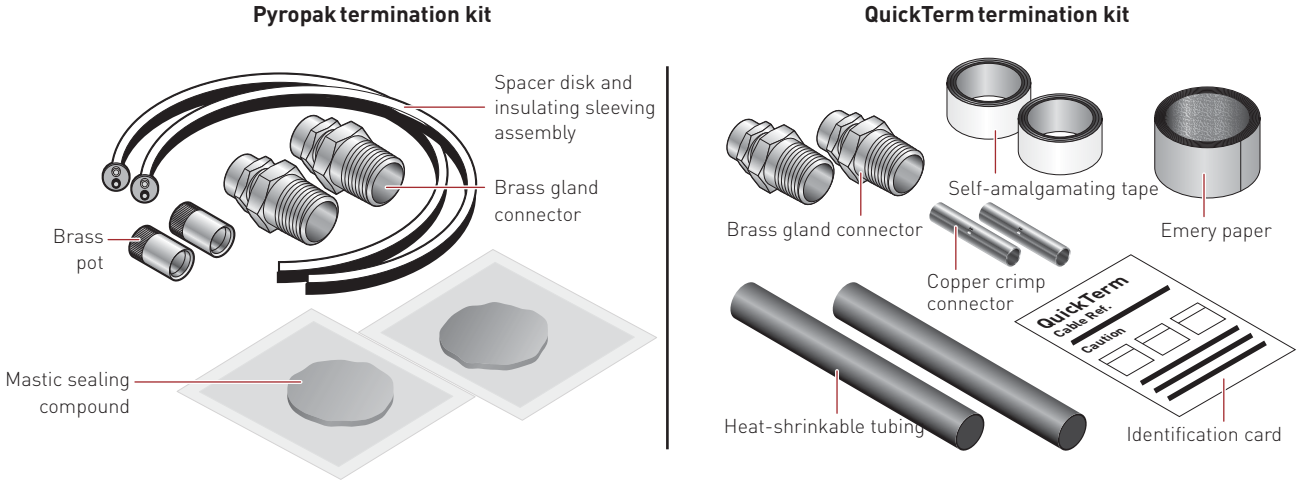


Fig. 9 Terminations for System 1850 MI cable

In cases where the manufactured length is shorter than the required run length, a splice is used to join individual lengths of cable. Two options for splicing System 1850 MI cable are available:

Factory fire-rated splice: A UL/ULC 2-hour fire-rated, all-welded joint is installed at the factory.

Field-installed fire-rated splice: A field-installed splice, consisting of a splice kit and a separate field installed fire protection kit, is used to extend cable length or to repair a damaged cable.

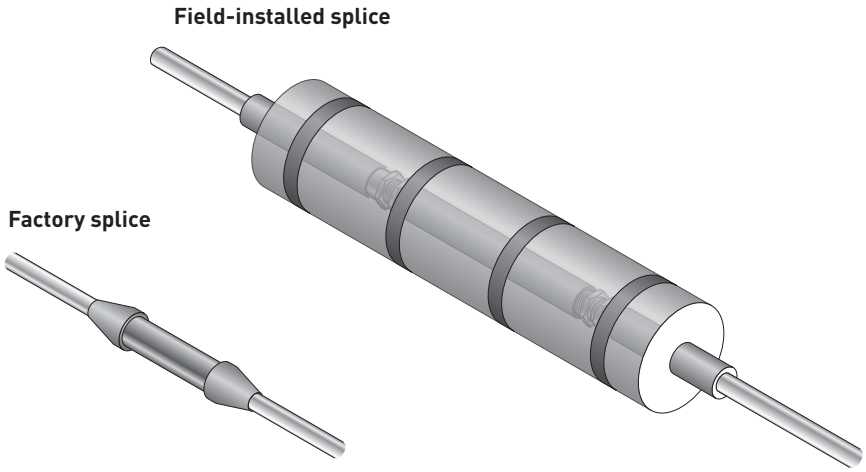


Fig. 10 Splices for System 1850 MI cable

TYPICAL SYSTEM INSTALLATION

A typical critical power circuit installation utilizing System 1850 MI cable is shown in Fig. 11. Additionally, components and accessories available for single and multiconductor MI cables are shown in Table 1. For further information on components and accessories, see the product data sheet in the Technical Data section.

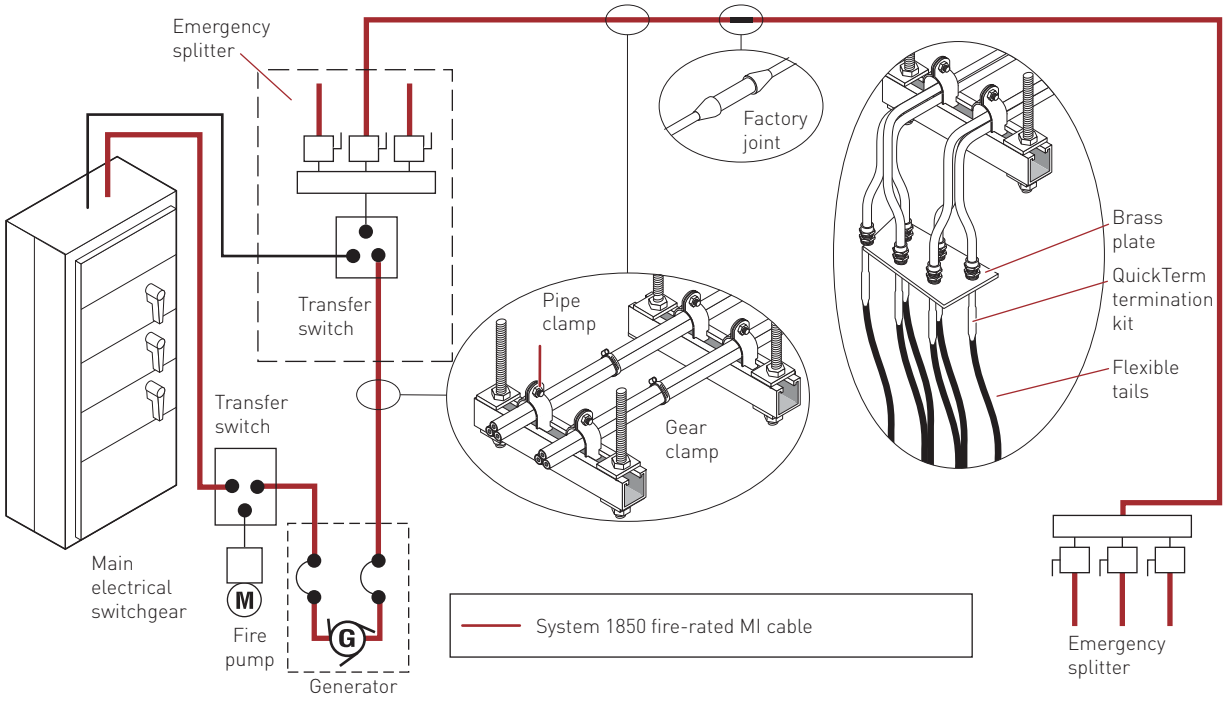


Fig. 11 Typical System 1850 power circuit system

TABLE 1 COMPONENT AND ACCESSORY AVAILABILITY

	Single conductor MI	Multiconductor MI
Pyropak termination kit	•	•
QuickTerm termination kit	•	
Field and factory splices	•	•
Brass plates	•	

Installation Guidelines

These installation guidelines apply to System 1850 MI cables only. When installing a system, refer to the requirements in the UL/ULC Fire Resistance Directory and System 1850 data sheet and installation instructions shipped with the product, and available on the Pentair Thermal Management web site at www.pentairthermal.com. Refer to national and local electrical codes for additional details. For further information, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

SUPPORTING SYSTEM 1850 MI CABLE

It is important that all support components are made of appropriate materials, such as copper, steel, stainless steel, and concrete. Low melting point or combustible materials such as aluminum, brass, plastic, lead, wood, etc. are not acceptable.

System 1850 MI cable may be directly mounted on noncombustible surfaces such as concrete or masonry, or supported by steel rod and channel (trapeze) systems. To achieve free air rating, spacing must be maintained between the cable bundles and also between the bundles and the mounting surface; refer to Fig. 12. UL/ULC listing requirements for fire-rated cables stipulate support spacing at certain intervals; refer to the installationinstructions shipped with the product and available on the Pentair Thermal Management web site, www.pentairthermal.com.

System 1850 MI cable should not be installed in conduit, other than when transitioning through a wall, floor, or ceiling.

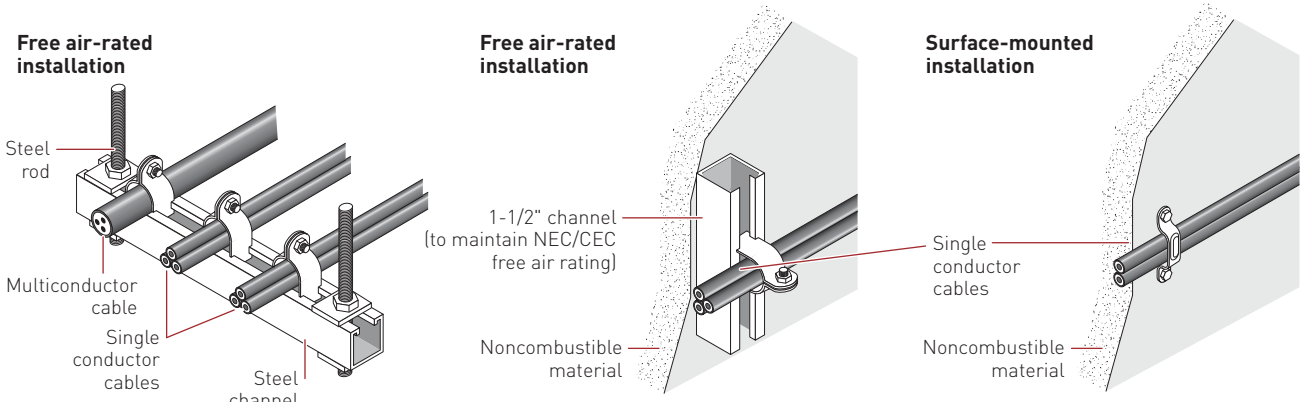


Fig. 12 Supporting System 1850 MI cable

It is important to keep the overall loading on the rod and channel system within limits. Table 2 shows the recommended loading guidelines based on the minimum channel depth of 1-1/2 inch. Note that the cable load calculations as shown in Table 2 take into account only the load represented by the MI cable.

TABLE 2 LOADING GUIDELINES

Cable load*	Support method
Up to 150 lbs (68 kg)	3/8" (10 mm) threaded rod
Between 150 lbs and 267 lbs (68 kg and 121 kg)	1/2" (13 mm) threaded rod
Between 267 lbs and 400 lbs (121 kg and 182 kg)	5/8" (16 mm) threaded rod
Channel	
1. Maximum width of 1-1/2 in (38 mm) channel: 36 in (915 mm)	
2. Maximum load per channel = 200 lbs (91 kg). Channel may be doubled to increase load to 400 lb (182 kg) or reduce spacing between supports ensuring that cable load does not exceed 200 lbs/channel.	

* Cable load (lbs) = lbs/ft cable x total number of runs x spacing between supports measured in feet
Cable load (kg) = kg/m cable x total number of runs x spacing between supports measured in meters

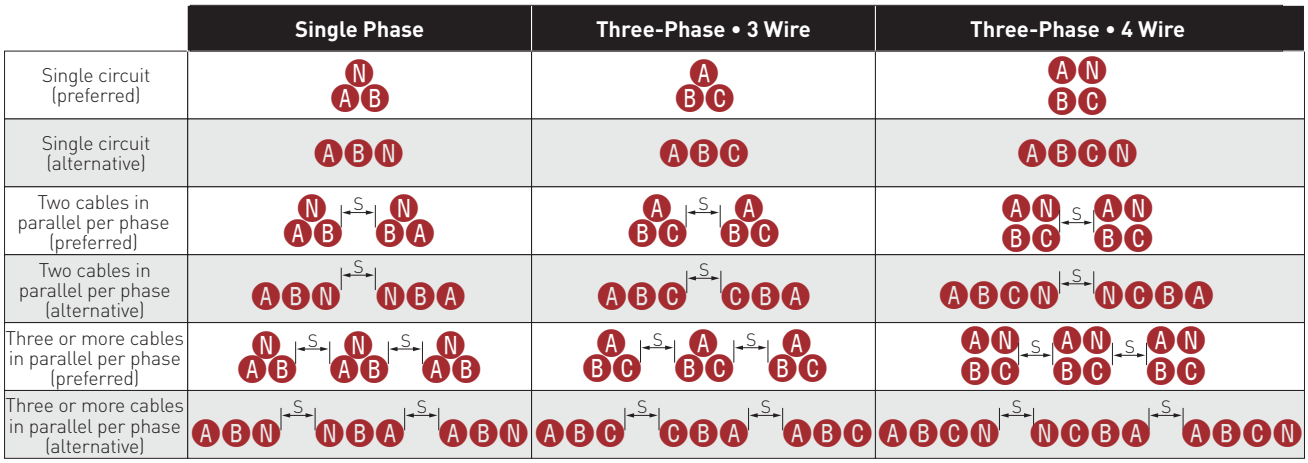
Note: UL/ULC listing requirements for fire-rated cables stipulate support spacing at certain intervals; refer to the installation instructions shipped with the product and available on the Pentair Thermal Management web site, www.pentairthermal.com.

SEISMIC CONSIDERATIONS

In areas where there is a risk of seismic activity, precautions must be taken where the cable crosses expansion joints and at termination points. For more information, see Appendix: Pyrotenax MI Cable Expansion and Vibration (H57613).

CABLE LAYOUT

In multiconductor cables, the magnetic effects of the phase conductors cancel each other out, allowing for cable installation in any configuration. However, single conductor cables should be bundled in groups containing one conductor from each phase to minimize the resulting magnetic field in each grouping. The grouped single conductor cables are then fastened tightly together, ensuring that the gland connectors at each end of the cable run are connected to the metal enclosure through a nonferrous entry, such as a brass plate, or in accordance with national electrical codes. Typical single conductor cable configurations are shown in Fig. 13. The neutral conductor may be located within or outside the cable group.



Note: For free air ampere ratings, the spacing "S" between bundles should be a minimum of 2.15 cable diameters in the U.S. (NEC) and Canada (CEC). For magnetic effect purposes, the neutral may be located as shown, or outside groups in the most convenient location.

Fig. 13 Recommended installation configurations

Electrical codes generally limit paralleling cable configurations to cable sizes 1/0 AWG and larger. The codes address the balancing of resistance by stipulating:

- All conductors must be the same length
- All conductors must be the same size and the same material
- All conductors must have the same type of insulation
- All conductors must be terminated in the same manner

A current measurement should be taken immediately after the cables begin to carry load. Load imbalances between conductors of up to 10% are tolerable and expected. Deviations above 10% must be investigated and corrected.

When installing single conductor cables through a ferrous enclosure, precautions must be taken to prevent induction heating in the steel. This is accomplished by removing a section of the enclosure and installing a nonferrous brass plate (in Canada, this is only required above 200 amperes). Brass plates with pretapped holes are available for the gland connectors.

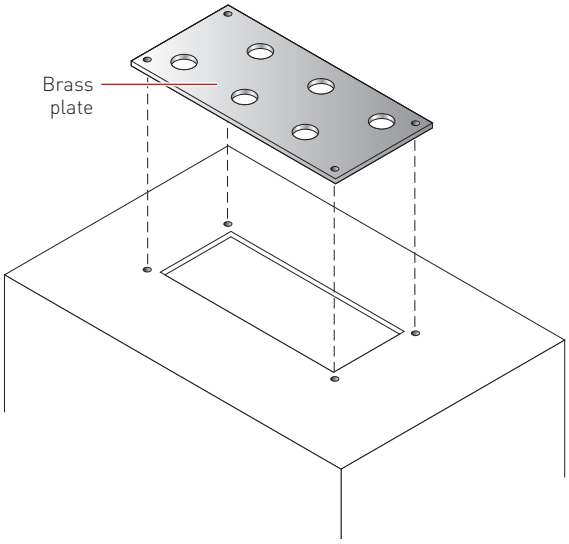


Fig. 14 Enclosure with cutout and brass plate

TERMINATING SYSTEM 1850 MI CABLE

Details on terminating System 1850 MI cables can be found in the installation instructions provided with each System 1850 MI cable termination kit.

Factory terminated System 1850 MI cable sets are available in a range of sizes and lengths. For details on terminated cable sets, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

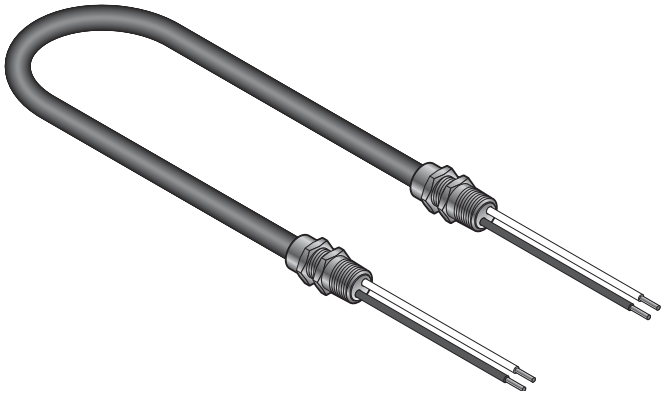


Fig. 15 Factory terminated System 1850 MI cable

CONNECTING SYSTEM 1850 MI CABLE

The termination gland is a brass fitting available in standard NPT sizes. The glands are supplied in 1/2", 3/4", 1", or 1-1/4" sizes, depending on the cable diameter.

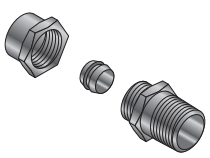


Fig. 16 Brass gland

Gland size information for each MI cable is available from the product data sheets in the Technical Data section. When tightened with the recommended torque, 25 ft-lbs for all gland sizes, this gland simultaneously seals the enclosure and grips the cable through a brass compression sleeve. This connection, when installed according to the installation instructions, provides the following benefits:

- Code-compliant bonding path from the cable sheath.
- Hydrostatic withstand pressure up to 500 lbs/in^2 (35 kg/cm^2)

Note: Terminations are not required to be fire-rated since the emergency equipment they serve is in a fire-rated room.

SPACE SAVING CABLE SYSTEM

This section provides an overview of general circuit design considerations and installation guidelines for Pyrotenax System 1850 Power Cables in space savings applications. For additional information, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258. Also, visit our web site at www.pentairthermal.com.

Contents

INTRODUCTION

Increased power consumption due to the expansion of office space in existing buildings, as well as the conversion of buildings to commercial use, has resulted in greater demand for the retrofitting of electrical power feeders. In many instances, this involves installing power cable in constricted spaces and along difficult runs.

Pentair Thermal Management Pyrotenax System 1850 mineral insulated (MI) power cable allows up to 80% space savings over traditional rigid conduit and wire solutions, and are easily installed in areas where space is limited.

Typical Locations

System 1850 MI power cables, when used in space saving applications, are ideal for high capacity feeders and low profile wiring in the following locations:

- Older high-rise buildings
- Historic buildings
- Health care facilities
- Any location where space is limited

System 1850 Mineral Insulated Cable

System 1850 MI cable offers a unique combination of dependability, versatility, and permanence while capable of operating continuously at ambient temperatures as high as 250°C (482°F).

CONSTRUCTION

Pyrotenax System 1850 MI cables are manufactured using only inorganic materials, copper and magnesium oxide. This construction is inherently tough, yet allows the cable to be bent and molded to fit into tight spaces. In addition, the totally inorganic construction of unjacketed System 1850 MI cable allows for an environmentally clean electrical cable that does not burn, produce smoke, or add fuel when exposed to fire conditions.

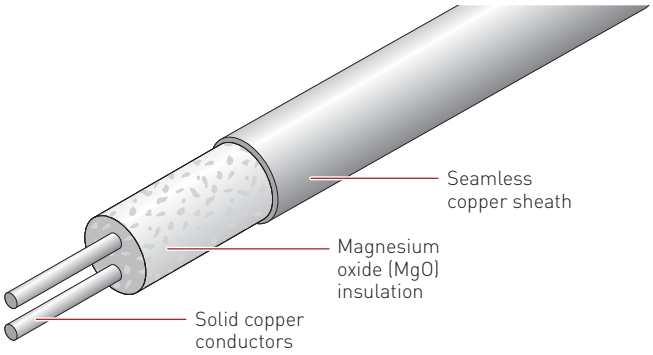


Fig. 1 System 1850 MI cable construction

System 1850 MI cables have a seamless metal sheath that allows the cable to withstand bending, twisting, pulling, and mechanical abrasion, while remaining fully functional. For superior corrosion protection, an optional polymer jacket is available and is suitable for use in temperatures as low as –40°C (–40°F).

CONFIGURATIONS

System 1850 MI cables are available in a range of sizes and conductor configurations, allowing for use in a diverse range of applications. For specifications, see the product data sheet in the Technical Data section.

Approvals and Certifications

Pyrotenax System 1850 MI cables meet the applicable requirements of the U.S. National Electrical Code (NEC) and the Canadian Electrical Code (CEC), and are UL Listed and CSA Certified in North America.

Factory terminated MI cable sets are approved for nonhazardous locations and hazardous locations. For specific approval information, see the product data sheet in the Technical Data section.

Pyrotenax power cables are also available for use outside North America and are manufactured to BS EN 60702-1 & 60702-2, Mineral Insulated Cables and Terminations. Contact Pentair Thermal Management for information on our range of cables certified for use worldwide.

CIRCUIT DESIGN CONSIDERATIONS

Power cable systems should only be designed by professionals familiar with generally accepted design practices. The information provided below relates specifically to designs using Pyrotenax MI power cables and must be followed, along with all relevant local codes and standards, to ensure that the systems are designed properly. For additional information, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

Cable Sizing

Power cable size is based on circuit breaker size, which in turn is based on load calculations. Special rules apply for motors where cable size is based on 125% of full load current. Use the ampacity tables specified in the electrical code to determine the cable size. If the calculated voltage drop exceeds the specified limits, a larger cable size must be chosen.

The NEC and CEC allow full "free air" ampacity for unjacketed single conductor Pyrotenax MI cables configured according to Fig. 2 as long as a space of 2.15 cable diameters is maintained between bundles.

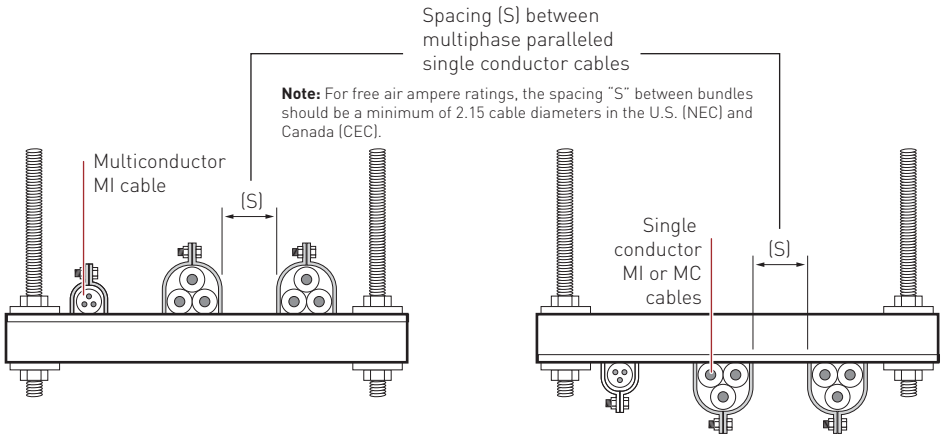


Fig. 2 Spacing of bundled conductors

Under the installation conditions shown in Fig. 2, the termination may need to be "sized-up" to keep it within its temperature limits in accordance with electrical code requirements (NEC 110.14(C)). MI cable terminations should be sized up in accordance with the installation instructions supplied with the termination kit.

Voltage Drop

Voltage drop calculations are based on calculated load, not circuit breaker rating.

For conventional cables, simple formulas are used to determine if the cable size listed in the ampacity tables meets the required voltage drop limits. While these formulas can be applied to System 1850 MI cable, voltage drop values specific to the characteristics of MI cable can be calculated using any of the following:

- A quick voltage drop calculator is available on the Pentair Thermal Management web site, www.pentairthermal.com
- PyroSizer MI cable sizing software is available on the Pentair Thermal Management web site, www.pentairthermal.com, or through your Pentair Thermal Management representative

Equipment Bonding

The copper sheath of System 1850 MI cables meets North American code requirements for an equipment grounding conductor, The brass gland completes the grounding path from the cable sheath to the equipment. For single conductor cables, the ground path includes a nonferrous brass plate as shown in Fig. 3 (in Canada, brass plates are required only for ampacities over 200 A).

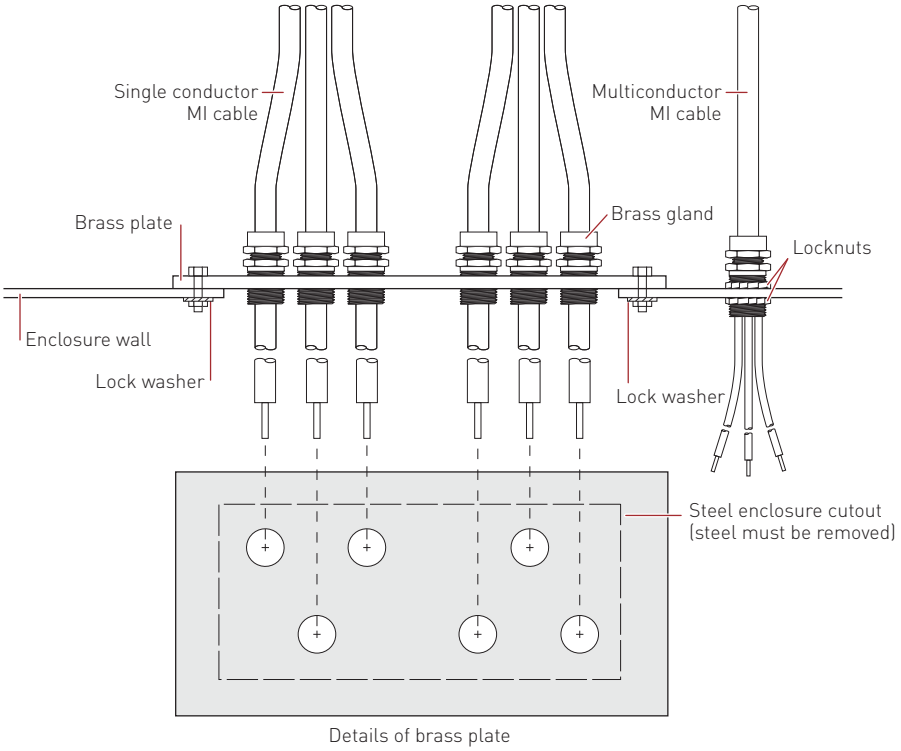


Fig. 3 Equipment bonding using brass plate

Short Circuit Capability

The following graphs give the maximum allowable short circuit currents for System 1850 MI cables. The first is based on the cable only. The cable will survive if the short circuit currents shown are not exceeded; however, the terminations could be damaged. The second graph provides the maximum short circuit current to avoid damaging the terminations.

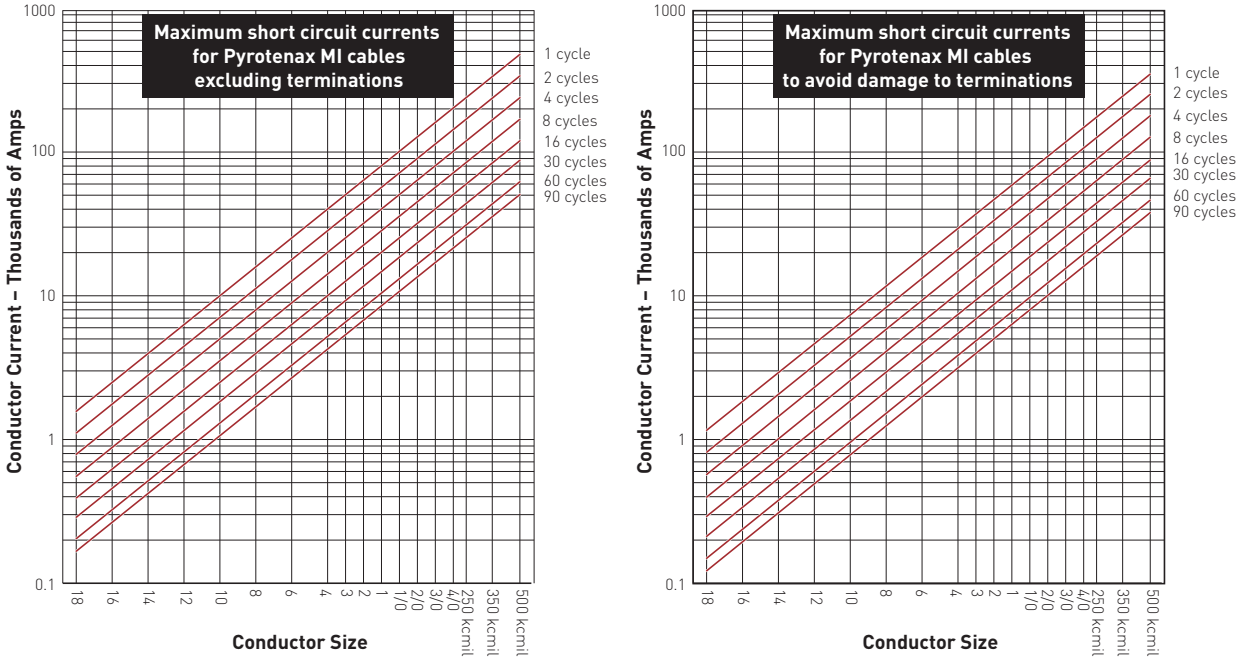


Fig. 4 Short circuit currents for System 1850 MI cable

Expansion and Vibration

In applications subject to expansion or vibration, take precautions to prevent mechanical damage to System 1850 MI cables. Refer to appendix: Pyrotenax MI Cable Expansion and Vibration (H57613) for details.

Corrosion and Copper-armored Cables

In most applications, System 1850 MI cables can be used without any additional protection against corrosion. However, in applications where the cable may be exposed to corrosives, such as when the cable is directly buried or embedded in concrete, additional protection in the form of a polymer jacket is recommended. Refer to appendix: Copper Sheathed Cable and Corrosion (H57614) for details.

Cable Termination

System 1850 MI cables are approved as a complete system only when used with the appropriate Pyrotenax termination and splice kits. The use of nonapproved components will compromise the reliability of the system and will invalidate approvals and warranties.

Two types of termination kits are available: Pyropak kits for all single and multiconductor cables, and QuickTerm kits for # 6 AWG and larger single conductor cables. The QuickTerm kits include a special connector to splice the solid MI conductor to a flexible tail (flexible tail not supplied).

Factory terminated System 1850 MI cable sets are available in a range of sizes and lengths. For details on terminated cable sets, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

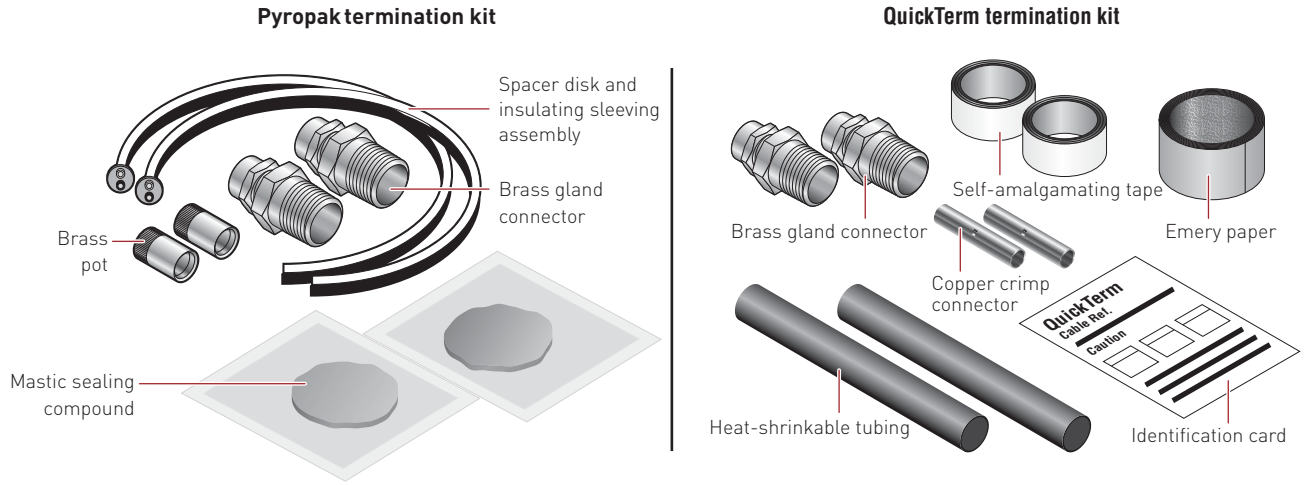


Fig. 5 Terminations for System 1850 MI cable

Cable Splices

In cases where the manufactured length is shorter than the required run length, a splice is used to join individual lengths of cable. Two options for splicing System 1850 MI cable are available:

Field-installed splice: A field-installed splice kit is available to extend the cable length or to repair a damaged cable.

Factory splice: An all-welded factory installed splice is available to extend the cable length.

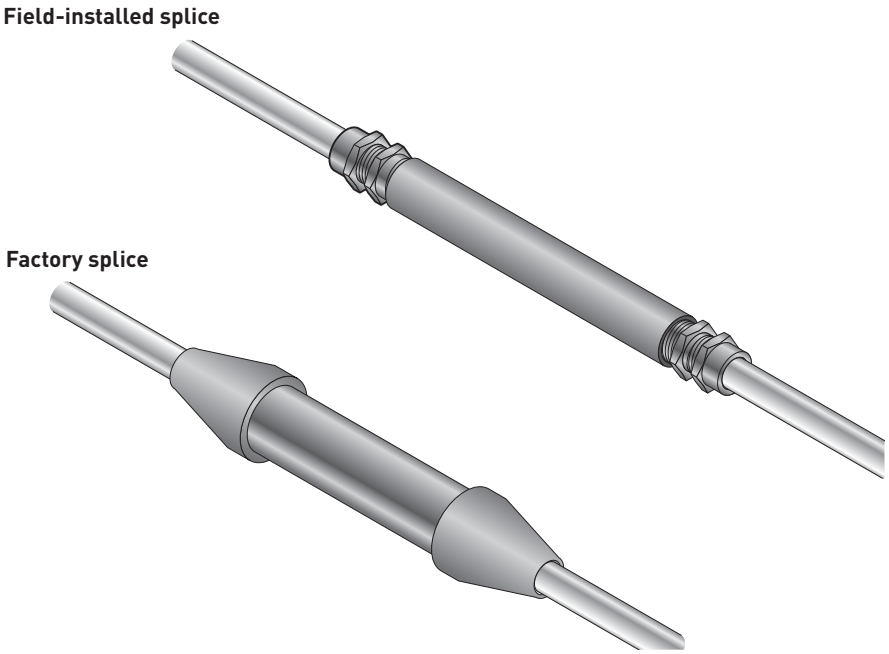


Fig. 6 Splices for System 1850 space saving MI cable

Typical Space Saving System Installation

A typical space saving power circuit installation utilizing System 1850 MI cable is shown in Figure 7. Additionally, components and accessories available for single and multiconductor MI cables are shown in Table 1. For further information on components and accessories, see the product data sheet in the Technical Data section.

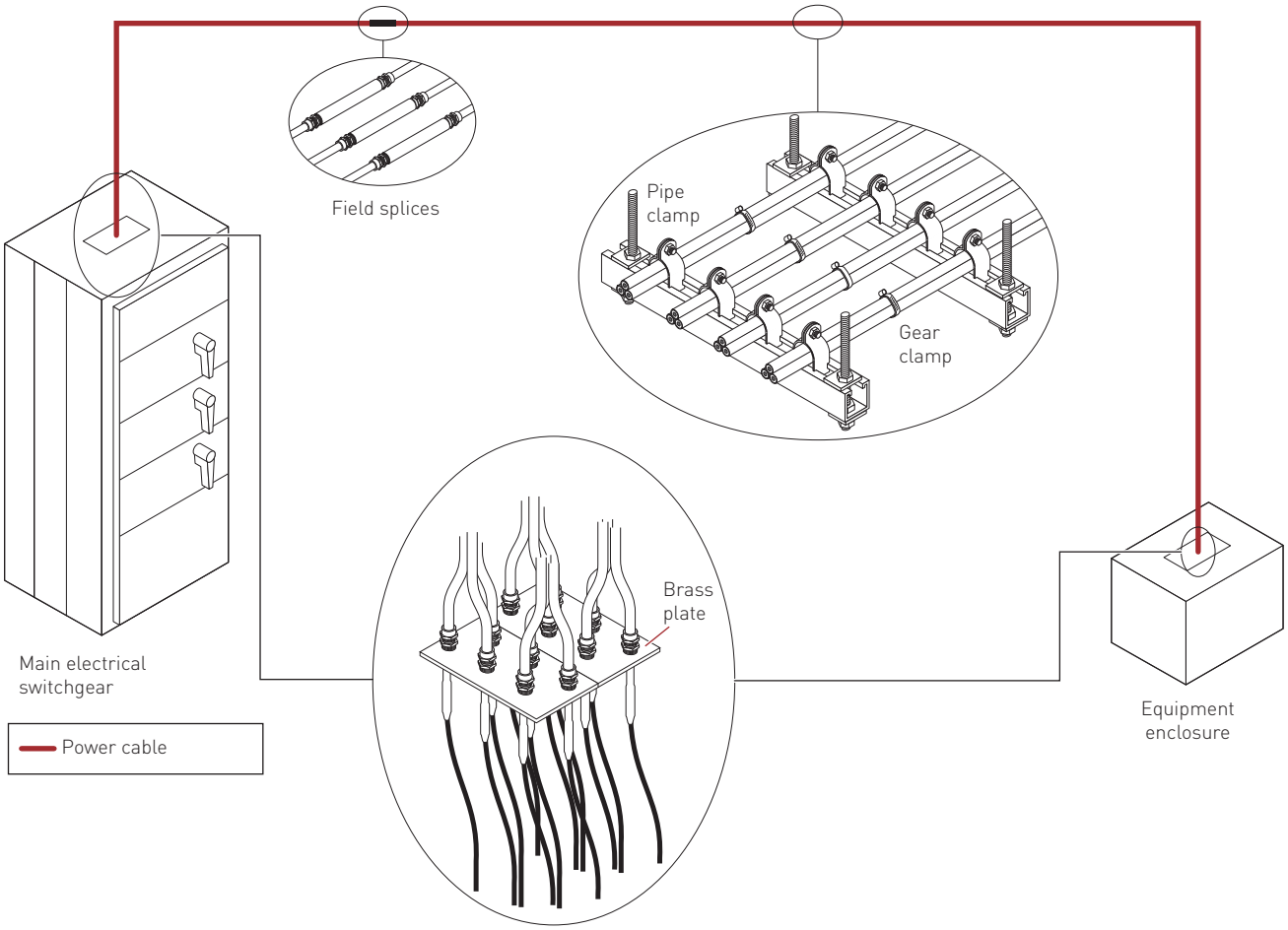


Fig. 7 Typical single conductor System 1850 space saving power cable system

TABLE 1 COMPONENT AND ACCESSORY AVAILABILITY FOR SYSTEM 1850 MI POWER CABLE

	Single conductor MI	Multiconductor MI
Pyropak termination kit	•	•
QuickTerm termination kit	•	
Field and factory splices	•	•
Brass plates	•	

INSTALLATION GUIDELINES

These installation guidelines apply to System 1850 MI cables used in space saving applications. For further details, refer to national and local electrical codes, the System 1850 data sheet, and the installation instructions shipped with the product. The data sheet and installation instructions are available on the Pentair Thermal Management web site at www.pentairthermal.com. Contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258 for additional information.

Supporting Space Saving MI Cables

System 1850 MI cables used in space savings applications may be directly mounted on any surface or supported by rod and channel (trapeze) systems. To achieve free air rating, spacing must be maintained between the cable bundles and also between the bundles and the mounting surface; refer to Fig. 8. Pentair Thermal Management and electrical codes require support spacing at certain intervals; refer to the installation instructions shipped with the product and available on the Pentair Thermal Management web site, www.pentairthermal.com.

Other than transitions through a wall, floor, or ceiling, MI cable should not be installed in conduit.

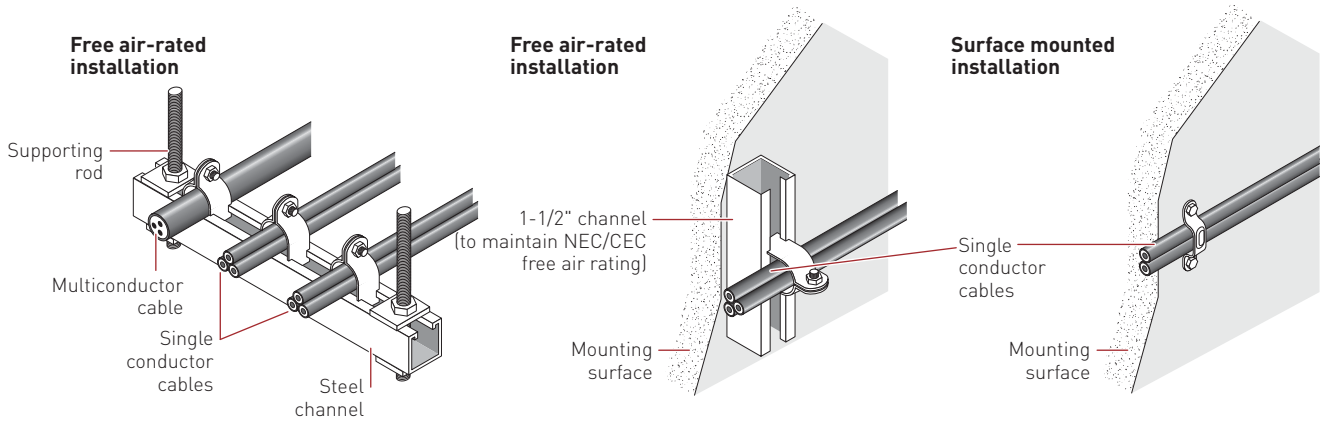


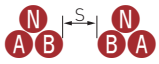
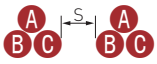
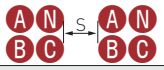
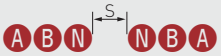
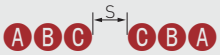
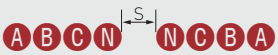
Fig. 8 System 1850 MI cables in space savings applications

Seismic Considerations

In areas where there is a risk of seismic activity, precautions must be taken where the cable crosses expansion joints and at termination points. Refer to appendix: Pyrotenax MI Cable Expansion and Vibration (H57613) for details.

Cable Layout

In multiconductor cables, the magnetic effects of the phase conductors cancel each other out, allowing for cable installation in any configuration. However, single conductor cables should be bundled in groups containing one conductor from each phase to minimize the resulting magnetic field in each grouping. The grouped single conductor cables are then fastened tightly together, ensuring that the gland connectors at each end of the cable run are connected to the metal enclosure through a nonferrous entry, such as a brass plate, or in accordance with national electrical codes. Typical single conductor cable configurations are shown in Fig. 9. The neutral conductor may be located within or outside the cable group.

	Single Phase	Three-Phase • 3 Wire	Three-Phase • 4 Wire
Single circuit (preferred)			
Single circuit (alternative)			
Two cables in parallel per phase (preferred)			
Two cables in parallel per phase (alternative)			
Three or more cables in parallel per phase (preferred)			
Three or more cables in parallel per phase (alternative)			

Note: For free air ampere ratings, the spacing "S" between bundles should be a minimum of 2.15 cable diameters in the U.S. (NEC) and Canada (CEC). For magnetic effect purposes, the neutral may be located as shown, or outside groups in the most convenient location.

Fig. 9 Recommended installation configurations

Electrical codes generally limit paralleling cable configurations to cable sizes 1/0 AWG and larger. The codes address the balancing of resistance by stipulating:

- All conductors must be the same length
- All conductors must be the same size and the same material
- All conductors must have the same type of insulation
- All conductors must be terminated in the same manner

A current measurement should be taken immediately after the cables begin to carry load. Load imbalances between conductors of up to 10% are tolerable and expected. Deviations above 10% must be investigated and corrected.

When installing single conductor cables through a ferrous enclosure, precautions must be taken to prevent induction heating in the steel. This is accomplished by removing a section of the enclosure and installing a nonferrous brass plate (in Canada, this is only required above 200 A). Brass plates with pretapped holes are available for the gland connectors.

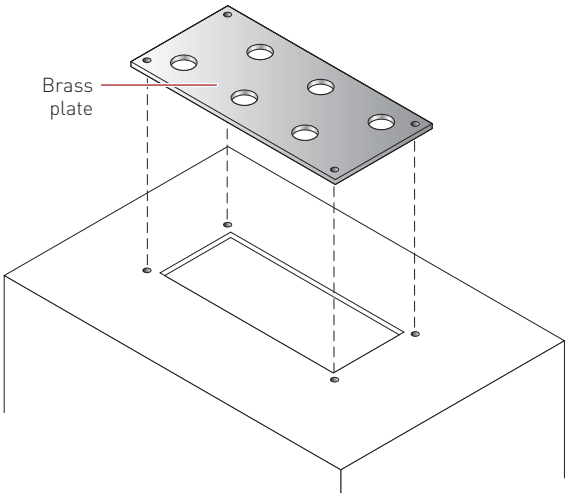


Fig. 10 Enclosure with cutout and brass plate

Terminating System 1850 MI Cables

Details on terminating System 1850 MI cables can be found in the installation instructions provided with each System 1850 MI cable termination kit.

Factory terminated System 1850 MI cable sets are available in a range of sizes and lengths. For details on terminated cable sets, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

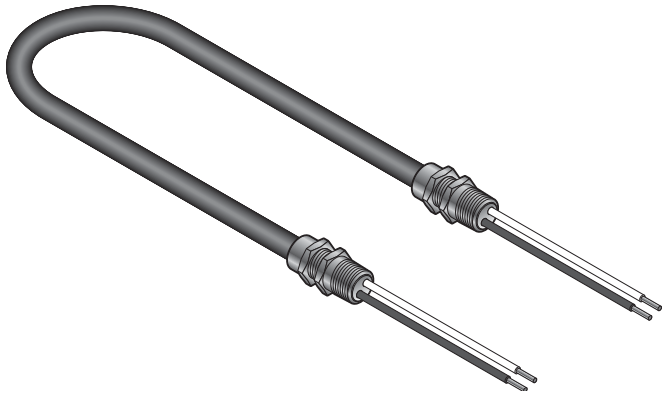


Fig. 11 Factory terminated System 1850 MI cable

Connecting System 1850 MI Cable

The termination gland is a brass fitting available in standard NPT sizes. The glands are supplied in 1/2", 3/4", 1", or 1-1/4" sizes, depending on the cable diameter.

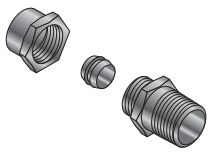


Fig. 12 Brass gland

Gland size information for each MI cable is available from the product data sheets in the Technical Data section. When tightened with the recommended torque (25 ft-lbs), this gland simultaneously seals the enclosure and grips the cable through a brass compression sleeve. This connection, when installed according to the installation instructions, provides the following benefits:

- Code-compliant bonding path through the cable sheath
- Hydrostatic withstand pressure up to 500 lbs/in^2 (35 kg/cm^2)

SYSTEM 1850-SE SERVICE ENTRANCE CABLE SYSTEM

This section provides an overview of general circuit design considerations and installation guidelines for a Pyrotenax System 1850-SE Service Entrance (SE) mineral insulated cable system. This system is designed as an alternative to concrete encasement for service conductors. Where conditions make concrete encasement difficult or impractical, Authorities Having Jurisdiction (AHJs) have accepted this system as an alternative to concrete encasement. For additional information, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258. Also, visit our web site at www.pentairthermal.com.

CONTENTS

INTRODUCTION

Increased power consumption due to the expansion of office space in existing buildings, as well as the conversion of buildings to commercial use, has resulted in greater demand for electrical power. Retrofitting service conductors can present particular difficulties as the electrical room is often located at a distance from the service entrance point. While this was a good location when the building was first constructed and service cables could easily be encased in concrete in the floor, it gives rise to significant difficulties after the fact, when encasement of the additional service conductors can be virtually impossible because of constricted space and congestion in service areas.

Pentair Thermal Management Pyrotenax System 1850-SE allows up to 80% space savings over traditional rigid conduit and wire solutions. The decision to accept the system as a alternative to concrete encasement is the responsibility of the Authorities Having Jurisdiction (AHJs). If accepted, either on a case-by-case basis or carte blanche as has been the case in several major cities, the system provides an effective solution to a difficult problem.

Typical Locations

System 1850-SE is ideal for high-capacity feeders and low-profile wiring in the following locations:

- Older high-rise buildings
- Historic buildings
- Health care facilities

System 1850-SE

A Pyrotenax System 1850-SE installation consists of System 1850 2-hour fire-rated single conductor MI cable, with special terminations for service entrance applications, and enclosed ventilated cable tray. System 1850-SE should be supported by steel rod and channel (trapeze) systems in one of two configurations.

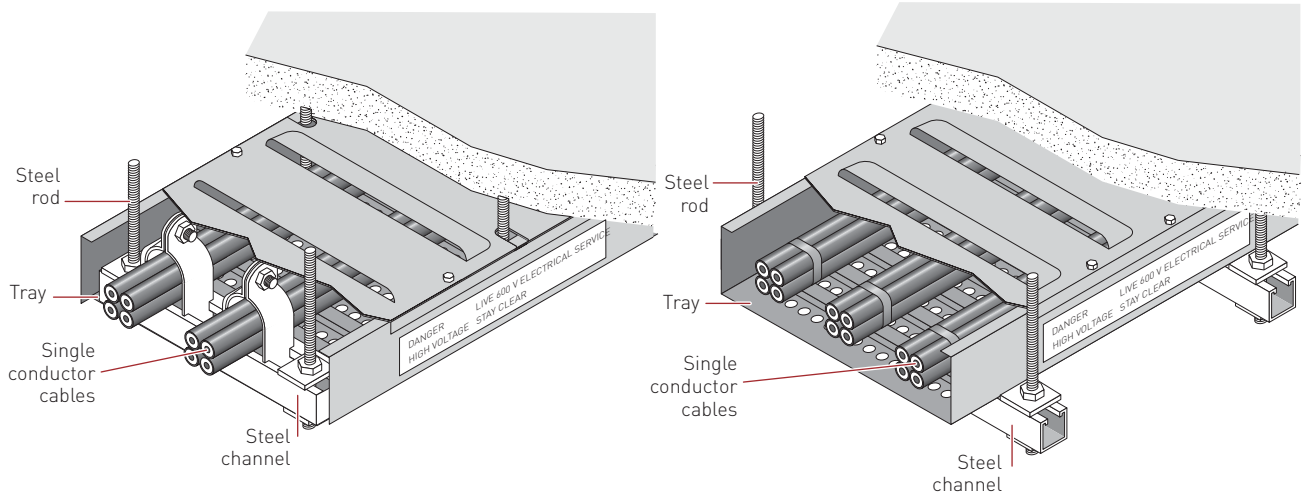


Fig. 1 System 1850-SE configurations

System 1850-SE MI cable is installed in an enclosed ventilated tray labeled along its length with warnings that this is a "live electrical service."

SYSTEM 1850 2-HOUR FIRE-RATED MINERAL INSULATED CABLE

Pyrotenax System 1850 MI wiring cables are manufactured using only inorganic materials, copper and magnesium oxide. This construction is inherently tough, yet allows the cable to be bent and molded to fit into tight spaces. In addition, the totally inorganic construction of unjacketed System 1850 cables allows for an environmentally clean electrical cable that does not burn, produce smoke, or add fuel when exposed to fire conditions.

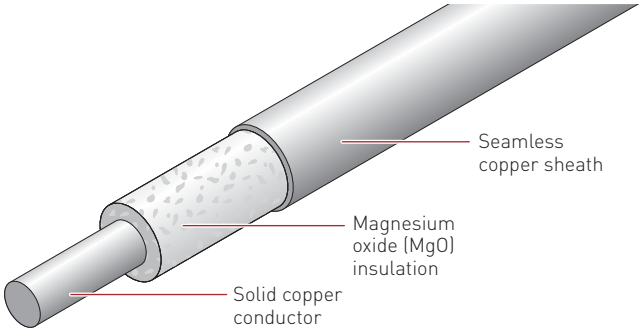


Fig. 2 System 1850 MI cable construction

For service entrance applications, both 350 kcmil and 500 kcmil single conductor cables are available. For specifications, see the product data sheet in the Technical Data section.

VENTILATED TRAY

A NEMA Class 12B Stainless steel ventilated tray complete with louvered cover, clamps, 90° and 45° bends, offsets, etc. is supplied.

The steel rod and channel used for the trapeze supports is not supplied.

Approvals and Certifications

All components of System 1850-SE are UL Listed and/or CSA Certified in North America.

CIRCUIT DESIGN CONSIDERATIONS

Service entrance systems should only be designed by professionals familiar with generally accepted design practices. The information provided below relates specifically to designs using Pyrotenax System 1850-SE and must be followed, along with all relevant local codes and standards, to ensure that the systems are designed properly. For additional information, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

Cable Sizing

System 1850-SE MI cable size is based on circuit breaker size, which in turn is based on load calculations. After choosing the appropriate circuit breaker size, use the ampacity tables specified in the electrical code to determine the cable size. If the calculated voltage drop exceeds the specified limits, a larger cable size must be chosen.

The National Electrical Code (NEC) allows full "free air" ampacity for unjacketed single conductor MI cables configured according to Fig. 3 as long as a space of 2.15 cable diameters is maintained between bundles.

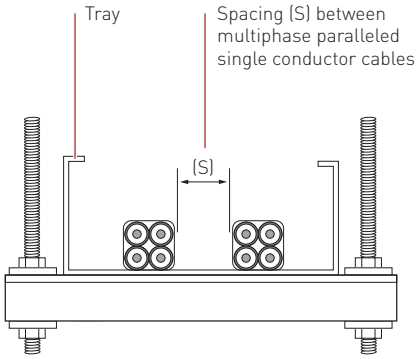


Fig. 3 Spacing of bundled conductors

Although unjacketed single conductor MI cable is unaffected by any temperature increase resulting under the installation conditions shown in Fig. 3, the termination may need to be "sized-up" to keep it within its temperature limits in accordance with electrical code requirements. Refer to Table 1, later in this section for more details.

Voltage Drop

Voltage drop calculations are based on calculated load, not circuit breaker rating.

For conventional cables, simple formulas are used to determine if the cable size listed in the ampacity tables meets the required voltage drop limits. While these formulas can be applied to System 1850-SE MI cable, voltage drop values specific to the characteristics of MI cable can be calculated using any of the following:

- An equation based on the run length, the conductor current, and the circuit voltage is provided in Appendix: Pyrotenax MI Voltage Drop Calculation (H57611)
- A quick voltage drop calculator is available on the Pentair Thermal Management web site, www.pentairthermal.com
- PyroSizer MI cable sizing software is available from the Pentair Thermal Management web site, www.pentairthermal.com, or through your Pentair Thermal Management representative

Equipment Bonding

The copper sheath of System 1850 cables meets the North American code requirements for an equipment grounding conductor. The brass gland completes the grounding path from the cable sheath to the equipment. For single conductor cables, the ground path includes a nonferrous brass plate, as shown in Fig. 4.

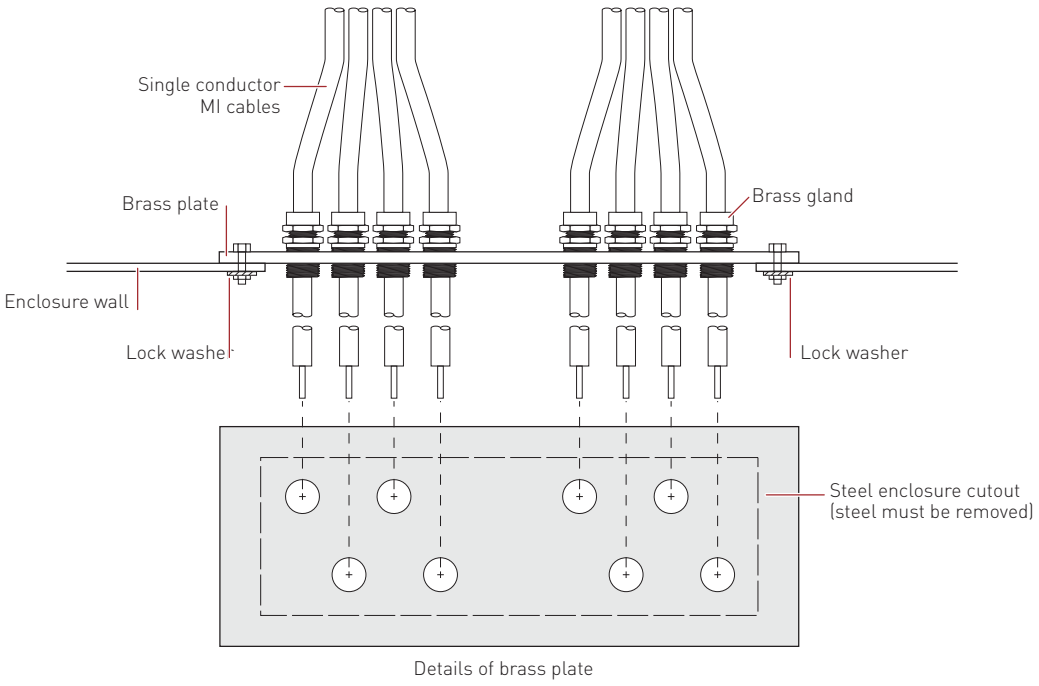


Fig. 4 Equipment bonding using brass plate

Short Circuit Capability

The following graphs give the maximum allowable short circuit currents for System 1850 cables. The first is based on the cable only. The cable will survive if the short circuit currents shown are not exceeded; however, the terminations could be damaged. The second graph provides the maximum short circuit current to avoid damage to terminations.

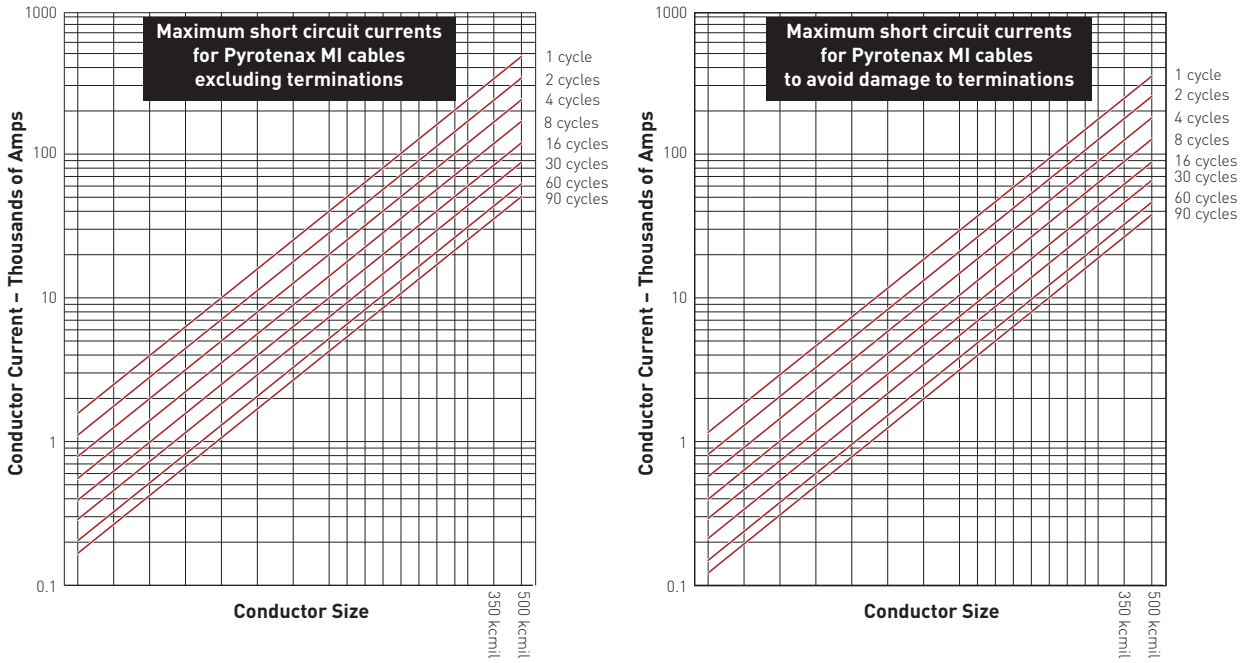


Fig. 5 Short circuit currents

To determine how System 1850-SE behaves when subjected to massive fault currents, tests were performed in which fault currents up to 40 kA at 600 V were fed into a deliberately created fault between the conductor and sheath and maintained for up to three seconds. The resulting arcing fault gave rise to substantial smoke and noise, but cardboard placed one foot under the tray was only pockmarked and did not ignite. For further details on the tests performed, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

Expansion and Vibration

In applications subject to expansion or vibration, take precautions to prevent mechanical damage. See Appendix: Pyrotenax MI Cable Expansion and Vibration (H57613) for details.

Corrosion and MI Cable

In most applications, System 1850 cables can be used without any additional protection against corrosion. System 1850-SE is not suitable for use in corrosive conditions.

Lightning Protection

A lightning arrester kit, SE-Protect, must be installed in areas where lightning activity is exceptionally high, and may also be used in any location where there is a concern about lightning activity. For further information about SE-Protect, please contact Pentair Thermal Management at (800) 545-6258.

Cable Termination

System 1850 cables are approved only when used with the appropriate Pyrotenax termination kits. The use of nonapproved components will compromise the reliability of the system and will invalidate approvals and warranties.

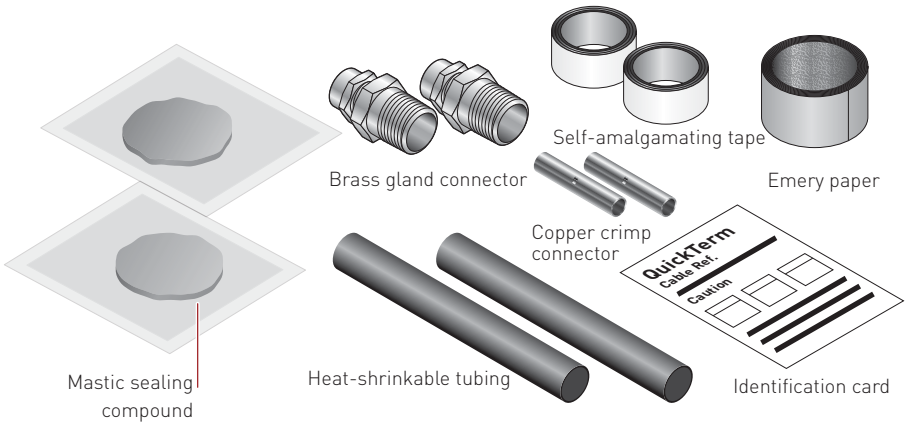


Fig. 6 SE-QuickTerm termination kit for System 1850-SE

The System 1850-SE cable uses a special termination kit to splice the solid MI conductor to a flexible tail (flexible tail not supplied).

The termination procedure for System 1850-SE cables must be reviewed prior to installation and terminations must be installed under the supervision of a Pentair Thermal Management Field Services Engineer. The Service Entrance QuickTerm kit uses mastic sealing compound as well as self-amalgamating tape. The mastic sealing compound must be carefully kneaded in and around the open end of the cable, between the conductor and sheath, before applying the self-amalgamating tape.

TABLE 1 SELECTION TABLE FOR SE-QUICKTERM TERMINATION KIT AND FLEXIBLE TAIL SIZE

MI cable size	Circuit ampacity	If landing on:	Termination method	Flexible tail size
350 kcmil	310 A maximum	Circuit breaker	Size-for-size	350 kcmil
	475 A maximum	Circuit breaker	Sized-up	750 kcmil
	505 A maximum	Bus bar	Sized-up	750 kcmil
500 kcmil	380 A maximum	Circuit breaker	Size-for-size	500 kcmil
	475 A maximum	Circuit breaker	Sized-up	750 kcmil
	620 A maximum	Bus bar	Sized-up	750 kcmil

Factory and Field Splices

Splices must not be used for service entrance applications.

Typical System Installation

A typical System 1850-SE service entrance installation is shown in Fig. 7.

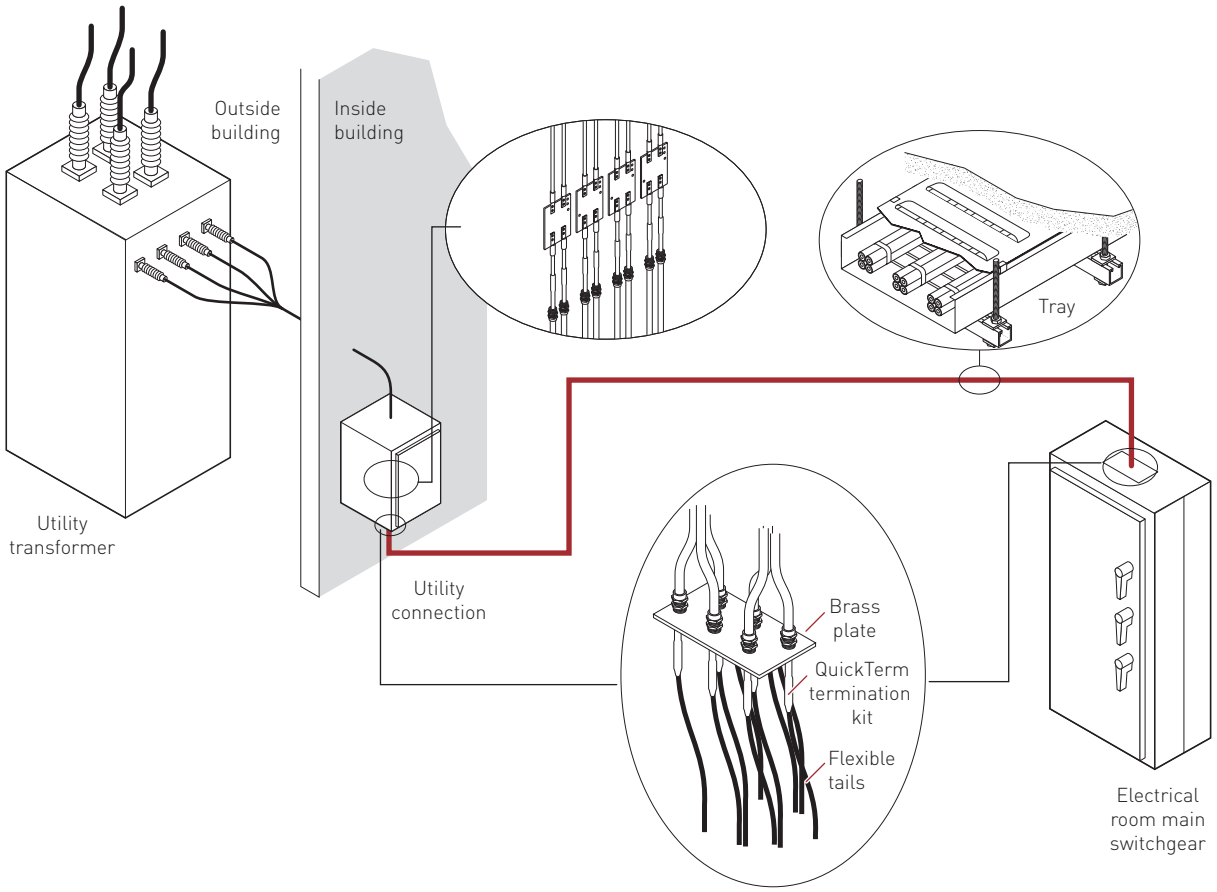


Fig. 7 Typical System 1850-SE system

INSTALLATION GUIDELINES

These installation guidelines apply to System 1850-SE only. When installing a system, refer to the System 1850-SE data sheet, and installation instructions shipped with the product, and available on the Pentair Thermal Management web site at www.pentairthermal.com. A Pentair Thermal Management Field Service Engineer must be on site before the installation and for commissioning. Refer to national and local electrical codes for additional details. For further information, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

Important: System 1850-SE terminations are different from other MI cable terminations and must be installed under the supervision of a Pentair Thermal Management Field Service Engineer.

Supporting System 1850-SE

It is important that all support components are made of appropriate materials, such as steel, stainless steel, and concrete. Low melting point or combustible materials such as aluminum, brass, plastic, lead, wood, etc. are not acceptable. For additional information on supporting System 1850-SE, contact your Pentair Thermal Management representative or phone Pentair Thermal Management at (800) 545-6258.

System 1850-SE cables are installed in ventilated cable tray supported by steel rod and channel (trapeze) systems suspended from the ceiling. Pentair Thermal Management loading requirements call for limits to the load on the steel rods. In addition, UL listing requirements stipulate support spacing at certain intervals. The combination can lead to closer spacing between supports than normal.

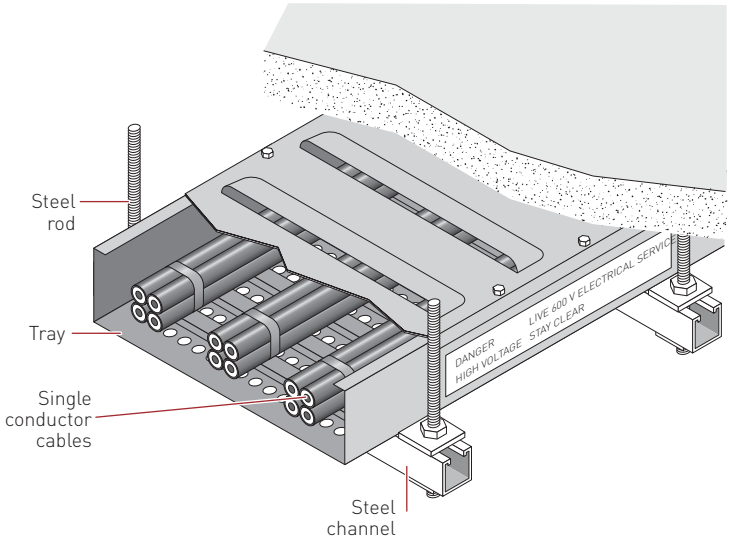


Fig. 8 Supporting System 1850-SE

System 1850-SE service entrance cable must be supported at intervals dependent on the cable tray loading and the configuration (number of trays, size of trapeze rods). Contact Pentair Thermal Management for the calculated distance between supports, based on the specific installation configuration.

TABLE 2 CONFIGURATION FOR 4-WIRE SYSTEM, 500 KCMIL MI

	4' spacing		6' spacing	
No. of sets	**Rod diameter**	**No. of channels**	**Rod diameter**	**No. of channels**
1–5	1/2"	Single	1/2"	Single
6	1/2"	Single	5/8"	Double
7–8	5/8"	Double	3/4"	Double
9	5/8"	Double	†	†
10	†	†	†	†
11–14	†	†	†	†

1. Maximum width of 1-1/2 in (38 mm) channel: 36 in (915 mm)

† Either support spacing must be reduced or cable tray may be double stacked to reduce load on channel. Contact Pentair Thermal Management for assistance.

TABLE 3 CONFIGURATION FOR 4-WIRE SYSTEM, 350 KCMIL MI

	4' spacing		6' spacing	
No. of sets	**Rod diameter**	**No. of channels**	**Rod diameter**	**No. of channels**
1–5	1/2"	Single	1/2"	Single
6–8	1/2"	Single	5/8"	Double
9	1/2"	Double	5/8"	Double
10	5/8"	Double	3/4"	Double
11–14	†	†	†	†

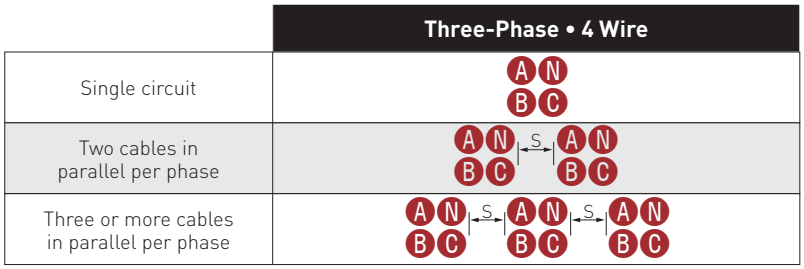
1. Maximum width of 1-1/2 in (38 mm) channel: 36 in (915 mm)
† Either support spacing must be reduced or cable tray may be double stacked to reduce load on channel. Contact Pentair Thermal Management for assistance.

Seismic Considerations

In areas where there is a risk of seismic activity, precautions must be taken where the cable crosses expansion joints and at termination points. For more information, see Appendix: Pyrotenax MI Cable Expansion and Vibration (H57613).

Cable Layout

Single conductor System 1850-SE cables should be bundled in groups containing one conductor from each phase to minimize the resulting magnetic field in each grouping. The grouped single conductor cables are then fastened tightly together, ensuring that the gland connector at each end of the cable run is connected to the metal enclosure through a brass plate. Typical single conductor cable configurations are shown in Fig. 9. The neutral conductor may be located within or outside the cable group.



Note: The spacing "S" between bundles should be a minimum of 2.15 cable diameters in the U.S. (NEC). Neutral may be located as shown, or outside groups in the most convenient location.

Fig. 9 Recommended installation configurations

Electrical codes generally limit paralleling cable configurations to cable sizes 1/0 AWG and larger. The codes address the balancing of resistance by stipulating:

- All conductors must be the same length
- All conductors must be the same size and the same material
- All conductors must have the same type of insulation
- All conductors must be terminated in the same manner

A current measurement should be taken immediately after the cables begin to carry load. Load imbalances between conductors of up to 10% are tolerable and expected. Deviations above 10% should be investigated and corrected.

When installing single conductor cables through a ferrous enclosure, precautions must be taken to prevent induction heating in the steel. This is accomplished by removing a section of the enclosure and installing a nonferrous brass plate. Brass plates with pretapped holes are available for the gland connectors.

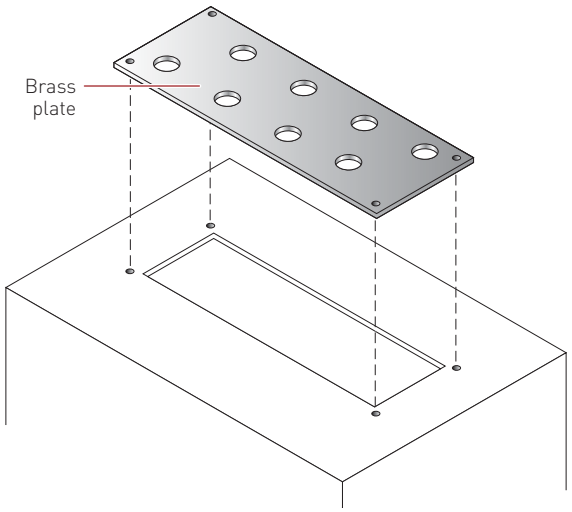


Fig. 10 Enclosure with cutout and brass plate

Terminating System 1850-SE MI Cable

Important: System 1850-SE terminations are different from other MI cable terminations and must be installed under the supervision of a Pentair Thermal Management Field Service Engineer.

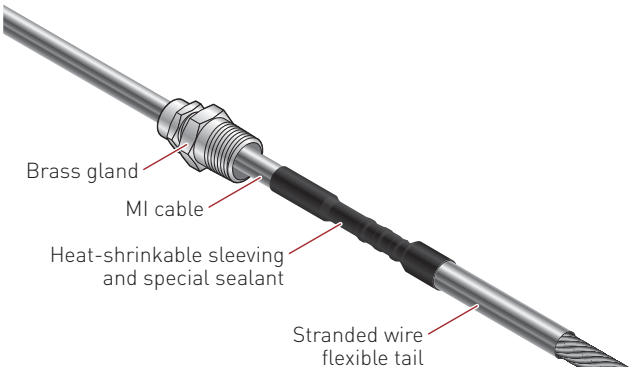


Fig. 11 System 1850-SE termination

Connecting System 1850-SE MI Cable

The termination gland is a 1-1/4" NPT brass gland that simultaneously seals the enclosure and grips the cable through a brass compression sleeve when tightened to the recommended torque (25 ft-lbs). This connection, when installed according to the installation instructions, provides the following benefits:

- Code-compliant bonding path from the cable sheath
- Hydrostatic withstand pressure up to 500 lbs/in^2 (35 kg/cm^2)

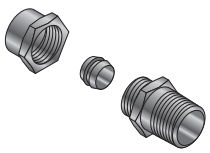


Fig. 12 Brass gland

Note: The terminations are not required to be fire-rated, since the emergency equipment they serve is in a fire-rated room.

TECHNICAL DATA SHEETS

This section provides technical data sheets for the Pentair Thermal Management commercial wiring products. Each data sheet is also available in .pdf format on our web site at www.pentairthermal.com.

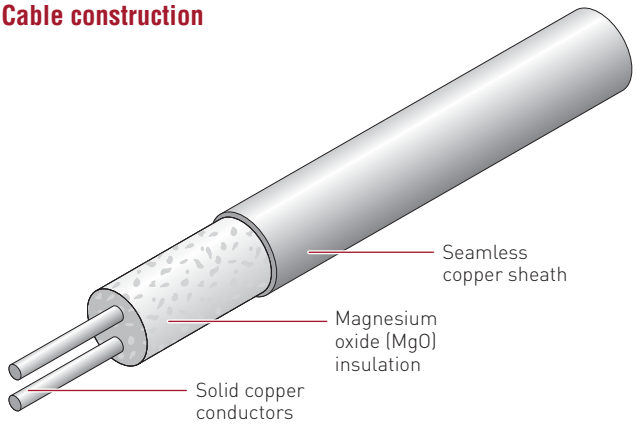
CONTENTS

SYSTEM 1850

2-HOUR FIRE-RATED, MINERAL INSULATED COPPER SHEATHED WIRING CABLE

For critical and essential circuit protection during a fire

Cable construction



PRODUCT OVERVIEW

Pyrotenax System 1850 MI cable is a UL Classified/ ULC Listed 2-hour fire-resistive cable tested to the UL 2196/ ULC-S139 fire test standards. System 1850 is also Factory Mutual (FM) approved as 2-hour fire-resistive. When installed in accordance with Pentair Thermal Management installation procedures, the result is a UL/ULC 2-hour fire-resistive system. This certification meets the requirements of an "Electrical Circuit Protective System" as referred to in Articles 695 and 700 of the National Electrical Code (NEC). The details of this system appear in Electrical Circuit Integrity System (FHIT and FHITC), System No. 1850, of the UL and ULC Fire Resistance Directory.

System 1850 cables are manufactured using only inorganic materials, copper and magnesium oxide, and arrive on the job site with a UL fire-resistive classification that does not require additional conduit or fireproofing.

Unlike a conduit and wire system, System 1850 unjacketed single conductor cables, configured according to Section 332.80(B) of the National Electrical Code or Section 4-004(10) of the Canadian Electrical Code, do not require derating and can be installed using the "free air" ratings of Table 310.15(B)(17)(NEC) or Table 1(CEC).

Applications include wiring for critical life-safety circuits in high-rise buildings, subways, tunnels, airports, and health care facilities.

System 1850 can be found in the following environments:

- High-rise buildings – emergency feeders for fire pumps, elevators, smoke extraction and pressurization fans, fire alarm wiring, etc.
- Hospitals and other institutions where mobility is limited, to preserve power and allow time for egress.
- Historic buildings where it can be installed unobtrusively, as well as to assure preservation of fire fighting systems.
- Tunnels and subways for smoke extraction fans, where its zero smoke properties make it unique.
- Airports, stadiums, hotels, banks, etc.

System 1850 MI cable terminations are typically field installed. Factory terminated cable sets are also available in a range of sizes and lengths. For details on terminated cable sets, contact Pentair Thermal Management.

For additional information, contact your Pentair Thermal Management representative or call (800) 545-6258.

CABLE CONSTRUCTION

Sheath	Seamless soft-drawn copper
Insulation	Highly compressed magnesium oxide (MgO)
Conductor type	Copper
Insulation voltage rating	600 V
Conductor size	16 AWG – 500 kcmil
Jacket (optional)	Polymer – do not use for fire-rated applications
Number of conductors	1, 2, 3, 4, or 7 standard[1]

[1] Contact Pentair Thermal Management for custom configurations.

CABLE TEMPERATURE RATING

Continuous exposure temperature	250°C (482°F); 90°C (194°F) with optional jacket
Maximum exposure temperature	1010°C (1850°F)

BENDING RADIUS

	NEC	CEC
Cables ⩽ 3/4" diameter	5 times cable diameter	6 times cable diameter
Cables > 3/4" diameter	10 times cable diameter	12 times cable diameter

TERMINATION KITS

	QuickTerm kit	Pyropak kit	Pyropak kit
Seal type	Self-amalgamating tape	Mastic compound	Epoxy resin
Gland fitting	Brass	Brass	Brass
Cable seal rating	Nonhazardous locations: 90°C (194°F) maximum	Nonhazardous and hazardous locations: 105°C (221°F) maximum	Nonhazardous and hazardous locations: 120°C (248°F) maximum[2] Optional epoxy resin available for 200°C (392°F)[2]
Cable configurations	For #6 AWG and larger single conductor cables	For all single and multiconductor cables	For all single and multiconductor cables
Tail sleeving (PVC)			
Standard sleeve length	–	12 in (300 mm) or 36 in (900 mm)[3]	12 in (300 mm) or 36 in (900 mm)[3]
Maximum exposure temperature	–	105°C (221°F)	105°C (221°F)[2]
Tail AWG size	Refer to product installation instructions	16 AWG – 500 kcmil solid	16 AWG – 500 kcmil solid

[2] For entire termination to achieve maximum temperature of epoxy resin seal, silicone fiberglass sleeving must be used (refer to Termination Kits data sheet).

[3] If longer tail lengths are required, contact Pentair Thermal Management.

Notes:

- For field-terminated cables, tails are obtained by stripping back the cable sheath; refer to the product installation instructions for details.
- For factory-terminated cables, epoxy resin seal and 12 in (300 mm) PVC insulated tails are standard.

600 V WIRING CABLE SPECIFICATIONS

Cable reference number	Conductor size (AWG)	Allowable ampacity NEC 75°C/90°C (A)	Allowable ampacity CEC 75°C/90°C (A)	Nominal coil length[4] [ft / (m)]	Nominal weight [lb/1000 ft / (kg/km)]	NPT gland size (in)
Single conductor						
1/10-277	10[5]	50 / 55	50 / 55	1742 / (531)	154 / (229)	1/2
1/8-298	8	70 / 80	70 / 80	1522 / (464)	179 / (266)	1/2
1/6-340	6	95 / 105	95 / 105	1178 / (359)	236 / (351)	1/2
1/4-402	4	125 / 140	125 / 140	818 / (249)	332 / (494)	1/2
1/3-449	3	145 / 165	145 / 165	667 / (203)	409 / (609)	3/4
1/2-449	2	170 / 190	170 / 190	667 / (203)	444 / (661)	3/4
1/1-496	1	195 / 220	195 / 220	546 / (166)	492 / (732)	3/4
1/1/0-512	1/0	230 / 260	230 / 260	496 / (151)	601 / (896)	3/4
1/2/0-580	2/0	265 / 300	265 / 300	387 / (118)	771 / (1150)	3/4
1/3/0-621	3/0	310 / 350	310 / 350	553 / (168)	939 / (1400)	3/4
1/4/0-684	4/0	360 / 405	360 / 405	455 / (139)	1128 / (1682)	1
1/250-746	250 kcmil	405 / 455	405 / 455	383 / (117)	1341 / (2000)	1-1/4
1/350-834	350 kcmil	505 / 570	505 / 570	284 / (86)	1675 / (2498)	1-1/4
1/500-1000	500 kcmil	620 / 700	620 / 700	197 / (60)	2403 / (3584)	1-1/4
Two conductor						
2/16-340	16	– / 18	– / –	1095 / (334)	189 / (281)	1/2
2/14-371	14[5]	20 / 25	20 / 25	957 / (292)	236 / (351)	1/2
2/12-402	12[5]	25 / 30	25 / 30	788 / (240)	275 / (409)	1/2
2/10-449	10[5]	35 / 40	35 / 40	635 / (194)	353 / (525)	3/4
2/8-512	8	50 / 55	50 / 55	468 / (143)	473 / (704)	3/4
2/6-590	6	65 / 75	65 / 75	355 / (108)	663 / (986)	3/4
2/4-684	4	85 / 95	85 / 95	404 / (123)	877 / (1305)	1
2/3-768	3	100 / 115	100 / 115	230 / (70)	1067 / (1587)	1-1/4
2/2-865	2	115 / 130	115 / 130	263 / (80)	1353 / (2013)	1-1/4
2/1-975	1	130 / 145	130 / 145	199 / (61)	1717 / (2555)	1-1/4
Three conductor						
3/16-355	16	– / 18	– / –	1009 / (307)	210 / (312)	1/2
3/14-387	14[5]	20 / 25	20 / 25	852 / (260)	257 / (382)	1/2
3/12-480	12[5]	25 / 30	25 / 30	554 / (169)	395 / (588)	3/4
3/10-480	10[5]	35 / 40	35 / 40	560 / (171)	419 / (623)	3/4
3/8-590	8	50 / 55	50 / 55	371 / (113)	637 / (948)	3/4
3/6-621	6	65 / 75	65 / 75	325 / (99)	738 / (1098)	3/4
3/4-746	4	85 / 95	85 / 95	225 / (69)	1079 / (1606)	1-1/4
3/3-834	3	100 / 115	100 / 115	180 / (55)	1339 / (1993)	1-1/4

600 V WIRING CABLE SPECIFICATIONS

Cable reference number	Conductor size (AWG)	Allowable ampacity NEC 75°C/90°C (A)	Allowable ampacity CEC 75°C/90°C (A)	Nominal coil length[4] [ft / (m)]	Nominal weight [lb/1000 ft / (kg/km)]	NPT gland size (in)
Four conductor						
4/16-387	16	– / 18 (14)[6]	– / –	851 / (259)	254 / (378)	1/2
4/14-465	14[5]	20 (16) / 25 (20)[6]	20 (16) / 25 (20)[6]	589 / (180)	366 / (545)	3/4
4/12-465	12[5]	25 (20) / 30 (24)[6]	25 (20) / 30 (24)[6]	568 / (173)	376 / (559)	3/4
4/10-590	10[5]	35 (28) / 40 (32)[6]	35 (28) / 40 (32)[6]	353 / (108)	606 / (902)	3/4
4/8-590	8	50 (40) / 55 (44)[6]	50 (40) / 55 (44)[6]	358 / (109)	658 / (979)	3/4
4/6-730	6	65 (52) / 75 (60)[6]	65 (52) / 75 (60)[6]	234 / (71)	1008/ (1500)	1-1/4
Seven conductor						
7/16-449	16	– / 14 (13)[6]	– / –	605 / (184)	338 / (503)	3/4
7/14-496	14[5]	16 (14) / 20 (18)[6]	16 (14) / 20 (18)[6]	499 / (152)	428 / (637)	3/4
7/12-543	12[5]	20 (18) / 24 (21)[6]	20 (18) / 24 (21)[6]	419 / (128)	528 / (786)	3/4
7/10-621	10[5]	28 (25) / 32 (28)[6]	28 (25) / 32 (28)[6]	335 / (102)	716 / (1065)	1
7/8-710	8	40 (35) / 44 (39)[6]	40 (35) / 44 (39)[6]	257 / (78)	982 / (1461)	1-1/4

[4] If longer lengths are required, contact Pentair Thermal Management.

[5] For 14 AWG, 12 AWG and 10 AWG, refer to appropriate sections of NEC and CEC governing conductor overcurrent protection limitations.

[6] On 4 and 7 conductor cable, the higher ampacity applies if one conductor is used as a neutral.

Notes:

- To obtain cable diameter: use last three or four digits in the cable reference number and move decimal point three places to the left; result is cable diameter in inches. Example: cable reference 4/10-590 is 0.590" diameter; cable reference 1/500-1000 is 1.000" diameter.
- For cable sizes up to 3/4" in diameter, add suffix "H" for polymer jacket after cable reference number. Example: cable reference 1/1-496H would be supplied with a polymer jacket over the copper sheath. Optional polymer jacket is not available for cables greater than 3/4" in diameter.

APPROVALS

BULK CABLE

Nonhazardous Locations

Hazardous Locations
Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

Nonhazardous Locations

FM Approvals GP-1
2-hour fire-resistive cable

UL Classified, 2-hour fire-resistive cable, tested to UL 2196

ULC Listed, 2-hour fire-resistant cable, tested to ULC-S139

TERMINATED CABLE

QUICKTERM KIT

Nonhazardous Locations

PYROPAK KIT (MASTIC COMPOUND SEAL)

Nonhazardous Locations

Hazardous Locations
Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

PYROPAK KIT (EPOXY RESIN SEAL)

Nonhazardous Locations

Hazardous Locations
Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

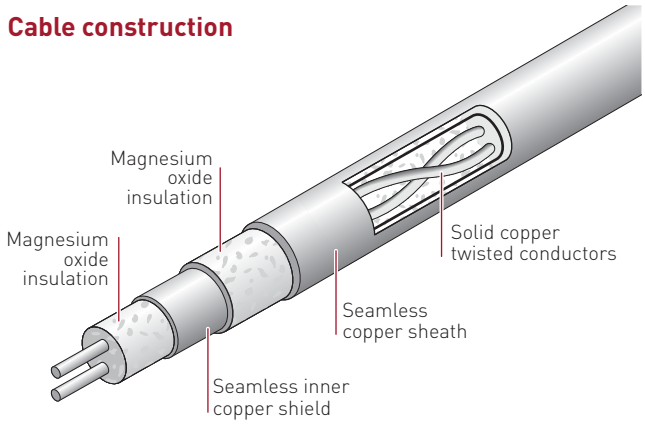
Note: Overall approval of the terminated cable depends on the termination kit used.

SYSTEM 1850 TWISTED PAIR

2-HOUR FIRE-RATED, MINERAL INSULATED COPPER-SHEATHED FIRE ALARM AND VOICE COMMUNICATION CABLE

For critical and essential circuit protection during a fire

Cable construction



Shielded twisted pair cable shown

PRODUCT OVERVIEW

Mineral insulated (MI) wiring cable for critical fire alarm circuit protection when survival throughout a fire is essential

Pyrotenax System 1850 fire alarm and voice comunication MI cable is a UL Classified/ ULC Listed 2-hour fire-resistive cable tested to the UL 2196/ULC-S139 fire test standards. System 1850 is also Factory Mutual (FM) approved as 2-hour fire-resistive. When installed in accordance with Pentair Thermal Management installation procedures, it meets the survivability requirements of NFPA 72 and Article 760 of the National Electrical Code (NEC).

System 1850 fire alarm and voice communication cables are manufactured using only inorganic materials, copper and magnesium oxide, and arrive on the job site with a UL fire-resistive classification that does not require additional conduit or fireproofing.

System 1850 fire alarm cable is CSA certified as FAS, FAS 90 and FAS 105 cable. Applications include the main trunk or "backbone" of multiplex alarm systems in high-rise buildings and institutions. System 1850 fire alarm and voice communication cable connects between the data-gathering panels throughout the building and the main fire alarm panel.

System 1850 can be found in the following environments.

- High-rise buildings – for fire alarm and voice communication systems
- Hospitals and other institutions where mobility is limited, for emergency communication systems
- Historic buildings where it can be installed unobtrusively, as well as to assure preservation of fire-fighting systems
- Tunnels and subways for the emergency voice communication system, where its zero smoke properties make it unique
- Airports, stadiums, hotels, banks, etc.

System 1850 Twisted Pair MI cable terminations are typically field installed. Factory terminated cable sets are also available. For details on terminated cable sets, contact Pentair Thermal Management.

For additional information, contact your Pentair Thermal Management representative or call (800) 545-6258.

CABLE CONSTRUCTION

Sheath/shield	Seamless soft-drawn copper
Insulation	Highly compressed magnesium oxide (MgO)
Conductor type	Copper
Insulation voltage rating	300 V
Conductor size	18 AWG and 16 AWG
Jacket (optional)	Polymer – do not use for fire-rated applications
Number of conductors	2

CABLE TEMPERATURE RATING

Continuous exposure temperature	250°C (482°F) 90°C (194°F) with optional jacket
Maximum exposure temperature	1010°C (1850°F)

BENDING RADIUS

	NEC	CEC
	5 times cable diameter	6 times cable diameter

TERMINATION KITS

	Pyropak kit	Pyropak kit
Seal type	Mastic compound	Epoxy resin
Gland fitting	Brass	Brass
Cable seal rating	Nonhazardous and hazardous locations: 105°C (221°F) maximum	Nonhazardous and hazardous locations: 120°C (248°F) maximum [1] Optional epoxy resin available for 200°C (392°F) [1]
Tail sleeving		
Standard sleeve length	12 in (300 mm)	12 in (300 mm)
Maximum exposure temperature	105°C (221°F)	105°C (221°F)
Tail AWG size		
Twisted pair	18 AWG and 16 AWG solid	18 AWG and 16 AWG solid
Shielded twisted pair	18 AWG and 16 AWG solid/18 AWG drain wire	18 AWG and 16 AWG solid/18 AWG drain wire

[1] For entire termination to achieve maximum temperature of epoxy resin seal, silicone fiberglass sleeving must be used (refer to Termination Kits data sheet, H58421)

Notes:

- For field-terminated cables, tails are obtained by stripping back the cable sheath; refer to the termination kit installation instructions for details.
- For factory-terminated cables, epoxy resin seal and 12 in (300 mm) PVC insulated tails are standard.

300 V TWISTED PAIR CABLE SPECIFICATIONS

	Twisted Pair		Shielded Twisted Pair	
Cable Reference Number	**2/18-215T**	**2/16-246T**	**2/18-324TS**	**2/16-364TS**
Conductor size (AWG)	18	16	18	16
Nominal coil length (ft)	3060	2084	1404	1107
Nominal coil length (m)	933	635	428	338
Nominal weight (lbs/1000 ft)	77	90	200	254
Gland size (NPT)	1/2"	1/2"	3/4"	3/4"
Twisted frequency (per ft)	4–6	4–6	4–6	4–6
Nominal conductor-to-conductor capacitance (pF/ft) @ 1 kHz	47	53	52	57
Nominal conductor-to-shield capacitance (pF/ft) (one wire to shield)	77	88	82	92
Velocity of propagation (%)	30–35	30–35	30–35	30–35
Nominal conductor resistance (ohms/1000 ft)	6.50	4.09	6.50	4.09
Nominal sheath/shield resistance (ohms/1000 ft)	0.8	0.6	0.3/1.0	0.1/0.8
Nominal diameter of outer sheath (in)	0.215	0.246	0.324	0.364
Nominal diameter of shield (in)	–	–	0.198	0.230

APPROVALS

BULK CABLE

C SP US

Nonhazardous Locations

Hazardous Locations
Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

c UL us LISTED

Nonhazardous Locations

CLASSIFIED UL — UL Classified, 2-hour fire-resistive cable, tested to UL 2196

ULC LISTED — ULC Listed, 2-hour fire-resistant cable, tested to ULC-S139

FM Approvals GP-1
2-hour fire-resistive cable

TERMINATED CABLE

PYROPAK KIT (MASTIC COMPOUND SEAL)

C SP US

Nonhazardous Locations

Hazardous Locations
Class I, Div. 1 and 2, Group A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

PYROPAK KIT (EPOXY RESIN SEAL)

C SP US

Nonhazardous Locations

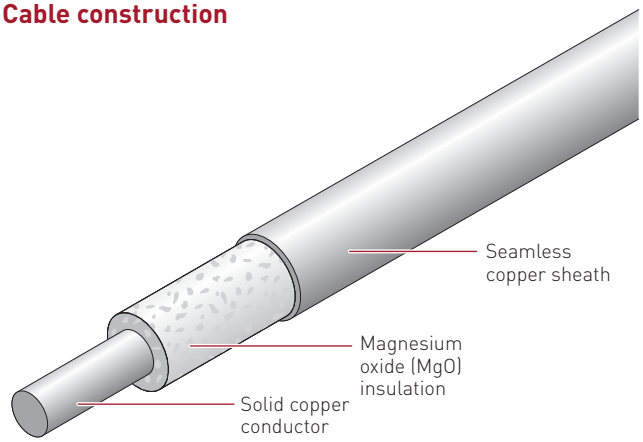
Hazardous Locations
Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

SYSTEM 1850-SE

2-HOUR FIRE-RATED, MI COPPER-SHEATHED SERVICE ENTRANCE CABLE SYSTEM

A service entrance system that allows service entrance conductors to be routed inside the building

Cable construction



PRODUCT OVERVIEW

When running traditional service entrance conductors through the building, electrical codes require that they be encased in concrete so that the conductors may be considered outside the building.

Pyrotenax System 1850-SE offers an alternative that has been approved by the Authorities Having Jurisdiction (AHJs) in several major cities, including New York, Washington D.C., and Philadelphia, and is allowed on a case-by-case basis in many other cities. In areas where lightning activity is exceptionally high, lightning protection must be installed.

System 1850 cable is manufactured using only inorganic materials and offers a unique combination of dependability, versatility, and permanence with zero smoke generation, zero fuel contribution, and zero flame spread.

Unlike a conduit and wire system, System 1850 cables do not typically require derating and can be installed using the "free air" ratings of Table 310.15(B)(17) of the 2011 National Electrical Code (NEC).

The System 1850-SE service entrance cable system consists of:

- UL Classified 2-hour fire-rated mineral insulated (MI) cable
- QuickTerm service entrance termination kits
- NEMA Class 12B stainless steel ventilated cable tray with louvered covers
- Optional SE-Protect lightning arrestor kit for lightning protection. For more information, contact Technical Support.

Applications include service entrance feeders for buildings.

System 1850-SE can be used in the following environments:

- High-rise buildings
- Health care facilities
- Historic buildings
- Airports, stadiums, hotels, banks etc.

For additional information, contact your Pentair Thermal Management representative or call (800) 545-6258.

CABLE CONSTRUCTION

Sheath	Seamless soft-drawn copper
Insulation	Highly compressed magnesium oxide (MgO)
Conductor type	Copper
Insulation voltage rating	600 V
Conductor size	350 kcmil, 500 kcmil
Number of conductors	1

CABLE TEMPERATURE RATING

Continuous exposure temperature	250°C (482°F)
Maximum exposure temperature	1010°C (1850°F)

BENDING RADIUS

NEC	CEC
10 times cable diameter	12 times cable diameter

TERMINATION KIT FOR SERVICE ENTRANCE APPLICATIONS

	QuickTerm kit
Seal type	Special service entrance seal
Gland fitting	Brass
Cable seal rating	Nonhazardous locations: 90°C (194°F) maximum

Termination and flexible tail size selection

MI cable size	Circuit ampacity	If landing on:	Termination method	Flexible tail size
350 kcmil	310 A maximum	Circuit breaker	Size-for-size	350 kcmil
	475 A maximum	Circuit breaker	Sized-up	750 kcmil
	505 A maximum	Bus bar	Sized-up	750 kcmil
500 kcmil	380 A maximum	Circuit breaker	Size-for-size	500 kcmil
	475 A maximum	Circuit breaker	Sized-up	750 kcmil
	620 A maximum	Bus bar	Sized-up	750 kcmil

600 V WIRING CABLE SPECIFICATIONS

Cable reference number	Conductor size (kcmil)	Current rating NEC (75°C)	Current rating CEC (75°C)	Nominal cable diameter (in)	Nominal coil length ft (m)	Nominal weight (lb/1000 ft)	NPT gland size (in)
Single conductor							
1/350-834	350	505	505	0.834	284 (86)	1675	1-1/4
1/500-1000	500	620	620	1.0	197 (60)	2403	1-1/4

System 1850-SE ampacity is shown for cables landing on bus bar. For cables landing on circuit breakers or heat-sensitive devices, Table 310.15(B)(16) 75°C ampacities apply to System 1850-SE cables.

APPROVALS

BULK CABLE

Nonhazardous Locations

Hazardous Locations
Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

Nonhazardous Locations

FM Approvals GP-1
2-hour fire-resistive cable

UL Classified, 2-hour fire-resistive cable, tested to UL 2196

ULC Listed, 2-hour fire-resistant cable, tested to ULC-S139

TERMINATED CABLE

QUICKTERM KIT

Nonhazardous Locations

Note: Overall approval of the terminated cable depends on the termination kit used.

TERMINATION KITS – COMMERCIAL WIRING

For Pyrotenax copper sheathed mineral insulated (MI) wiring cable

PRODUCT OVERVIEW

The Pyropak and QuickTerm termination kits are used to field-terminate Pyrotenax copper sheathed MI wiring cables.

QuickTerm Termination Kit
The QuickTerm termination kit is used to field-terminate #6 AWG and larger single conductor copper-sheathed MI wiring cable in nonhazardous areas and is available in two versions. The size-for-size QuickTerm kit allows the MI solid conductor to be joined to an equal size flexible tail. The sized-up QuickTerm kit allows the MI solid conductor to be joined to a larger size flexible tail.

The QuickTerm kit contains enough material to terminate two cable ends and offers the following features and benefits:

- Includes a special connector to splice the solid MI conductor to a flexible tail
- Reduces the time required to make the cable termination
- Offers improved flexibility of the tail in the cabinet or enclosure

The flexible tail, supplied by the installer, must be compatible with the current rating of the circuit. The tail size selected will depend on whether a "Size-for-size" or a "Sized-up" QuickTerm is used (see "Table 1 QuickTerm Kit Configuration Information" for QuickTerm tail sizes). For further information on installing QuickTerm kits, refer to:

- QuickTerm Installation Instructions (Size-for-size) (H58290)
- Sized-up QuickTerm Installation Instructions (H58264)
- Service Entrance QuickTerm Termination Kit Installation Instructions (H58379)

Pyropak Termination Kit
Pyropak termination kits are available for all copper sheathed cables. 14 AWG to 8 AWG single conductor and all multiconductor copper-sheathed cables must be terminated with a Pyropak termination kit.

Pyropak kits are approved for use in nonhazardous and hazardous areas. The cable end is sealed using either a mastic sealing compound or an epoxy sealing compound, depending on the temperature rating required. Each kit contains enough material to terminate two cable ends.

To reduce installation time, mineral insulated wiring cables can be supplied with factory terminated ends. Copper-sheathed cables are supplied with brass gland connectors and the cable ends are sealed using the epoxy sealing compound. Refer to the System 1850 data sheet (H57442) and the System 1850 Twisted Pair data sheet (H57473) for further information on wiring cables for use in commercial applications.

Pyrotenax mineral insulated wiring cables are approved as a complete system only when used with the appropriate Pyrotenax termination kit. The use of nonapproved components will compromise the reliability of the system and invalidate approvals and warranties.

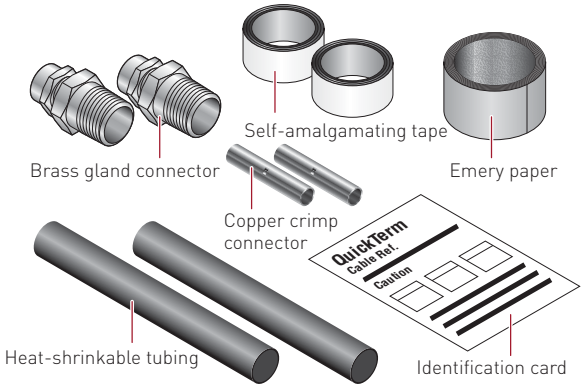
For more information on termination kits for MI cable, contact your Pentair Thermal Management representative or phone (800) 545-6258.

TERMINATION KITS

	Copper-sheathed cables
Pyropak	Yes
QuickTerm (single conductor cables)	Yes*

* Available for #6 AWG and larger cables

QUICKTERM TERMINATION KITS FOR SINGLE CONDUCTOR COPPER-SHEATHED CABLES



Termination type	Field termination (for two cable ends)
Seal type	Self-amalgamating tape
Temperature rating	194°F (90°C) maximum
Gland connector	Brass
Gland size	1/2", 3/4", 1", or 1-1/4" NPT depending on cable size
Cable configurations	For #6 AWG and larger single conductor copper-sheathed cables
Tail type and AWG size	Supplied by installer (see for tail size) **Note:** Use a cable certified for the application

APPROVALS

C SP US

Nonhazardous Locations

QUICKTERM KIT CATALOG NUMBER CONFIGURATOR

QTRM / BR / 125 / 500 / 1000 / 500 / 90 / NH / SE

QTRM

Gland material
BR = Brass

Gland thread size
050 = 1/2 in.
075 = 3/4 in.
100 = 1 in.
125 = 1-1/4 in.
(see Table 1)

MI cable AWG or KCMIL size
Example:
006 = 6 AWG
1-0 = 1/0 AWG
500 = 500 KCMIL
(see Table 1)

MI cable OD
Example: 0449 = 0.449 in.
1000 = 1.000 in.
(see Table 1)

Service entrance
SE = Yes
Blank= No

Approval classification
NH = Nonhazardous
NA = Nonapproved

Temperature rating
90 = 90°C

Tail AWG or KCMIL size
Example:
006 = 6 AWG
1-0 = 1/0 AWG
500 = 500 KCMIL
(see Table 1)

Example: Sized-up QuickTerm kit required for 1/3/0-621, single conductor # 3/0 AWG cable to use a 350 kcmil tail is:
Catalog No.: QTRM / BR / 075 / 3-0 / 0621 / 350 / 90 / NH

TABLE 1 QUICKTERM KIT CONFIGURATION INFORMATION

System 1850 - Fire-rated MI cable

Common information for all QuickTerm kits					
MI cable reference number	**Gland thread size (in)**	**MI cable size (AWG / kcmil)**	**MI cable diameter (in)**	**Tail size required for Sized-up QuickTerm[1] (AWG / kcmil)**	**Tail size required for Size-for-size QuickTerm[1] (AWG / kcmil)**
1/6-340	1/2	6	0.340	2	6
1/4-402	1/2	4	0.402	1/0	4
1/3-449	3/4	3	0.449	2/0	3
1/2-449	3/4	2	0.449	3/0	2
1/1-496	3/4	1	0.496	4/0	1
1/1/0-512	3/4	1/0	0.512	4/0	1/0
1/2/0-580	3/4	2/0	0.580	250	2/0
1/3/0-621	3/4	3/0	0.621	350	3/0
1/4/0-684	1	4/0	0.684	500	4/0
1/250-746[2]	1-1/4	250	0.746	500 600	250
1/350-834[2]	1-1/4	350	0.834	500 750	350
1/500-1000	1-1/4	500	1.000	750	500

[1] Stranded conductor tail to be supplied by contractor / installer.
[2] Sized-up QuickTerm: select the appropriate tail size for application.

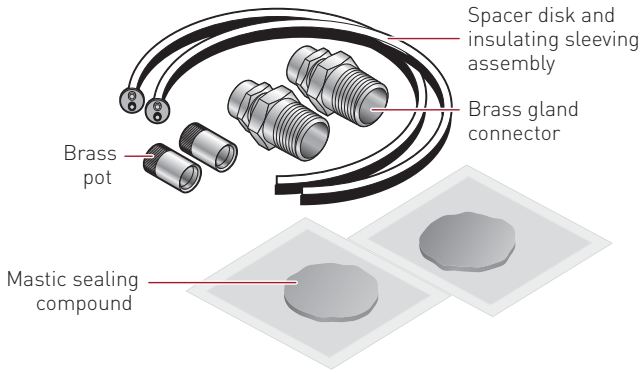
System 1850-SE - Service Entrance MI cable

Common information for all QuickTerm kits					
MI cable reference number	**Gland thread size (in)**	**MI cable size (AWG / kcmil)**	**MI cable diameter (in)**	**Tail size required for Sized-up QuickTerm[1] (AWG / kcmil)**	**Tail size required for Size-for-size QuickTerm[1] (AWG / kcmil)**
1/350-834[2]	1-1/4	350	0.834	500 750	350
1/500-1000	1-1/4	500	1.000	750	500

[1] Stranded conductor tail to be supplied by contractor / installer.
[2] Sized-up QuickTerm: select the appropriate tail size for application.

PYROPAK TERMINATION KITS FOR COPPER-SHEATHED CABLES

Mastic sealing compound



Termination type	Field termination (for two cable ends)
Pot type	Threaded pot/screw-on pot
Seal type	Mastic sealing compound
Temperature rating	

Maximum Temperature	Mastic	Tail Sleeving	Area Classification
105°C (221°F)	Standard	PVC	Hazardous and nonhazardous

Gland connector	Brass
Gland size	1/2", 3/4", 1", or 1-1/4" NPT depending on cable size
Cable configurations	For single and multiconductor cables
Standard tail length	12 in (30 cm) or 36 in (91 cm) (If longer tail lengths are required, contact Pentair Thermal Management)
Tail AWG size	16 AWG – 500 kcmil solid

APPROVALS

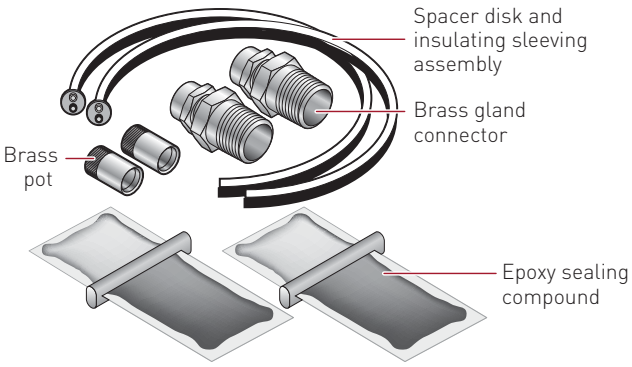
C SP US

Nonhazardous Locations

Hazardous Locations

Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

Epoxy sealing compound



Termination type	Field termination (for two cable ends)
Pot type	Threaded pot/screw-on pot
Seal type	Epoxy sealing compound
Temperature rating	

Maximum Temperature	Epoxy	Tail Sleeving	Area Classification
221°F (105°C)	Standard	PVC	Hazardous and nonhazardous
248°F (120°C)	Standard	Silicone fiberglass	Hazardous and nonhazardous
302°F (150°C)	Optional	Silicone fiberglass	Hazardous and nonhazardous
392°F (200°C)	Optional	Silicone fiberglass	Nonhazardous

Gland connector	Brass
Gland size	1/2", 3/4", 1", or 1-1/4" NPT depending on cable size
Cable configurations	For single and multiconductor cables
Standard tail length	12 in (30 cm) or 36 in (91 cm) (If longer tail lengths are required, contact Pentair Thermal Management)
Tail AWG size	16 AWG – 500 kcmil solid

APPROVALS

C SP US

Nonhazardous Locations

Hazardous Locations

Class I, Div. 1 and 2, Groups A, B, C, D
Class II, Div. 1 and 2, Groups E, F, G
Class III

Note: For field-terminated cables, tails are obtained by stripping back the cable sheath; refer to the product installation instructions for details.

PYROPAK KIT CATALOG NUMBER CONFIGURATOR FOR COPPER-SHEATHED CABLE

Imperial: PPAK / BR / 125 / T 1 / 1000 / 105 / D1 / 01 / 500 / A036B012IN
or
Metric: PPAK / BR / 125 / T 1 / 1000 / 105 / D1 / 01 / 500 / A091B030CM

PPAK

Gland material
BR = Brass

Gland thread size
050 = 1/2 in.
075 = 3/4 in.
100 = 1 in.
125 = 1-1/4 in.
(see Table 2)

Type of pot
T = Threaded pot/screw-on pot

Tail material
1 = PVC sleeving*
3 = Silicone fiberglass sleeving**

MI cable OD
Example: 0449 = 0.449 in.
1000 = 1.000 in.
(see Table 2)

Termination temperature rating (°C)
Using standard epoxy sealing compound:

Temperature	Tail material	Approvals
105	PVC sleeving*	D1/D2/NA/NH
120	Silicone fiberglass sleeving**	D1/D2/NA/NH

Using optional epoxy sealing compound:

Temperature	Tail material	Approvals
150	Silicone fiberglass sleeving**	D1/D2/NA/NH
200	Silicone fiberglass sleeving**	NA/NH

Using mastic sealing compound:

Temperature	Tail material	Approvals
105	PVC sleeving*	D1/D2/NA/NH

Tail length both ends & unit of measure
Imperial example:
A036B012IN = 36" tail end "A", 12" tail end "B"
Metric example:
A091B030CM = 91 cm tail end "A", 30 cm tail end "B"
Note: A Pyropak kit includes material to terminate both ends of a cable run. Select tail length for each end.

AWG or KCMIL size
Example:
016 = 16 AWG
1-0 = 1/0 AWG
500 = 500 KCMIL
(see Table 2)

Number of conductors
Example:
01 = 1 conductor
04 = 4 conductors
10 = 10 conductors

Area classification
D1 = Class I, Div 1 & 2, Groups A, B, C & D
Class II, Div 1 & 2, Groups E, F & G
Class III
Note: For D1 locations, epoxy sealing compound is normally supplied.
D2 = Class I, Div 2, Groups A, B, C & D
Class II, Div 2, Groups E, F & G
Class III

NA = Nonapproved
NH = Nonhazardous

Note: Specify "Standard" or "Optional" epoxy sealing compound or "Mastic" sealing compound when ordering.
* PVC sleeving is standard
** Select Silicone fiberglass sleeving if termination will be exposed to temperatures between 105°C and 200°C

Legend
D1 = Division 1
D2 = Division 2
NA= Nonapproved
NH= Nonhazardous

Example: Pyropak kit required for 4/14-465, four-conductor, # 14 AWG cable, for Class I, Div 1, with 12 in PVC insulated tails on both ends, and using standard epoxy sealing compound is:
Catalog No.: PPAK / BR / 075 / T1 / 0465 / 105 / D1 / 04 / 014 / A012B012IN with standard epoxy sealing compound

TABLE 2 PYROPAK KIT CONFIGURATION INFORMATION FOR COPPER-SHEATHED CABLES

System 1850 – Fire-rated MI cable

MI Cable reference number	Gland thread size (in)	MI cable diameter (in)	MI cable size (AWG/kcmil)
Single conductor			
1/16-215	1/2	0.215	16
1/14-230	1/2	0.230	14
1/12-246	1/2	0.246	12
1/10-277	1/2	0.277	10
1/8-298	1/2	0.298	8
1/6-340	1/2	0.340	6
1/4-402	1/2	0.402	4
1/3-449	3/4	0.449	3
1/2-449	3/4	0.449	2
1/1-496	3/4	0.496	1
1/1/0-512	3/4	0.512	1/0
1/2/0-580	3/4	0.580	2/0
1/3/0-621	3/4	0.621	3/0
1/4/0-684	1	0.684	4/0
1/250-746	1-1/4	0.746	250
1/350-834	1-1/4	0.834	350
1/500-1000	1-1/4	1.000	500
Two conductor			
2/16-340	1/2	0.340	16
2/14-371	1/2	0.371	14
2/12-402	1/2	0.402	12
2/10-449	3/4	0.449	10
2/8-512	3/4	0.512	8
2/6-590	3/4	0.590	6
2/4-684	1	0.684	4
2/3-768	1-1/4	0.768	3
2/2-865	1-1/4	0.865	2
2/1-975	1-1/4	0.975	1
Three conductor			
3/16-355	1/2	0.355	16
3/14-387	1/2	0.387	14
3/12-480	3/4	0.480	12
3/10-480	3/4	0.480	10
3/8-590	3/4	0.590	8
3/6-621	3/4	0.621	6
3/4-746	1-1/4	0.746	4
3/3-834	1-1/4	0.834	3
Four conductor			
4/16-387	1/2	0.387	16
4/14-465	3/4	0.465	14
4/12-465	3/4	0.465	12
4/10-590	3/4	0.590	10
4/8-590	3/4	0.590	8
4/6-730	1-1/4	0.730	6

TABLE 2 PYROPAK KIT CONFIGURATION INFORMATION FOR COPPER-SHEATHED CABLES

System 1850 – Fire-rated MI cable			
MI Cable reference number	**Gland thread size (in)**	**MI cable diameter (in)**	**MI cable size (AWG/kcmil)**
Seven conductor			
7/16-449	3/4	0.449	16
7/14-496	3/4	0.496	14
7/12-543	3/4	0.543	12
7/10-621	1	0.621	10
7/8-710	1-1/4	0.710	8
Twisted pair (two conductor)			
2/18-215T	1/2	0.215	18
2/16-246T	1/2	0.246	16
Shielded twisted pair (two conductor)			
2/18-324TS	3/4	0.324	18
2/16-364TS	3/4	0.364	16

SPLICES – COMMERCIAL WIRING

FACTORY AND FIELD INSTALLED SPLICES

For Pyrotenax copper sheathed mineral insulated (MI) wiring cable

PRODUCT OVERVIEW

Splices for copper-sheathed cables
Factory and field installed fire-rated and non-fire-rated splices are used to join individual lengths of Pyrotenax MI cable in cases where the manufactured length is shorter than the run length. Field splices may also be used to repair damaged cables.

Factory installed fire-rated and non-fire-rated splices are rugged, all welded in-line splices for copper-sheathed wiring cables with up to seven conductors. In fire-rated applications, the splice is available for 0.402 in (10.2 mm) and larger diameter cables and is supplied with an integral UL Classified 2-hour fire rating that requires no additional fire protection.

Field installed non-fire-rated splice kits are available for copper-sheathed cables with up to seven conductors. These splice kits are also used to repair damaged cables.

In non-fire-rated applications where the field installed splice is installed outdoors or indoors where moisture is present, it must be protected with a moisture protection kit. In fire-rated applications, it must be used in conjunction with a field installed fire protection kit that provides up to two hours of fire protection at temperatures up to 1010°C (1850°F) — based on the ASTM E119 time-temperature curve used in the UL 2196 fire test.

Pyrotenax commercial MI wiring cables are approved as a complete system only when used with the appropriate Pyrotenax termination and splice kits. The use of nonapproved components will compromise the reliability of the system and will invalidate approvals and warranties.

For more information on splice kits for MI cable, contact your Pentair Thermal Management representative or phone (800) 545-6258.

SPLICES AND ACCESSORIES AVAILABLE FOR COPPER-SHEATHED CABLES

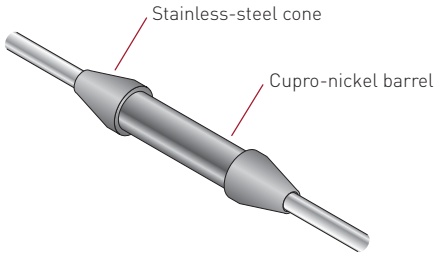
Factory installed fire-rated or non-fire-rated splice (FRJ)

Field installed non-fire-rated splice (STJ)

Field installed moisture protection kit (STJMPR) (used with non-fire-rated splice)

Field installed fire protection kit (STJFPR) (used with non-fire-rated splice)

FACTORY INSTALLED FIRE-RATED SPLICE FOR COPPER-SHEATHED CABLES



Splice type	Factory installed (for cables 0.402 in (10.2 mm) and larger in diameter)	
Temperature rating	1010°C (1850°F) based on ASTM E119 two-hour time-temperature curve	
Cable configurations	1 to 7 conductors	
Material	Cupro-nickel barrel with stainless-steel end cones	
Dimensions (approximate)	Cables up to 0.768 in (19.5 mm) OD	10 in long x 1-3/4 in diameter (25.4 cm long x 4.4 cm diameter)
	Cables greater than 0.768 in (19.5 mm) OD	10 in long x 2 in diameter (25.4 cm long x 5.1 cm diameter)

APPROVALS

Nonhazardous Locations

Nonhazardous Locations

FM Approvals GP-1
2-hour fire-resistive cable

UL Classified, 2-hour fire-resistive cable, tested to UL 2196

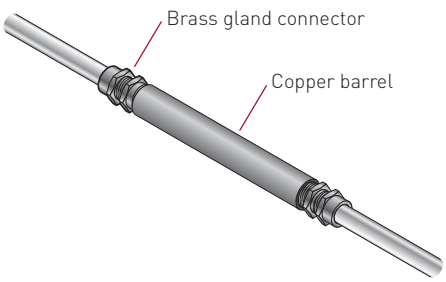
ULC Listed, 2-hour fire-resistant cable, tested to ULC-S139

Order reference	Description
FRJ+Cable reference number	Factory installed fire-rated splice (for System 1850 cables only)

Example: Order reference number for fire-rated splice for 1/1-496 System 1850 cable is: FRJ1/1-496.

FIELD INSTALLED NON-FIRE-RATED SPLICE AND MOISTURE PROTECTION KIT FOR COPPER-SHEATHED CABLES

Field-installed non-fire-rated splice kit

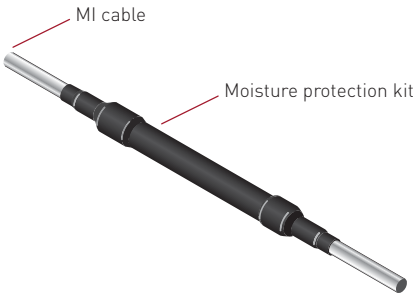


Splice type	Field installed
Temperature rating	105°C (221°F)
Cable configurations	All single and multiconductor cables
Material	Copper barrel with brass gland connectors
Dimensions (approx.)	13 in long x 2 in dia. (33 cm long x 5 cm diameter)

APPROVALS

Nonhazardous Locations

Moisture protection kit



Type	Field installed
Temperature rating	90°C (194°F)
Cable configurations	All single and multiconductor cables
Material	Heat-shrinkable tubing

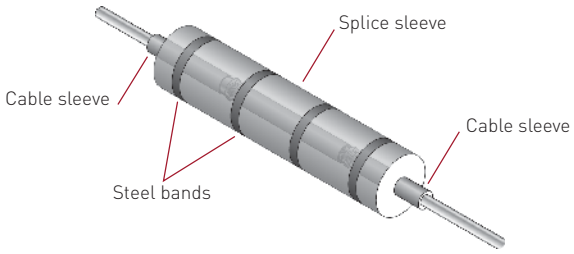
APPROVALS

Nonhazardous Locations

Order Reference	Description
STJ+Cable reference number	Field installed splice (for System 1850 cables)
STJMPRO12A	Moisture protection kit for 1/2" Conn size, 0.188 - 0.219" cable OD
STJMPRO12B	Moisture protection kit for 1/2" Conn size, 0.220 - 0.370" cable OD
STJMPRO12C	Moisture protection kit for 1/2" Conn size, 0.371 - 0.418" cable OD
STJMPRO34A	Moisture protection kit for 3/4" Conn size, 0.324 - 0.621" cable OD
STJMPRO1A	Moisture protection kit for 1" Conn size, 0.621 - 0.699" cable OD
STJMPRO114A	Moisture protection kit for 1-1/4" Conn size, 0.699 - 1.000" cable OD

Example: Order reference number for field installed splice for 1/1-496 System 1850 cable is: STJ1/1-496.

FIELD-INSTALLED FIRE PROTECTION KIT FOR COPPER-SHEATHED CABLES



Type	Field installed (for use with non-fire-rated splice)
Material	Endothermic mat
Fire protection kit temperature rating	1010°C (1850°F) based on ASTM E119 two-hour time-temperature curve
Cable configurations	All single and multiconductor cables
Dimensions approx. (for splice sleeve)	24-1/2 in long x 7 in dia. (62 cm long x 18 cm dia.)

Order reference	Description
STJFPR012	Fire protection kit for cables using 1/2" NPT gland connector
STJFPR034	Fire protection kit for cables using 3/4" NPT gland connector
STJFPR01	Fire protection kit for cables using 1" NPT gland connector
STJFPR0114	Fire protection kit for cables using 1-1/4" NPT gland connector

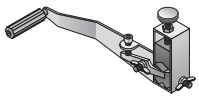
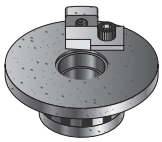
Note: Specify MI cable reference number along with fire protection kit order reference when ordering this part.

PENTAIR

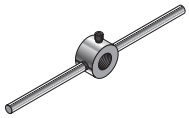
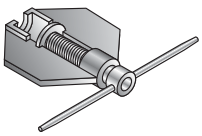
Pyrotenax BRAND

TOOLS

CABLE STRIPPING TOOLS

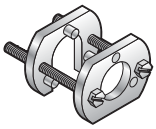
Product name	Order reference	Description
Sheathmaster 	GL	Hand-type stripping tool to strip the sheath of copper-sheathed MI cable. For use with MI cable sizes up to and including 250 kcmil.
	GLB	Replacement blade for Sheathmaster GL tool.
Ratchet stripper head 	RSTRIPASY	Ratchet sheath stripper head for stripping the sheath of copper-sheathed MI cables with diameters of 0.684 inches and greater. The ratchet stripper head must be inserted into a conduit threading tool (not supplied) such as RIDGID® Model 00-R or equivalent, or RIDGID® Model 770 power drive tool with 00-R adapter or equivalent. A cable guide bushing (not included) is required for each cable diameter to be stripped (see below)
	PSTRIPB	Replacement blade for ratchet stripper head.
Cable guide bushing 	PSBUSH1000	Bushing for 1" diameter cable
	PSBUSH975	Bushing for 0.975" diameter cable
	PSBUSH865	Bushing for 0.865" diameter cable
	PSBUSH834	Bushing for 0.834" diameter cable
	PSBUSH768	Bushing for 0.768" diameter cable
	PSBUSH746	Bushing for 0.746" diameter cable
	PSBUSH730	Bushing for 0.730" diameter cable
	PSBUSH710	Bushing for 0.710" diameter cable
	PSBUSH684	Bushing for 0.684" diameter cable

PYROPOTTER, CRIMPING AND COMPRESSION TOOLS

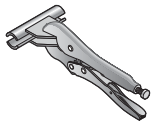
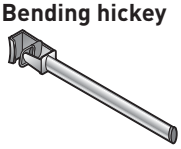
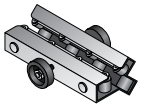
Product name	Order reference	Description
Pyropotter pot threading tool		The Pyrotenax Pyropotter tool simplifies installation of the pot,allowing it to be installed more quickly, accurately and securely than by any other means.
	PYROPOT12	Tool to install 1/2 in pot
	PYROPOT34	Tool to install 3/4 in pot
	PYROPOT1	Tool to install 1 in pot
	PYROPOT114	Tool to install 1-1/4 in pot
Handle type crimping and compression tool		Heavy duty handle type crimping and compression tool easily completes the MI cable termination. For use with termination kits using fiber caps and mastic compound seal.
	MIC1/2	1/2" crimping and compression tool
	MIC3/4	3/4" crimping and compression tool

Technical Data Sheets

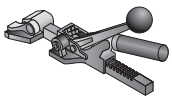
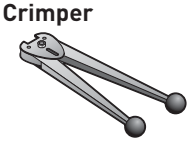
PYROPOTTER, CRIMPING AND COMPRESSION TOOLS

Product name	Order reference	Description
Screw type crimping and compression tool		Screw type crimping and compression tool easily completes the MI cable termination. For use with termination kits using fiber caps and mastic compound seal.
	CC1/2	1/2" crimping and compression tool
	CC3/4	3/4" crimping and compression tool
	CC1	1" crimping and compression tool
	CC11/4	1-1/4" crimping and compression tool

CABLE HANDLING TOOLS

Product name	Order reference	Description
Handvise	HANDVISE	Vise-grip-type tool used to support cable while installing termination.
		
Bending hickey		Bending tool assists in making bends in MI cable.
	HICMED	Medium size 0.39" – 0.63" OD cable
	HICLGE	Large size 0.63" – 0.75" OD cable
	HIC114	Extra large size 0.75" – 1.25" OD cable
Pyrohickey		Heavy duty bending tool specially modified to prevent damage to the MI cable sheath when making bends in the cable. Fits a standard conduit bending tool handle with 1" threads (handle not supplied).
	PYROHICKEY3834 PYROHICKEY341	Bends 3/8" to 3/4" MI cable Bends 3/4" to 1" MI cable
Cable Straightener	STRSM	Manual tool to straighten MI cables up to 1/2" in diameter
		

BANDING TOOLS

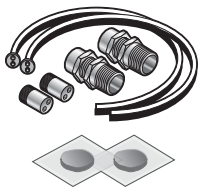
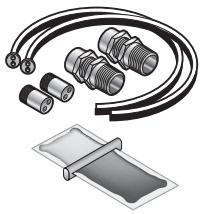
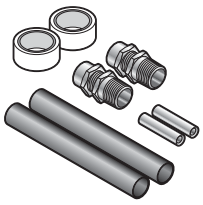
Product name	Order reference	Description
Tensioner	T34P	Ratchet-type tensioning tool tightens stainless-steel banding used to support MI cables.
		
Crimper	S12P	Crimping tool used to crimp clip onto stainless steel banding.
		

TWISTED PAIR DRAIN WIRE TOOL

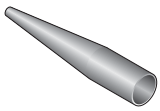
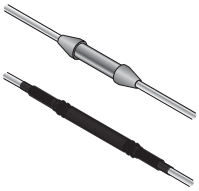
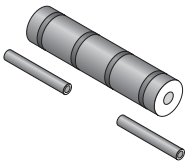
Product name	Order reference	Description
Twisted pair drain wire tool	TWISTPRTOOL	Drain wire tool used to fix drain wire ring to shield of shielded twisted-pair copper-sheathed MI cable.
		

COMPONENTS AND ACCESSORIES

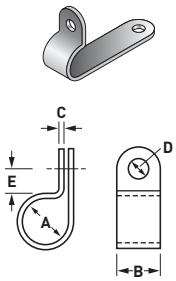
TERMINATION KITS

Product name	Order reference	Description
Pyropak kit w/ mastic compound 	Refer to data sheet H58421 or contact Pentair Thermal Management for order reference number	Pyropak termination kit with mastic sealing compound contains all material necessary to terminate two MI cable ends in nonhazardous or hazardous locations (see data sheet H58421). Available with 12" (30 cm) or 36" (90 cm) tails.
Pyropak kit w/ epoxy resin seal 	Refer to data sheet H58421 or contact Pentair Thermal Management for order reference number	Pyropak termination kit with epoxy sealing compound contains all material necessary to terminate two MI cable ends in nonhazardous and hazardous locations (see data sheet H58421). Available with 12" (30 cm) or 36" (90 cm) tails.
QuickTerm kit 	Refer to data sheet H58421 or contact Pentair Thermal Management for order reference number	QuickTerm termination kits use a self-amalgamating tape and contain all the material necessary to terminate two ends of #6 AWG and larger single conductor copper-sheathed MI cable.
600 V warning label 	600VLABEL	Adhesive backed 600 volt warning label to be applied directly to the sheath of System 1850 MI cable to indicate the presence of mineral insulated wiring cables and to distinguish the cable from copper pipes. Use one label every 10 ft (3 m) alternating on either side of cable run (10 pieces per package).
600 V warning label 	600VLABELSE	Adhesive backed 600 volt warning label to be applied directly to System 1850-SE service entrance cable tray to indicate the presence of mineral insulated wiring cables. Use one label every 10 ft (3 m) alternating on either side of cable tray (10 pieces per package).

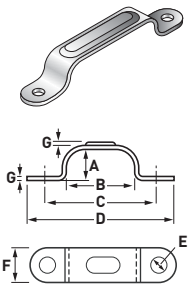
COMPONENTS

Product name	Order reference	Description
PVC shrouds		Recommended for polymer-jacketed copper-sheathed MI cables, PVC shrouds are used to protect the brass gland connector from corrosion.
	SHRD1/2	PVC shroud for 1/2" gland
	SHRD3/4	PVC shroud for 3/4" gland
	SHRD1	PVC shroud for 1" gland
Splices	Refer to data sheet H58429 or contact Pentair Thermal Management for order reference number	Splices are used to extend the nominal coil length where longer runs are required. Available for fire-rated and non-fire-rated cables.
		Factory-installed splices. Available for fire-rated applications.
		Field-installed splices for non-fire-rated applications
Field fire - protection kit		Thermal barrier system for fire protection of a field-installed splice for copper-sheathed MI cables. One kit is required for each field-installed splice.
	STJFPR012	For use with a field-installed splice utilizing 1/2" gland
	STJFPR034	For use with a field-installed splice utilizing 3/4" gland
	STJFPR01	For use with a field-installed splice utilizing 1" gland
	STJFPR0114	For use with a field-installed splice utilizing 1-1/4" gland

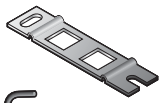
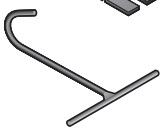
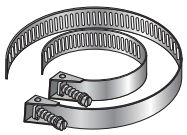
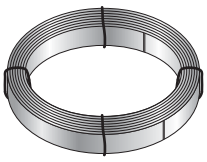
ACCESSORIES

Product name	Order reference	Cable diameter	Description				
One-hole clips			Clips to secure a single copper-sheathed MI cable directly to mounting surface. For cables up to 0.75" in diameter. Material – copper.				
			A	**B**	**C**	**D**	**E**
	CLIP196	0.196 - 0.215"	0.200"	5/16"	0.028"	5/32"	3/16"
	CLIP216	0.216 - 0.235"	0.220"	"	"	"	"
	CLIP236	0.236 - 0.255"	0.240"	"	"	"	"
	CLIP256	0.256 - 0.275"	0.260"	"	"	"	"
	CLIP276	0.276 - 0.295"	0.280"	"	"	"	"
	CLIP296	0.296 - 0.315"	0.300"	3/8"	"	13/64"	7/32"
	CLIP316	0.316 - 0.335"	0.320"	"	"	"	"
	CLIP336	0.336 - 0.365"	0.340"	"	"	"	"
	CLIP366	0.366 - 0.395"	0.370"		"	"	"
	CLIP396	0.396 - 0.425"	0.400"	"	"	"	"
	CLIP426	0.426 - 0.465"	0.430"	"	"	"	"
	CLIP466	0.466 - 0.505"	0.470"	"	"	"	"
	CLIP506	0.506 - 0.535"	0.510"	1/2"	0.047"	7/32"	1/4"
	CLIP536	0.536 - 0.585"	0.540"	"	"	"	"
	CLIP585	0.586 - 0.625"	0.590"	"	"	"	"
	CLIP626	0.626 - 0.665"	0.630"	"	"	"	"
	CLIP666	0.666 - 0.705"	0.670"	5/8"	0.055"	9/32"	5/16"
	CLIP706	0.706 - 0.745"	0.710"	"	"	"	"
	CLIP746	0.746 - 0.785"	0.750"	"		"	"

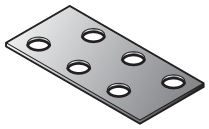
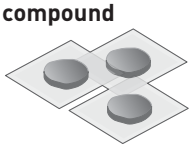
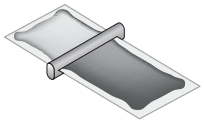
ACCESSORIES

Product name	Order reference	Cable diameter	Description						
Two-way straps			Straps to secure two copper-sheathed MI cables directly to mounting surface. For cables up to 0.75" in diameter. Material - copper.						
			A	**B**	**C**	**D**	**E**	**F**	**G**
	2STP210	0.210 - 0.225"	0.207"	0.469"	1-1/16"	1-7/16"	5/32"	5/16"	0.028"
	2STP226	0.226 - 0.246"	0.226"	0.508"	"	"	"	"	"
	2STP247	0.247 - 0.277"	0.246"	0.571"	"	"	"	"	"
	2STP278	0.278 - 0.309"	0.274"	0.634"	"	"	"	"	"
	2STP310	0.310 - 0.345"	0.305"	0.713"	1-13/32"	1-53/64"	13/64"	3/8"	"
	2STP346	0.346 - 0.387"	0.344"	0.795"	"	"	"	"	"
	2STP388	0.388 - 0.434"	0.384"	0.874"	"	"	"	"	"
	2STP435	0.435 - 0.465"	0.423"	0.953"	1-29/32"	2-7/16"	7/32"	1/2"	0.047"
	2STP466	0.466 - 0.512"	0.467"	1.035"	"	"	"	"	"
	2STP513	0.513 - 0.545"	0.506"	1.114"	"	"	"	"	"
	2STP546	0.546 - 0.590"	0.545"	1.201"	"	"	"	"	"
	2STP591	0.591 - 0.637"	0.589"	1.299"	"	"	"	"	"
	2STP638	0.638 - 0.700"	0.636"	1.417"	2-13/32"	3-3/64"	9/32"	5/8"	0.055"
	2STP701	0.701 - 0.755"	0.699"	1.543"	"	"	"	"	"

ACCESSORIES

Product name	Order reference	Description
Support bracket and hanger		
	BRACK	The bracket is used to support single conductor copper-sheathed MI cables banded together in triplex and quadraplex. Use with MI cable sizes 1/0 AWG and smaller.
	HANG	The hanger is used with the support bracket to temporarily hold the MI cables as they are being banded together.
Adjustable banding		Adjustable, easy-release pipe straps used to band MI cables in triplex or quadruplex.
	WPS-01	For 0.275" to 0.621" OD cable
	WPS-03	For 0.684" to 1.0" OD cable
Banding	BAND100FT	Stainless steel banding used to band MI cables together. 100 ft roll x 1/2" wide x 0.020" thick (30.5 m roll x 13 mm wide x 0.5 mm thick). Use with BANCLIP100 banding clips ordered separately.
		
Clips	BANDCLIP100	Stainless steel clips used with stainless steel banding to group MI cables together. 100 clips per package. Use with BAND100FT stainless steel banding ordered separately.
		

ACCESSORIES

Product name	Order reference	Description
Brass plates 	See table	Brass plates are used to avoid induction heating of ferrous metal enclosures where single conductor cables pass through the wall of the enclosure. Custom sizes available.
Mastic sealing compound 	COMGRN4	Used to seal MI cable ends for nonhazardous and hazardous locations. Mastic compound does not require curing. Ten pieces per package.
Standard epoxy resin sealing compound	EPOXIPAC	Used to seal MI cable ends for nonhazardous and hazardous locations. Maximum temperature 248°F (120°C). Order additional 13.3 ml 2-part epoxy packs as required (see table below).
Optional epoxy resin sealing compound 	DURACOM	Used to seal MI cable ends for nonhazardous and hazardous locations. Maximum temperature 392°F (200°C). Order additional 13.3 ml 2-part epoxy packs as required (see table below).

Brass Plate Ordering Information

	Number of holes			
Hole size	**3 hole**	**4 hole**	**5 hole**	**6 hole**
1/2"	3HO1/2	4HO1/2	5BP12	6BP12
3/4"	3HO3/4	4HO3/4	5BP34	6HO3/4
1"	3HO1	4HO1	5BP1	6HO1
1-1/4"	3HO1-1/4	4HO1-1/4	5BP114	6HO1-1/4

Two-Part Epoxy Requirements

Gland size	**1 pot**	**2 pots**	**3 pots**	**4 pots**
1/2"	1	1	1	2
3/4"	1	2	3	4
1"	2	3	5	6
1-1/4"	2	4	5	7

CODES AND STANDARDS

This section provides technical information sheets for the Pentair Thermal Management wiring systems products. Each technical information sheet is also available in .pdf format on our web site at www.pentairthermal.com.

CONTENTS

FLAME SPREAD, SMOKE, AND FIRE TESTS

FIRE TEST

UL 2196 & ULC-S139

The North American standard fire test for electrical cables. Cable mounted on a masonry wall is exposed to flames raising the temperature to 1000°F in 5 minutes, 1700°F in 1 hour, and 1850°F in 2 hours, followed by the full force of a firefighter's hose stream. Throughout the fire test and after the hose stream test, the cable is energized and must maintain the electrical integrity of the circuit.

FLAME SPREAD AND SMOKE TESTS

UL 1581 (VW-1) AND CSA 2556 (FT1)

This test establishes the resistance of a cable to the vertical propagation of flame. A vertically mounted 0.6 m sample is subjected to 5 x 15 second applications of a defined laboratory burner flame. The extent of flame damage along the sample and the time to self-extinguish are determined.

UL 1581 AND CSA 2556 (FT2)

This test establishes the resistance of a cable to the horizontal propagation of flame and the dropping of flaming particles. A horizontally mounted 0.25 m sample is subjected to a 30 second application of a defined laboratory burner flame. The extent of flame damage along the sample is determined.

IEEE 1202 AND UL1685 AND CSA 2556 (FT4)

This test establishes the resistance of a cable to the propagation of flame while installed in a vertical tray. 2.4 m samples are mounted in a vertical tray, filling the tray to a defined extent. A defined ribbon burner flame is applied at the bottom of the samples for 20 minutes. The char height must not exceed 1.5 m from the burner.

UL 1666 AND FIRE PROPAGATION/ RPI

This test establishes the resistance to fire propagation of a cable while installed in a vertical run (e.g. between floors or in a shaft). Two vertically mounted 5.33 m samples are subjected to a defined flame in a chamber with specified air flow and under specific test conditions. The length of degradation of the cable is determined.

NFPA 262 AND ULC S102.4 (FT6)

This test establishes the resistance of a cable to the propagation of flame and production of smoke while installed in a horizontal run.

7.3 m samples of cable are placed across the width of a "Steiner Tunnel" and subjected to defined flame and airflow conditions. The length of damaged cable, the smoke density and peak smoke release rate are determined.

UL 1685 AND CSA 2556 (ST1 LIMITED SMOKE)

This test establishes the total smoke released and peak smoke release rate in a cable during the vertical tray flame tests (See "IEEE 1202 and UL 1685 and CSA 2556 (FT4)" above).

FIRE PUMP CONTROL WIRING

DOES THE CONTROL CIRCUIT WIRING FOR A FIRE PUMP REQUIRE FIRE PROTECTION?

Yes. National Electrical Code (NFPA 70, 2014 Edition) Section 695.14 (A) (Control Circuit Failures) gives direction as to the importance of control circuits.

> "695.14(A) Control Circuit Failures. External control circuits that extend outside the fire pump room shall be arranged so that failure of any external circuit (open or short circuit) shall not prevent the operation of a pump(s).... shall not prevent the controller(s) from starting the fire pump(s) due to causes other than these external control circuits. All control conductors within the fire pump room that are not fault tolerant shall be protected against physical damage."

Section 695.14(F) states:

> "695.14(F) Generator Control Wiring Methods. Control conductors installed between the fire pump power transfer switch and the standby generator supplying the fire pump during normal power loss shall be kept entirely independent of all other wiring. They shall be protected to resist potential damage by fire or structural failure. They shall be permitted to be routed through a building(s) using one of the following methods: (1) Be encased in a minimum 50 mm (2 in.) of concrete. (2) Be protected by a fire-rated assembly listed to achieve a minimum fire rating of 2 hours and dedicated to the fire pump circuits. (2) Be a listed electrical circuit protective system with a minimum 2-hour fire rating. The installation shall comply with any restrictions provided in the listing of the electrical circuit protective system used."

In summary, the NEC allows embedding conductors in 50 mm (2 in) of concrete, or allows wiring to be "...within enclosed construction dedicated to the fire pump circuits and having a minimum 2-hour fire resistance rating..." or 2-hour Electrical Circuit Protective Systems.

2014 NEC CHANGES: ARTICLES 517 & 700

DOES THE 2014 NEC HAVE NEW REQUIREMENTS FOR PROTECTION OF ELECTRICAL CONDUCTORS FOR FIRE PUMP AND EMERGENCY SYSTEMS?

One of the issues with previous article 700 language was the identification of specific "occupancy classes" which often confused engineers. The 2014 National Electrical Code addresses this issue:

ARTICLE 700: EMERGENCY SYSTEMS

Section 700.10(D) in the 2014 NEC has removed all reference to "occupancy classes" and just requires that emergency feeders be protected as long as a building is 75 feet tall or has an occupancy level of 1000 persons or more. This change takes away any possible questions or confusion. The rest of the language stays the same namely:

The options for fire protection of emergency conductors in the 2014 code are:

(1) Be installed in spaces or areas that are fully protected by an approved automatic fire suppression system

(2) Be a listed electrical circuit protective system with a minimum 2-hour fire rating

(3) Be protected by a listed thermal barrier system for electrical system components with a minimum of 2-hour fire rating

(4) Be protected by a listed fire-rated assembly that has a minimum fire rating of 2-hour, and **contains only emergency wiring circuits**

(5) Be encased in a minimum of 50 mm (2 in) of concrete

Note that "thermal barrier" systems must be listed for protection of "electrical system components," whereas there are no fire-rated assemblies (gypsum enclosures) listed for electrical cable protection.

ARTICLE 517: HEALTH CARE FACILITIES

Section 517.26 now requires that the Life Safety Branch of the essential electrical system shall meet the requirements of Article 700. This means that any health care facility that is 75 feet tall or taller or has an occupancy of 1000 persons or more must have the emergency feeders protected for 2 hours as per section 700.10(D).

UL FIRE TEST GUIDELINES

The North American Fire Test Standards (for evaluation of the ability of electrical cables to maintain circuit integrity under fire conditions), UL 2196 and ULC-S139, are two of the most discerning fire tests for electrical cable anywhere in the world. They are based on the same fire test protocol that is used for all types of fire-rated construction elements - doors, floors, etc. - modified to allow for testing of electrical integrity of the circuit during the test and the subsequent impact of a firefighter's hose stream.

Full details of each manufacturer's listings can be found on the UL Online Certifications web site by entering "http://database.ul.com/cgi-bin/XYV/cgifind.new/LISEXT/1FRAME/index.html" in the address field and typing "FHIT" in the "UL Category Code" field on the resulting search page. The Pentair Thermal Management Listing for MI cable is System 1850. Also on that site is the "UL Guidelines for Electrical Circuit Integrity Systems", which is paraphrased below:

UL ELECTRICAL CIRCUIT INTEGRITY SYSTEMS GUIDE

Fire ratings apply only to the combination of components and materials specified in the individual system. Components and materials are not intended to be interchanged between systems. Electrical circuit integrity systems are intended to be fastened to a concrete or masonry wall or a concrete floor-ceiling assembly.

- The normal temperature rise in ANSI/UL 2196 is intended to represent a fully developed interior building fire.
- Each design of fire-resistive cable is tested. The system contains the construction details of the tested configuration.
- Cable is tested as a complete system. The system includes the cable and/ or raceway support, couplings, boxes/conduit bodies, optional splices, vertical supports, grounding conductors, pulling lubricants, cable tray, etc. Cable or raceway supports need to hold the cable in place during the fire and hose stream. The hardware, clamps, strut, etc., are generally stated to be made of steel.
- Systems that require a raceway are tested with the minimum raceway diameter and the minimum raceway type with their respective coupling(s). Raceways having larger diameters are acceptable. Raceways with greater wall thickness are also acceptable. Intermediate metal conduit (IMC) is acceptable for use in systems where electrical metallic tubing (EMT) is specified.
- The raceway is intended to be connected together using the coupling type referenced in the system, such as steel setscrew type for EMT or threaded types of coupling for IMC. No other couplings are intended to be used unless noted in the specific system.
- If a box, conduit body, supports (such as a grip), splice or other components are tested, it is noted in the system.
- If a splice is tested, it is also described in the system. Boxes should be sized per the method described in the NEC.
- The maximum distance between the supports is described in the individual systems and must not be exceeded even if an alternate raceway is used.

- The support requirements are for both the horizontal and vertical configuration unless otherwise noted in a specific system. Cable installed in a vertical raceway is not supported by the raceway. The maximum vertical distance tested and the cable support mechanism (s) are detailed in the system (This is in contrast to MI cable, where a support on the outside of the cable also supports the conductors.)
- A dedicated raceway is the required configuration unless otherwise noted in the system The system will specify an allowable ground wire. If not specified, the ground should be the same as the fire-rated wire described in the system. Use of any other ground wire violates the system fire rating.
- Authorities Having Jurisdiction should be consulted as to the specific requirements covering the installation and use of these systems.

APPENDIXES

CONTENTS

PENTAIR

PYROTENAX MI CABLE CHARACTERISTICS

DIMENSIONAL CHARACTERISTICS

TABLE 1 CONDUCTOR DIMENSIONS (NOMINAL)

AWG/kcmil	18	16	14	12	10	8	6	4	3	2	1	1/0	2/0	3/0	4/0	250	350	500
Dia. (in)	0.040	0.051	0.064	0.081	0.102	0.128	0.162	0.204	0.229	0.258	0.289	0.325	0.365	0.410	0.460	0.500	0.590	0.707
Dia. (mm)	1.02	1.30	1.63	2.06	2.59	3.25	4.11	5.18	5.82	6.55	7.34	8.26	9.27	10.41	11.68	12.70	14.99	17.96
Area (kcmil)	1.62	2.58	4.11	6.53	10.38	16.51	26.25	41.74	52.63	66.37	83.69	105.50	133.10	167.80	211.60	250	350	500
Area (sq mm)	0.81	1.32	2.08	3.32	5.27	8.30	13.30	21.09	26.57	33.73	42.32	53.52	67.51	85.18	107.22	126.68	176.38	253.28

TABLE 2 MINIMUM SHEATH THICKNESS (SYSTEM 1850 MI CABLE)

	Single conductor		Two conductor		Three conductor		Four conductor		Seven conductor	
	600 V		600 V		600 V		600 V		600 V	
AWG/ kcmil	in	mm	in	mm	in	mm	in	mm	in	mm
16	0.016	0.41	0.023	0.58	0.023	0.58	0.024	0.61	0.027	0.69
14	0.017	0.43	0.026	0.66	0.026	0.66	0.026	0.66	0.028	0.71
12	0.018	0.46	0.026	0.66	0.027	0.69	0.027	0.69	0.028	0.71
10	0.019	0.48	0.027	0.69	0.028	0.71	0.028	0.71	0.031	0.79
8	0.020	0.51	0.027	0.69	0.028	0.71	0.030	0.76	0.036	0.91
6	0.022	0.56	0.030	0.76	0.031	0.79	0.034	0.86		
4	0.024	0.61	0.034	0.86	0.036	0.91				
3	0.026	0.66	0.038	0.97	0.038	0.97				
2	0.027	0.69	0.042	1.07						
1	0.028	0.71	0.046	1.17						
1/0	0.028	0.71								
2/0	0.030	0.76								
3/0	0.032	0.81								
4/0	0.035	0.89								
250	0.037	0.94								
350	0.039	0.99								
500	0.041	1.04								

TABLE 3 INSULATION THICKNESS (NOMINAL) (BETWEEN CONDUCTORS AND BETWEEN CONDUCTORS AND SHEATH)

	in	mm
System 1850 600 V cables	0.061	1.55

MECHANICAL CHARACTERISTICS

TABLE 4 CABLE TENSILE STRENGTH (SYSTEM 1850 MI CABLE)

AWG/ kcmil	Single conductor		Two conductor		Three conductor		Four conductor		Seven conductor	
	600 V		600 V		600 V		600 V		600 V	
	lb	kg	lb	kg	lb	kg	lb	kg	lb	kg
16	320	145	670	304	740	336	865	392	1,180	535
14	376	171	815	370	920	417	1,010	458	1,495	678
12	460	209	970	440	1,170	531	1,340	608	1,880	853
10	595	270	1,260	572	1,480	671	1,790	812	2,660	1,207
8	685	311	1,600	726	1,950	885	2,420	1,098		
6	1,047	475	2,200	998	2,800	1,270	3,540	1,606		
4	1,480	671	3,130	1,420	4,050	1,837				
3	1,775	805								
2	2,105	955								
1	2,520	1,143								
1/0	3,075	1,395								
2/0	3,760	1,705								
3/0	4,560	2,068								
4/0	5,620	2,549								
250	6,560	2,976								
350	8,800	3,992								
500	12,000	5,443								

Note: Values are calculated assuming an ultimate tensile strength of 22,000 psi for copper. Maximum pulling load should not exceed 35% of these values.

TABLE 5 TERMINATION PERFORMANCE

Code-compliant bonding path from the cable sheath.

Hydrostatic withstand pressure up to 500 lbs/in^2 (35 kg/cm^2) when torqued to 25 ft-lbs.

ELECTRICAL CHARACTERISTICS (CURRENT RATING AND TERMINATION SIZE)

TABLE 6 CURRENT RATING (90°C RATING)

AWG/ kcmil	Single conductor			Two conductor			Three conductor			Four conductor			Seven conductor		
	CEC	NEC	Gland	CEC	NEC	Gland	CEC	NEC	Gland	CEC	NEC	Gland	CEC	NEC	Gland
16	—	24	1/2"	—	18	1/2"	—	18	1/2"	—	18/14	1/2"	—	14/13	3/4"
14	35	35	1/2"	25	25	1/2"	25	25	1/2"	25/20	25/20	3/4"	20/18	20/18	3/4"
12	40	40	1/2"	30	30	1/2"	30	30	3/4"	30/24	30/24	3/4"	24/21	24/21	3/4"
10	55	55	1/2"	40	40	3/4"	40	40	3/4"	40/32	40/32	3/4"	32/28	32/28	1"
8	80	80	1/2"	55	55	3/4"	55	55	3/4"	55/44	55/44	3/4"	44/39	44/39	1-1/4"
6	105	105	1/2"	75	75	3/4"	75	75	3/4"	75/60	75/60	1-1/4"			
4	140	140	1/2"	95	95	1"	95	95	1-1/4"						
3	165	165	3/4"	115	115	1-1/4"	115	115	1-1/4"						
2	190	190	3/4"	130	130	1-1/4"									
1	220	220	3/4"	145	145	1-1/4"									
1/0	260	260	3/4"												
2/0	300	300	3/4"												
3/0	350	350	3/4"												
4/0	405	405	1"												
250	455	455	1-1/4"												
350	570	570	1-1/4"												
500	700	700	1-1/4"												

Note:

1. Current ratings are based on 30°C (86°F) ambient. For ambients in excess of 30°C (86°F), refer to electrical codes for the derating factors.
2. In the case of four and seven conductor cables, the higher current rating applies if one conductor is used as a neutral.
3. For 14 AWG, 12 AWG 10 AWG, refer to appropriate sections of NEC and CEC governing conductor overcurrent protection limitations.

TABLE 7 CURRENT RATING (75°C RATING)

AWG/ kcmil	Single conductor			Two conductor			Three conductor			Four conductor			Seven conductor		
	CEC	NEC	Gland	CEC	NEC	Gland	CEC	NEC	Gland	CEC	NEC	Gland	CEC	NEC	Gland
16	—	—	1/2"	—	—	1/2"	—	—	1/2"	—	—	1/2"	—	—	3/4"
14	30	30	1/2"	20	20	1/2"	20	20	1/2"	20/16	20/16	3/4"	16/14	16/14	3/4"
12	35	35	1/2"	25	25	1/2"	25	25	3/4"	25/20	25/20	3/4"	20/18	20/18	3/4"
10	50	50	1/2"	35	35	3/4"	35	35	3/4"	35/28	35/28	3/4"	28/25	28/25	1"
8	70	70	1/2"	50	50	3/4"	50	50	3/4"	50/40	50/40	3/4"	40/35	40/35	1-1/4"
6	95	95	1/2"	65	65	3/4"	65	65	3/4"	65/52	65/52	1-1/4"			
4	125	125	1/2"	85	85	1"	85	85	1-1/4"						
3	145	145	3/4"	100	100	1-1/4"	100	100	1-1/4"						
2	170	170	3/4"	115	115	1-1/4"									
1	195	195	3/4"	130	130	1-1/4"									
1/0	230	230	3/4"												
2/0	265	265	3/4"												
3/0	310	310	3/4"												
4/0	360	360	1"												
250	405	405	1-1/4"												
350	505	505	1-1/4"												
500	620	620	1-1/4"												

Note:

1. Current ratings are based on 30°C (86°F) ambient. For ambients in excess of 30°C (86°F), refer to electrical codes for the derating factors.
2. In the case of four and seven conductor cables, the higher current rating applies if one conductor is used as a neutral.
3. For 14 AWG, 12 AWG 10 AWG, refer to appropriate sections of NEC and CEC governing conductor overcurrent protection limitations.

TABLE 8 CONDUCTOR RESISTANCE (OHMS/1000 FT) AT 25°C (77°F)

AWG/kcmil	18	16	14	12	10	8	6	4	3	2	1	1/0	2/0	3/0	4/0	250	350	500
Nominal DC resistance	6.51	4.09	2.58	1.62	1.02	0.641	0.403	0.253	0.201	0.159	0.126	0.100	0.079	0.063	0.050	0.042	0.030	0.021
Maximum DC resistance	7.05	4.25	2.73	1.72	1.08	0.680	0.427	0.269	0.213	0.169	0.134	0.106	0.084	0.067	0.052	0.045	0.032	0.022

Temperature Coefficient of Resistance

The resistance of copper conductors will increase with temperature in accordance with the following formula:

$R_T = R\,[1+.0039\,(T-25)]$ R = resistance at 25°C

R_T = resistance at new temperature T = new temperature (°C)

TABLE 9 NOMINAL CAPACITANCE AND INDUCTANCE (SYSTEM 1850 MI CABLE)

	Capacitance (µF/1000 ft)		Inductance (µH/1000 ft)	
	Single conductor	Multiconductor	Single conductor	Multiconductor
AWG/kcmil	600 V	600 V	600 V	600 V
16	0.055	0.043	90	103
14	0.064	0.049	80	99
12	0.076	0.058	70	91
10	0.082	0.067	66	86
8	0.101	0.079	56	81
6	0.119	0.095	50	77
4	0.128	0.101	47	73
3	0.130	0.102	47	67
2	0.167	0.108	40	65
1	0.173	0.107	39	65
1/0	0.211		35	
2/0	0.205		35	
3/0	0.232		33	
4/0	0.272		30	
250	0.268		31	
350	0.283		30	
500	0.281		30	

PYROTENAX MI VOLTAGE DROP CALCULATIONS

To calculate voltage drop for a three-phase line-to-line circuit, the following formula should be used with the appropriate Factor "A" from Table 2 or Table 3. These calculations are simplified for ease of use and give approximate results.

$$\text{Voltage drop} = \frac{\text{(Run length) X (Circuit current) X (Temp. const.) X (Factor "A")}}{1000}$$

$$\text{Percentage voltage drop} = \frac{\text{Voltage drop X 100}}{\text{Circuit voltage}}$$

Note: Use the calculated load (not the fuse or breaker rating) to determine voltage drop.

TABLE 1 TEMPERATURE CONSTANT

Cable at full rated current	1.00
Cable at 3/4 rated current	0.95
Cable at 1/2 rated current	0.91
Cable at 1/4 rated current	0.88

Note that these calculated voltage drops represent the line-to-line voltage drop in a three-phase system. To estimate the single-phase voltage drop, multiply the three-phase line-to-line voltage drop by 1.16. In those rare instances where the line-to-neutral voltage drop in a three-phase system is required, multiply the three-phase line-to-line voltage drop by 0.58.

TABLE 2 VOLTAGE DROP FACTOR "A" FOR SINGLE CONDUCTOR CABLE IN TREFOIL, 90°C CONDUCTOR TEMPERATURE

Cable reference	Conductor size AWG/kcmil	Lagging power factor in percent						
		100	95	90	85	80	75	30
1/6-340	6	0.894	0.867	0.892	0.790	0.749	0.708	0.323
1/4-402	4	0.576	0.565	0.543	0.519	0.494	0.469	0.225
1/3-449	3	0.45	0.444	0.429	0.411	0.393	0.373	0.187
1/2-449	2	0.355	0.353	0.341	0.328	0.314	0.299	0.154
1/1-496	1	0.285	0.286	0.278	0.268	0.257	0.246	0.132
1/1/0-512	1/0	0.226	0.229	0.223	0.216	0.208	0.200	0.111
1/2/0-580	2/0	0.181	0.187	0.183	0.178	0.173	0.166	0.098
1/3/0-621	3/0	0.146	0.153	0.151	0.148	0.144	0.139	0.086
1/4/0-684	4/0	0.119	0.127	0.126	0.124	0.121	0.118	0.077
1/250-746	250	0.104	0.112	0.112	0.111	0.109	0.107	0.073
1/350-834	350	0.077	0.086	0.088	0.087	0.087	0.085	0.063
1/500-1000	500	0.061	0.071	0.073	0.073	0.073	0.073	0.058

TABLE 3 VOLTAGE DROP FACTOR "A" FOR THREE CONDUCTOR CABLE, 90°C CONDUCTOR TEMPERATURE

Cable reference	Conductor size AWG	Lagging power factor in percent						
		100	95	90	85	80	75	30
3/14-387	14	5.746	5.463	5.179	4.895	4.611	4.328	1.766
3/12-480	12	3.600	3.424	3.248	3.071	2.895	2.718	1.122
3/10-480	10	2.279	2.169	2.058	1.947	1.836	1.725	0.721
3/8-590	8	1.459	1.389	1.320	1.250	1.180	1.110	0.475
3/6-621	6	0.920	0.877	0.834	0.790	0.747	0.704	0.309
3/4-746	4	0.591	0.565	0.538	0.511	0.484	0.457	0.210
3/3-834	3	0.476	0.455	0.434	0.413	0.392	0.371	0.175

Example:

Run length	500'
Circuit current	100 A
Voltage	600 V, three-phase
Power factor	85%
Initial cable size	1/0 AWG

$$\text{Voltage drop} = \frac{500 \times 100 \times 0.91 \times 0.216}{1000} = 9.8 \text{ V}$$

$$\text{Percent voltage drop} = \frac{9.8 \times 100}{600} = 1.63\%$$

If the voltage drop is over the desired limit, select a larger cable and repeat. Alternatively, use parallel runs of smaller cable, calculating voltage drop on the reduced current carried by each run.

For fire pump motors, check that the voltage drop does not exceed 5% @ 115% rated current, and does not equal or exceed 15% at locked rotor current, including the drop in the motor/generator.

Note: Ensure all the applicable requirements of national and local electrical codes are met.

PYROTENAX MI TEMPERATURE CHARACTERISTICS

COPPER SHEATH CABLES

Pyrotenax unjacketed MI cables are nonflammable; when exposed to fire conditions, they will not burn, contribute fuel, or emit flammable or toxic gases.

The temperature limit of the cable for continuous operation is determined only by the progressive oxidation temperature of the copper sheath, 250°C (482°F) in normal atmosphere.

For higher temperature applications, the cable may be exposed to continuous temperatures above 250°C (482°F); however, a reduced sheath life should be anticipated, as shown in Table 1.

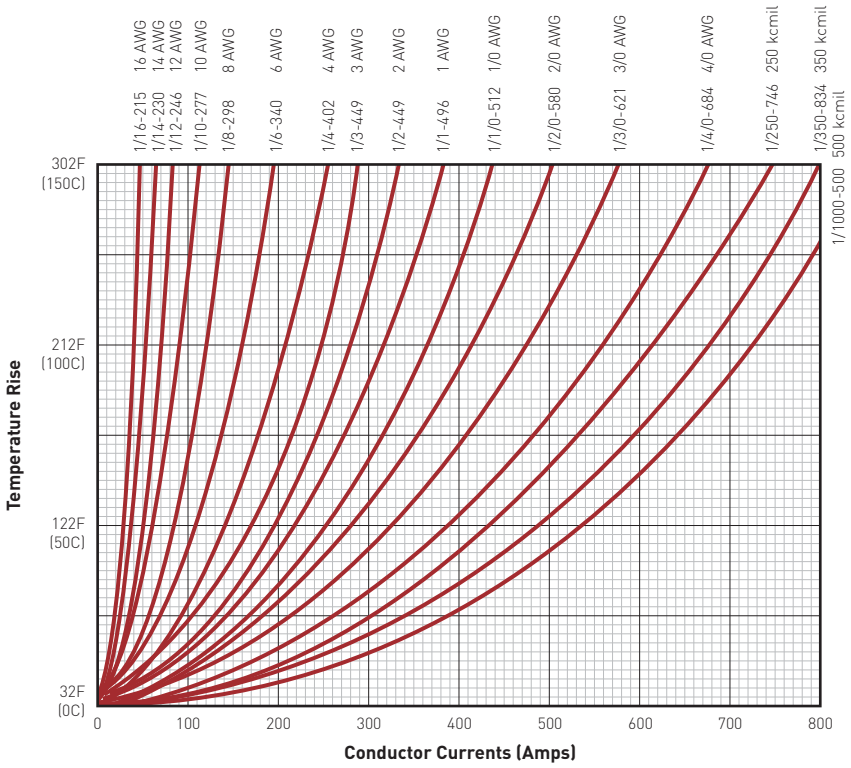
TABLE 1 DECREASE IN COPPER SHEATH THICKNESS AS A FUNCTION OF TIME AT VARIOUS TEMPERATURES

Decrease in sheath thickness, mils*	Years at 250°C (482°F)	Years at 400°C (752°F)	Hours at 800°C (1472°F)
1	2.57	0.0583	0.259
2	10.3	0.233	1.04
5	64.3	1.46	6.48
10	257	5.83	25.9

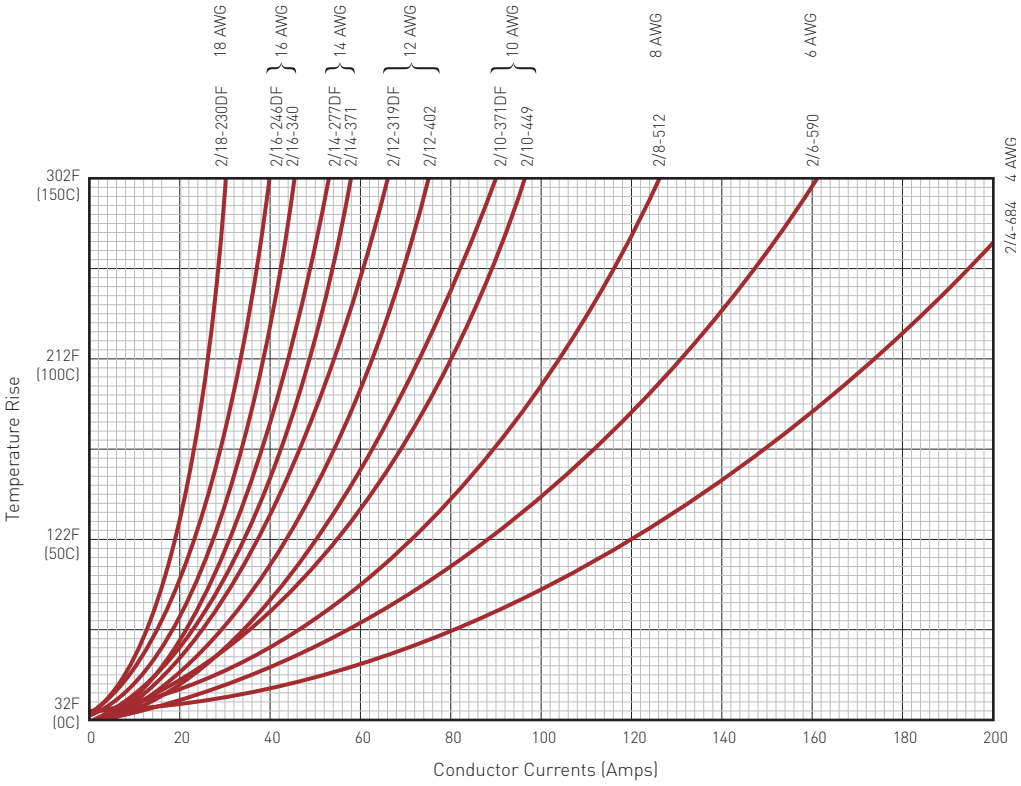
*1 mil = 0.001 inch

SHEATH TEMPERATURE RISE

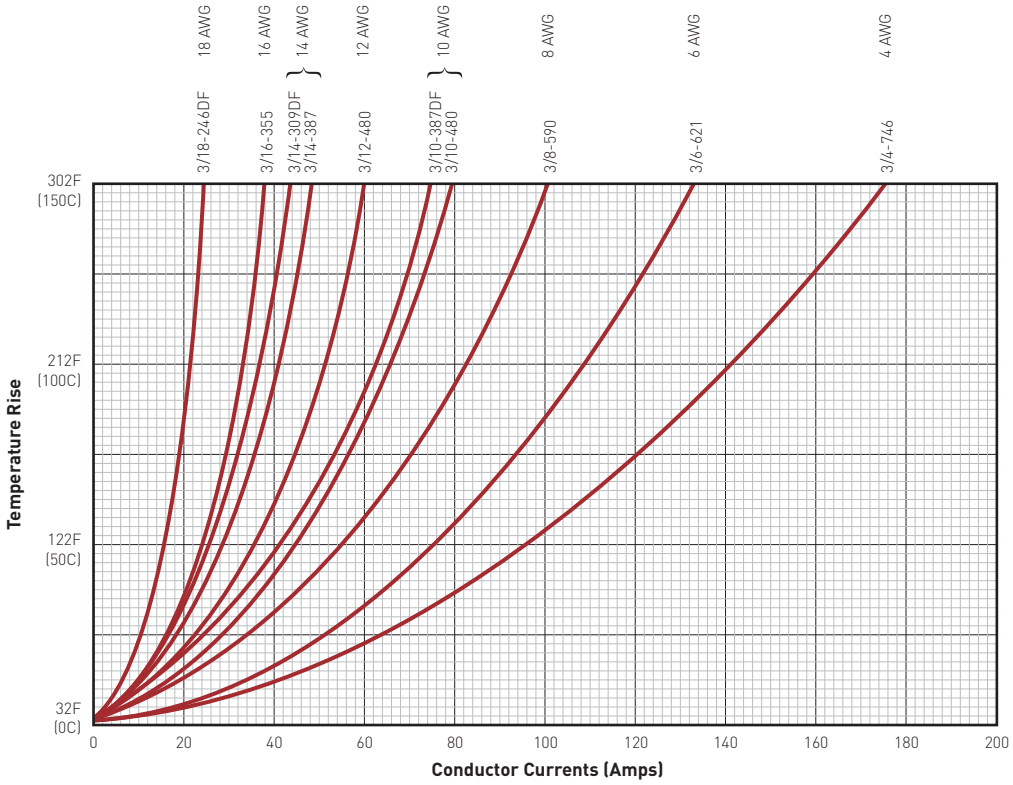
The following graphs show the expected sheath temperature rise on MI cables under free air conditions when installed according to the appropriate product installation instructions. Note that the curves are based on the cable being in free air at 25°C (77°F) and sheath temperatures will be lower if the cables are embedded in a medium which has a quenching or cooling effect. Conversely, if the cables are surrounded by a medium which acts as a heat insulator, the sheath temperatures will be higher for a given current.



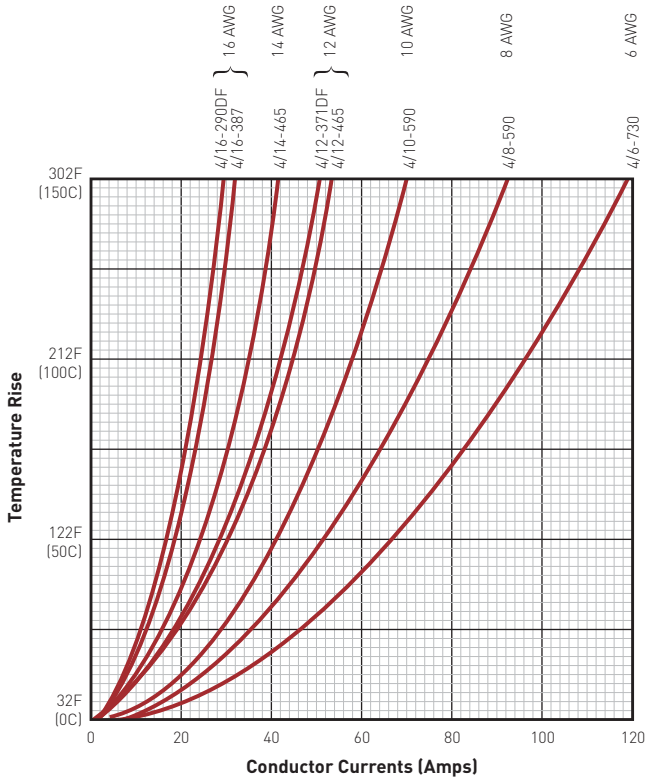
Graph 1 Sheath temperature rise for 600 V MI single conductor cables in free air conditions



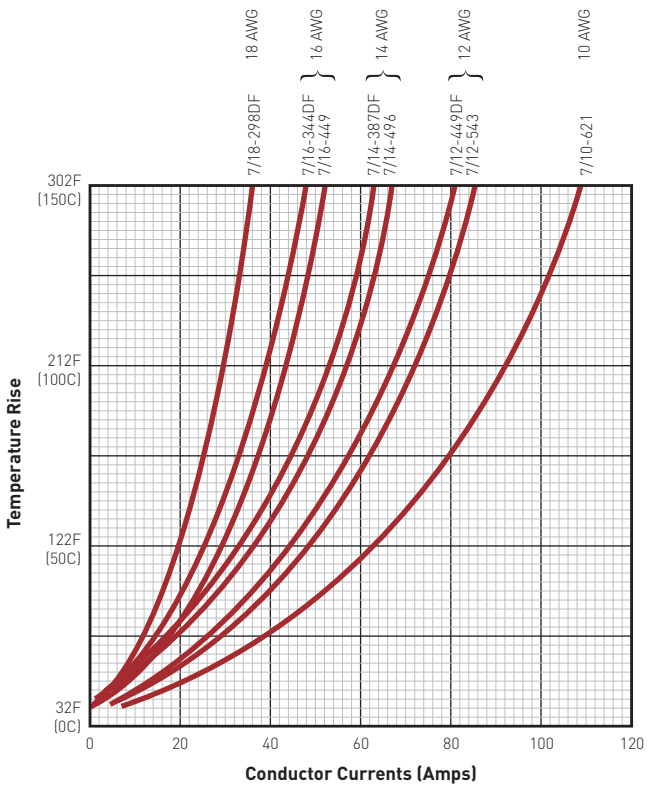
Graph 2 Sheath temperature rise for 300 V and 600 V MI two conductor cables in free air conditions



Graph 3 Sheath temperature rise for 300 V and 600 V MI three conductor cables in free air conditions



Graph 4 Sheath temperature rise for 300 V and 600 V MI four conductor cables in free air conditions



Graph 5 Sheath temperature rise for 300 V and 600 V MI seven conductor cables in free air conditions

Note: Values are based on the Neher-McGrath calculation, AIEE 1957.

Termination Temperature Limits

There are several terminations available for sealing and terminating Pyrotenax MI cables. The temperature limit for these terminations is dependent on the sealing material and sleeving used. Refer to the product data sheets for additional information.

PYROTENAX MI CABLE EXPANSION AND VIBRATION

On occasion it is necessary to provide for expansion of a cable operating under abnormal temperature conditions, or to prevent mechanical damage which may result from the relative movement of different items of equipment traversed by a cable.

Conditions encountered in commercial applications can be satisfied by providing, between securing clips or other fixation methods, a right angle bend (Fig. 1), two right angle bends (Fig. 2), or one semicircular bend and two 45° angle bends (Fig. 3) in the cable, whichever is most appropriate for a particular installation.

For MI cable the bending radius should not be less than six times the cable diameter for cables up to 0.75 inch (19 mm) diameter and 12 times the cable diameter for cables greater than 0.75 inch (19 mm) diameter. Where the termination is subject to vibration, an expansion loop as shown in Fig. 4 is recommended.

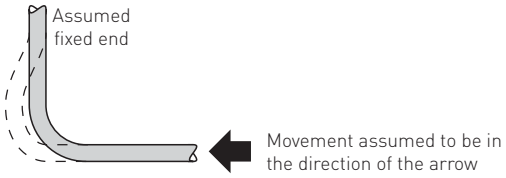


Fig. 1 Single right angle bend

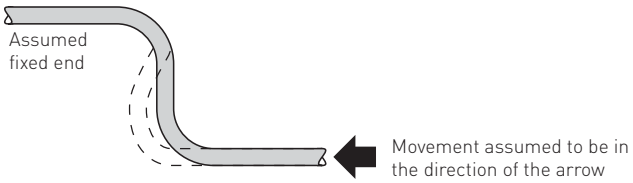


Fig. 2 Two right angle bends

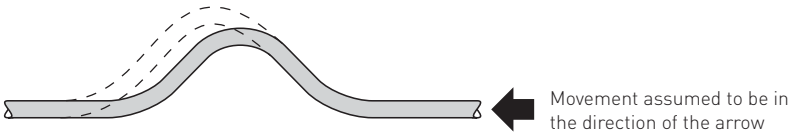


Fig. 3 One semicircular bend

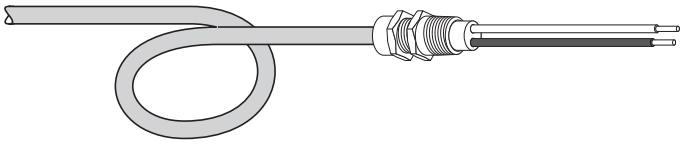


Fig. 4 Expansion loop on termination end

COPPER SHEATHED CABLE AND CORROSION

Copper sheathed cables are noted for their general resistance to chemical corrosion as compared to most other metals. However, as with all metals, there are certain environments which will be detrimental.

Copper is susceptible to oxidizing acids such as nitric, sulfurous, and concentrated sulfuric acid. Similarly, it is attacked by oxidizing salts. Ions that are susceptible to reduction include ferric, stannic, and mercuric. Although resistant to attack by most dry gases, it is susceptible to corrosion by wet fluorine, chlorine, bromine, iodine, and ammonia. Sulfur compounds have a strong tendency to attack it. For applications involving corrosion, contact Pentair Thermal Management or consult a corrosion handbook.

When copper is in contact with a metal more active in electrochemical potential, through an electrolyte, corrosion of the metal may be stimulated. The common metals most likely to be affected are aluminum, magnesium, zinc, and, in some cases, galvanized steel. In actual practice the surface area of the cable or cathode is so small in comparison to the anodic metal that very little corrosion will take place. For example, the cable is often used on aluminum and galvanized steel towers without any serious corrosion problem occurring. Again, the surface area is so small in comparison that, for most applications, this type of corrosion can be ignored.

Stress corrosion cracking is a combination of both stress and corrosion which causes metal embrittlement and cracking. Since the cables must be bent during installation, they invariably contain sufficient surface stress so that when exposed to particular corrosive agents, cracking can occur. For this type of corrosion with copper, the only known corrosive agent is ammonia or ammonia-bearing materials called amines. For ammonia to cause this type of cracking, traces of moisture and carbon dioxide, as normally found in the atmosphere, are also required. This type of corrosion cracking has been encountered where urine has been in contact with the cable during installation. There is very little apparent surface corrosion; however, the cable sheath becomes brittle and may eventually crack with the slightest stress. In any case, this particular type of corrosion has been relatively rare.

Where the copper sheath could be corroded, an extruded HDPE polymer jacket can be supplied.

TABLE 1 JACKET MATERIAL AVAILABLE FOR MI CABLE

Jacket material	Typical thickness (in)	Typical thickness (mm)	Flammability (ASTM D635)	Maximum operating temperature (continuous)	Minimum installation temperature
Polyethylene	0.040	1.0	FT4	120°C (248°F)	–40°C (–40°F)

The following table lists various materials and their resistance to chemicals under average conditions. However, it is intended only as a guide and does not imply a guarantee due to the number of variable conditions which may be encountered.

TABLE 2 CORROSION RESISTANCE TABLE

	Material						
Chemical	**Copper**	**Cupro Nickel**	**Alloy 825**	**304 Stainless**	**Inconel 600**	**Polyethylene**	**PVC**
Acetic Acid	S	E	E	S	S	S	S
Acetic Anhydride	S	S	E	S	S	N	N
Acetone	S	E	E	E	E	N	N
Acetylene	N	N	E	E	S	N	E
Alcohols	E	E	E	E	–	S	E
Alum	S	E	E	N	S	E	E
Alumina	E	E	E	N	N	–	E
Aluminum Chloride	S	S	E	N	–	E	E
Aluminum Hydroxide	E	E	E	E	–	S	E
Aluminum Sulfate	S	E	E	N	S	E	E
Ammonia, Absolutely dry	N	E	E	E	E	E	E
Ammonia, moist	N	S	E	E	E	N	N
Ammonium Hydroxide	N	S	E	E	E	E	E
Ammonium Chloride	S	S	E	N	S	E	E
Ammonium Nitrate	N	S	E	E	S	E	E
Ammonium Sulfate	S	S	E	S	S	E	E
Amyl Acetate	S	S	E	E	E	N	N
Amyl Alcohol	E	E	E	–	–	E	S
Aniline	N	N	E	E	E	S	N
Aniline Dyes	N	N	E	E	E	N	N
Asphalt	E	E	E	E	–	–	E
Atmosphere, Industrial	E	E	E	E	E	E	E
Atmosphere, Marine	S	E	E	N	S	E	E
Atmosphere, Rural	E	E	E	E	E	E	E
Barium Carbonate	E	E	E	E	E	E	E
Barium Chloride	S	S	E	S	S	E	E
Barium Hydroxide	N	E	E	S	E	E	E
Barium Sulfate	N	E	E	E	–	E	E
Barium Sulfide	N	S	E	E	–	E	S
Beer	S	E	E	E	E	E	E
Beet Sugar Syrups	E	E	E	E	–	–	E
Benzine	E	E	E	E	E	N	N
Benzoic Acid	E	E	E	S	–	E	E
Benzol	E	E	E	E	E	E	N
Black Liquor, Sulphate Process	S	S	E	S	N	–	E
Bleaching Powder, wet	S	S	S	N	N	–	N
Borax	S	E	E	E	E	E	E
Bordeaux Mixture	E	E	–	E	–	–	–
Boric Acid	S	E	E	S	E	E	E

Ratings: E – The material should be suitable under most conditions.
S – The material offers fair corrosion resistance. It may be considered in place of a material with an "E" rating when some property other than corrosion resistance governs its use.
N – The material is not suitable.

TABLE 2 CORROSION RESISTANCE TABLE

Chemical	Material						
	Copper	Cupro Nickel	Alloy 825	304 Stainless	Inconel 600	Polyethylene	PVC
Brines	S	E	E	–	S	E	E
Bromine, dry	E	E	E	N	–	N	N
Bromine, moist	S	S	S	N	E	N	N
Butane	E	E	E	E	E	–	E
Butyl Alcohol	S	S	E	–	–	E	S
Butyric Acid	S	S	E	E	S	N	N
Calcium Bisilite	S	S	E	S	N	S	E
Calcium Chloride	S	S	E	E	E	E	E
Calcium Hydroxide	S	E	E	S	E	E	E
Calcium Hypochlorite	S	S	S	N	S	E	E
Cane Sugar Syrups	E	E	E	E	E	–	E
Carbolic Acid	S	S	E	S	E	E	E
Carbon Dioxide, dry	E	E	E	E	E	E	E
Carbon Dioxide, moist	S	E	E	S	E	E	E
Carbonated Water	S	E	E	E	–	E	–
Carbonated Beverages	S	E	E	E	E	E	E
Carbon Disulfide	N	–	E	E	–	N	N
Carbon Tetrachloride, dry	E	E	E	E	E	N	S
Carbon Tetrachloride, moist	S	E	E	S	E	N	N
Castor Oil	E	E	E	E	E	E	E
Chlorine, dry	S	E	E	S	–	S	N
Chlorine, moist	N	S	S	N	N	N	N
Chloracetic Acid	S	S	E	N	S	–	S
Chloroform, dry	E	E	E	E	E	N	N
Chromic Acid	N	N	E	N	N	S	S
Cider	S	S	E	S	–	E	E
Citric Acid	S	E	E	S	–	E	E
Coffee	E	E	E	E	–	–	–
Copper Chloride	N	N	E	S	N	E	E
Copper Nitrate	N	N	E	E	N	E	E
Copper Sulfate	S	E	E	E	S	E	E
Corn Oil	E	E	E	E	E	E	E
Cottonseed Oil	E	E	E	E	E	E	E
Creosote	S	E	E	N	–	N	N
Crude Oil	E	E	E	E	–	–	–
Ethers	E	E	E	E	E	N	N
Ethyl Acetate	E	E	E	S	S	N	N
Ethyl Alcohol	E	E	E	E	–	E	E
Ethyl Chloride	S	S	E	E	E	N	N

Ratings: E – The material should be suitable under most conditions.
S – The material offers fair corrosion resistance. It may be considered in place of a material with an "E" rating when some property other than corrosion resistance governs its use.
N – The material is not suitable.

TABLE 2 CORROSION RESISTANCE TABLE

	Material						
Chemical	**Copper**	**Cupro Nickel**	**Alloy 825**	**304 Stainless**	**Inconel 600**	**Polyethylene**	**PVC**
Ethylene Glycol	E	E	E	E	–	E	S
Ferric Chloride	N	N	S	N	N	E	E
Ferric Sulfate	N	N	E	E	E	E	E
Ferrous Chloride	N	S	S	N	N	E	E
Ferrous Sulfate	S	S	E	S	–	E	E
Formaldehyde	S	E	E	S	E	E	S
Formic Acid	S	S	E	N	S	E	N
Freon	E	E	E	E	–	E	E
Fruit Juices	S	S	E	E	E	E	E
Fuel Oil	S	E	E	N	S	N	S
Furfural	E	E	E	E	S	N	N
Gasoline	E	E	E	E	E	N	N
Gelatine	E	E	E	E	E	–	E
Glucose	E	E	E	E	E	E	E
Glue	E	E	E	–	–	–	–
Glycerine	S	E	E	E	E	E	E
Hydrobromic Acid	N	N	S	N	N	E	E
Hydrocarbons, Pure	E	E	E	E	E	E	E
Hydrochloric Acid	N	N	S	N	N	E	E
Hydrocyanic Acid, dry	S	S	S	N	S	S	N
Hydrofluosilicic Acid	S	S	E	N	S	–	S
Hydrogen	E	E	E	E	–	E	E
Hydrogen Peroxide	N	N	E	S	E	S	E
Hydrogen Sulfide, dry	N	E	E	S	S	E	E
Hydrogen Sulfide, moist	N	N	E	S	S	E	E
Kerosene	E	E	E	E	E	N	E
Lacquers	E	E	E	S	–	–	–
Lacquer Solvents	E	E	E	–	–	–	–
Lactic Acid	S	E	E	S	S	E	S
Lime	S	E	E	S	–	–	E
Line–Sulfur	N	N	–	E	–	–	E
Linseed Oil	S	S	E	E	S	S	E
Magnesium Chloride	S	S	E	S	E	E	E
Magnesium Hydroxide	E	E	E	E	S	E	E
Magnesium Sulfate	S	E	E	E	E	E	E
Mercury	N	N	E	E	E	E	E
Mercury Salts	N	N	E	E	S	E	E
Methyl Alcohol	S	S	E	E	E	E	S
Methyl Chloride, dry	S	E	E	E	E	N	N

Ratings: E – The material should be suitable under most conditions.
S – The material offers fair corrosion resistance. It may be considered in place of a material with an "E" rating when some property other than corrosion resistance governs its use.
N – The material is not suitable.

TABLE 2 CORROSION RESISTANCE TABLE

Chemical	Material						
	Copper	Cupro Nickel	Alloy 825	304 Stainless	Inconel 600	Polyethylene	PVC
Milk	S	E	E	E	E	E	E
Mine Water	N	–	E	E	–	E	E
Natural Gas	E	E	E	E	E	–	–
Nitric Acid	N	N	E	S	N	S	N
Nitrogen	E	E	E	–	S	–	–
Oleic Acid	S	S	E	N	E	N	E
Oxalic Acid	S	S	E	N	E	E	E
Oxygen	E	E	E	E	E	–	E
Palmitic Acid	S	S	E	N	–	S	E
Paraffin	E	E	E	E	–	–	–
Phosphoric Acid	S	S	E	N	S	S	E
Potassium Carbonate	E	E	E	E	E	E	E
Potassium Chloride	S	E	E	N	E	E	E
Potassium Chromate	E	E	E	S	E	E	E
Potassium Cyanide	N	N	E	E	E	E	E
Potassium Dichromate, Acid	N	N	E	E	S	E	E
Potassium Hydroxide	S	E	E	S	E	E	E
Potassium Sulfate	E	E	E	E	E	E	E
Propane	E	E	E	E	–	–	E
Rosin	S	E	E	E	–	–	–
Sea Water	S	E	E	N	S	E	E
Sewage	E	E	E	–	–	E	E
Silver Salts	N	N	E	E	–	E	E
Soap Solutions	E	E	E	E	–	E	E
Sodium Bicarbonate	E	E	E	S	S	E	E
Sodium Bisulfate	S	E	E	S	S	E	E
Sodium Bisulfite	S	S	E	S	S	E	E
Sodium Carbonate	E	E	E	E	E	E	E
Sodium Chloride	S	E	E	N	E	E	E
Sodium Chromate	E	E	E	–	–	–	–
Sodium Cyanide	N	N	E	E	–	E	E
Sodium Dichromate, Acid	N	N	E	–	–	E	E
Sodium Hydroxide(Caustic Soda)	S	E	E	S	E	E	E
Sodium Hypochlorite	S	S	S	N	N	E	E
Sodium Nitrate	S	E	E	S	E	E	E
Sodium Peroxide	S	S	E	E	E	–	E
Sodium Phosphate	E	E	E	E	E	–	E
Sodium Silicate	S	E	E	E	E	–	–
Sodium Sulfate	E	E	E	E	S	E	E

Ratings: E – The material should be suitable under most conditions.
S – The material offers fair corrosion resistance. It may be considered in place of a material with an "E" rating when some property other than corrosion resistance governs its use.
N – The material is not suitable.

TABLE 2 CORROSION RESISTANCE TABLE

	Material						
Chemical	**Copper**	**Cupro Nickel**	**Alloy 825**	**304 Stainless**	**Inconel 600**	**Polyethylene**	**PVC**
Sodium Sulfide	N	N	E	N	S	E	E
Sodium Sulfite	S	S	E	E	S	E	E
Sodium Thiosulfate	N	N	E	E	E	E	E
Steam	E	E	E	E	–	E	–
Stearic Acid	S	E	E	S	E	E	E
Sugar Solutions	E	E	E	–	–	E	E
Sulfur, dry	S	E	E	S	S	E	E
Sulfur, molten	N	N	S	S	N	–	N
Sulfur Chloride, dry	E	E	E	S	–	–	E
Sulfur Dioxide, dry	E	E	E	E	E	S	E
Sulfur Dioxide, moist	S	N	E	S	N	S	N
Sulfur Trioxide, dry	E	E	E	–	–	E	E
Sulfuric Acid, 80–95%	N	S	E	N	N	N	S
Sulfuric Acid, 40–80%	N	N	E	N	N	N	E
Sulfuric Acid, 40%	N	S	E	N	S	E	E
Sulfurous Acid	S	N	E	N	N	E	E
Tannic Acid	S	E	E	E	–	E	E
Tar	E	E	E	–	–	–	–
Tartaric Acid	S	E	E	S	S	S	E
Toluene	E	E	E	E	E	N	N
Trichloracetic Acid	S	S	E	E	–	–	–
Trichlorethylene, dry	E	E	E	S	S	N	N
Trichlorethylene, moist	S	E	E	S	S	N	N
Turpentine	E	E	E	S	E	N	E
Varnish	E	E	E	E	–	–	–
Vinegar	S	E	E	S	E	E	E
Water, Potable	S	E	E	E	–	E	E
Zinc Chloride	S	S	E	N	–	E	E
Zinc Sulfate	S	E	E	S	–	E	E

Ratings: E – The material should be suitable under most conditions.
S – The material offers fair corrosion resistance. It may be considered in place of a material with an "E" rating when some property other than corrosion resistance governs its use.
N – The material is not suitable.

Disclaimer: Information is believed to be reliable and is based on generally available technical literature. However, no guarantee is expressed or implied. User must verify product suitability for each application.

COPPER SHEATHED CABLE — SHEATH CURRENTS

SINGLE CONDUCTOR CABLE

Single conductor cables present certain application considerations that do not arise in multiconductor cable installations. These considerations apply to both single conductor mineral insulated copper sheath cables and polymer insulated cables having an aluminum or copper armor or sheath. Sheath voltages in single conductor cables arise as a result of three physical principles:

1 All electric currents, AC or DC, generate a magnetic field

As shown in Fig. 1, the magnetic field generated by the flow of current surrounds the conductor completely and radiates laterally outward, becoming weaker with increasing distance. In the case of a DC circuit, the magnetic field is constant and has a strength determined by, among other factors, the magnitude of the DC current.

Neither the strength nor direction of the magnetic field is constant in the AC current case. Rather, the field reacts to the current's changing nature by itself alternating in strength and direction.

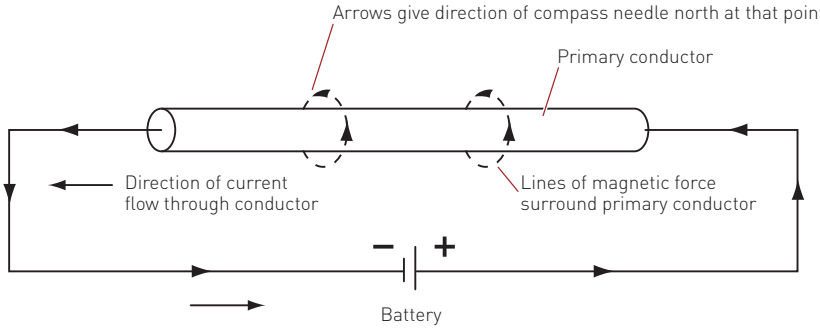


Fig. 1 Magnetic field generated by current flow

2 Faraday's Law of Induction

Faraday found that a changing magnetic field will induce a voltage by which a current can flow. A magnetic field generated by a DC current cannot induce a steady-state voltage, as the field does not change. An AC current, with its attendant alternating magnetic field will, however, induce a voltage which, if a closed path is available, will cause a current to flow.

3 Lenz's Law

Lenz added to Faraday's work on the induction principle by developing a theory that explained the direction or polarity of the induced voltage. He found that the direction of the induced current, which flows as a result of the induced voltage, is such as to oppose the magnetic field which created it (see Fig. 2).

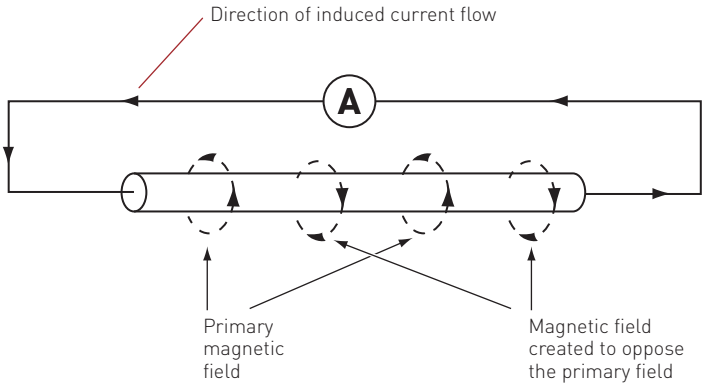


Fig. 2 Lenz's Law: opposing polarity of magnetic fields

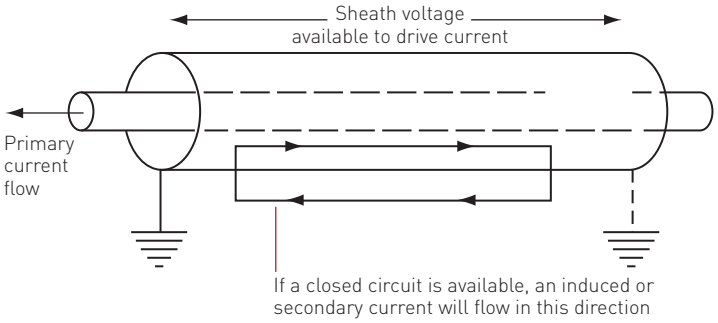


Fig. 3 Induced current in sheath

Fig. 3 shows the net result of the induction effect as applied to any metal-sheathed, single conductor cable.

The 60 Hz alternating current flowing in the conductor itself (termed primary current) generates a changing magnetic field which surrounds the entire cable assembly. That field then acts to induce a voltage in the metal sheath of the cable. If the metal sheath is grounded at more than one point, a closed circuit is available and the induced sheath voltage will cause an electric current to circulate through the sheath and grounding system.

The direction of the circulating sheath current is at all times in opposition to the flow in the primary conductor as a result of Lenz's Law.

Sheath voltages cannot be prevented. They arise from Faraday's Induction Principle and can be minimized only by proper grounding of the cable sheath. That, however, leads to sheath circulating currents as multiple grounds provide closed paths for sheath current to flow.

Sheath current magnitude is not dependent on cable length. Rather, it is a function of primary current magnitude, cable diameter, and sheath material. As length increases, so does the induced sheath voltage, and, in a compensatory manner, the total sheath electrical resistance. Since both voltage and resistance are directly proportional to length, the resulting sheath current, by Ohm's law, remains constant.

Sheath voltages can reach significant values, usually in the order of a few volts to tens of volts. Although not normally life threatening, the potentials can be sufficient to cause sparking under certain circumstances and can pose a serious danger in explosive atmospheres (Class I, II, or III hazardous locations). Even in nonhazardous environments, incidents of sheath-to-ground sparking can be unnerving to maintenance personnel and should be avoided.

Proper grounding of the sheath will minimize induced sheath voltages and prevent occurrences of sparking, but circulating currents will flow through the metal sheath via the grounding paths and can produce 1^2R heating of the cable sheath itself. In addition, the energy loss involved in producing the sheath heating effects are manifest in slightly increased voltage drop on the circuit that is supplied by the cables in ques-

tion. (Sheath heating due to circulating currents can be a serious problem. Derating may be necessary if conductor temperatures are to be kept to less than 90°C.)

Sheath voltages and currents tend to increase with increased spacing between the conductors of a circuit. This effect results from the concept of field cancellation: the closer together the conductors, the better the cancellation of the fields and the weaker the overall resulting magnetic field which surrounds all circuit conductors. Refer to Fig. 4.

Maximum cancellation occurs, of course, when the cables' sheaths are in actual contact. However, mutual heating effects of each conductor on the others must then be considered.

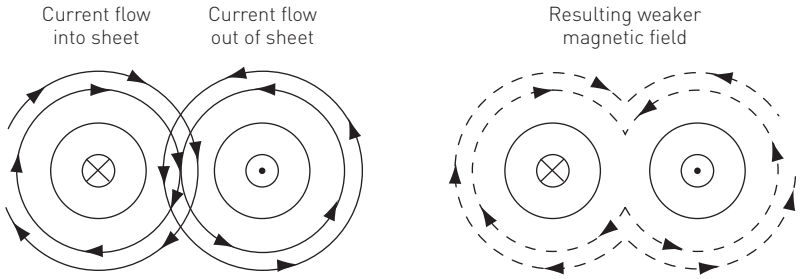


Fig. 4 Overlapping fields result in weaker magnetic field

OTHER MAGNETIC EFFECTS

Induced voltages resulting from alternating magnetic fields are the cause of a second type of circulating current. These currents (termed "eddy" currents) flow in the metal plates through which single conductor cables may enter a switchgear enclosure and result when voltages that generate secondary magnetic fields are induced by Faraday's Law. Refer to Fig. 5.

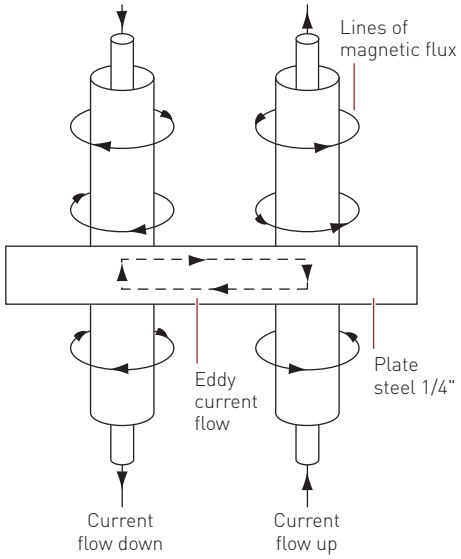


Fig. 5 Single conductor feeders with magnetic fields

Eddy currents do contribute to heating of the metal plates through I^2R losses. In this type of application, however, the losses tend to be low as a result of the relatively small cross-sectional area of the metal enclosure and need not be directly addressed. (In other applications, like those involving ferromagnetic cores, eddy current losses can be very large and are an important factor in total "iron" losses.)

Hysteresis loss is the third and final type of heating effect arising as a result of the changing magnetic field surrounding a single conductor cable.

Here, the magnetic field (alternating at two times 60 Hz) creates a similarly alternating magnetic field within the ferromagnetic metal (normally steel) making up the wall or plate through which the conductors enter an enclosure. In each cycle of magnetization, the molecules comprising the structure realign themselves in the

direction of the impressed field, and it is this realignment, with attendant frictional losses, that results in hysteresis heating.

The magnitude of the hysteresis loss is determined to a large degree by the magnetic flux density which exists within the metal. Magnetic flux density is a measure of the strength of the magnetic field; losses can be greatly reduced by limiting the flux density.

Note that hysteresis losses can occur only in ferromagnetic metals (e.g. iron, steel, nickel) as only these materials have magnetic permeabilities great enough to allow significant flux densities to develop. It is for this reason that metal-sheathed single conductor cables always incorporate sheaths of nonmagnetic material, copper in the case of MI cable, and copper or aluminum in the case of armored cable.

Steps can be taken to prevent hysteresis heating of cable entry plates:

- A nonmetallic plate made of an insulating material can be used in place of the usual steel entry.
- A replacement plate of nonmagnetic material (aluminum or brass) can be installed. Only ferromagnetic metals are subject to hysteresis heating; other metals cannot be magnetized and do not suffer losses.
- An air gap can be introduced into the magnetic circuit in which the magnetic flux exists. Its effect, because air has a very low magnetic permeability, is to drastically reduce the flux density in much the same manner as a large resistance limits current flow in an electric circuit. As discussed earlier, hysteresis losses are greatly dependent upon the magnitude of the flux density and they are, therefore, significantly lowered.

INSTALLATION RECOMMENDATIONS

The NEC and CEC both allow bundled single conductor MI cable to be sized according to the free air tables provided a spacing of 2.15 cable diameters is maintained between bundles.

The following recommendations regarding the installation of single conductor Pyrotenax MI cables are based on manufacturer's test data and on many years of in-service experience. For additional installation information contact Pentair Thermal Management.

- Single conductor cable is subject to 90°C (free air) ampacity rating. The 90°C ampacity rating may not be appropriate for all applications; for example, applications where there are high ambient temperatures or where jacketed cable is being used. Contact Pentair Thermal Management for additional information.
- Cables should be run in triangular or square bundles containing one conductor from each phase. Sheaths should be in contact throughout the run length. The neutral conductor in four-wire systems may be located within the bundle, or run separately. Cables are best bundled using stainless steel adjustable bands or banding kits, available from the manufacturer. Cables should be banded between supports according to the installation instructions shipped with the cable.
- Less preferable, but acceptable, are installations in which the conductors are laid flat under a common securing clip with sheaths in contact. Field cancellation is not as complete as in the case of triangular or square bundles and higher sheath voltages and circulating currents will result. In general, however, the incremental effect will be very small. Most important is that a common clip be used to maintain sheath contact.

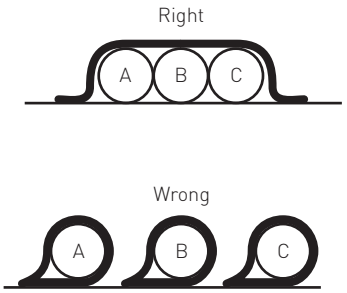


Fig. 6 Clips to maintain sheath contact

- To eliminate hysteresis heating effects, one of the following precautions must be taken (in the CEC, these rules apply only when conductor current exceeds 200 amperes):
  - Nonferrous metal entrance plates can be used at each end of the run. A 1/4-in thick brass plate with threaded entries is available, for MI cable, from Pentair Thermal Management.
  - In dry locations, slots can be cut between each of the phase conductors, such that all entry holes are joined by an air gap.
  - Nonmetallic entrance plates can be used at each end of the run. To provide proper equipment grounding, a separate bonding conductor must then be run, as the normal bonding route of the copper sheath will be isolated from the switchgear enclosure.
- Where either nonferrous or nonconducting entry plates are employed, bushings and locknuts must also be made of a nonferrous material to avoid hysteresis heating of the accessory. Mineral insulated cable gland connectors must also be made of a nonferrous material.
- For installations involving polymer jacketed cable, consult the manufacturer for specific instructions regarding cable spacing and derating factors to be applied.
- In hazardous locations, it is vital that sparking between cable sheaths or between sheath and ground does not occur. Therefore, it is recommended that either:
  - Cables be run with metal sheaths in contact and grounded at both ends to minimize sheath voltages.
  - Cables be jacketed and grounded at one end only to prevent circulating currents. Because sheath voltages cannot then be eliminated, the jacket must be continuous so that accidental shorting of the voltages cannot occur.

PARALLELING OF SINGLE CONDUCTOR CABLES

It is often necessary to employ more than one conductor per phase when dealing with very large current loads for reasons of conductor size, ease of installation, and cost. In so doing, it is incumbent upon the user to ensure that each of the conductors in a phase group carries its proportionate share of the total line current so as not to overload, and consequently excessively heat, the other conductors in the group.

The intent is to have each of the conductors in a phase group carry exactly the same current load by arranging the cables such that the AC impedance is identical from one conductor to another.

The electrical codes address the problem of ensuring balanced AC resistance in each of the conductors comprising a phase group:

- All conductors must be the same length
- All conductors must be the same size and the same material
- All conductors must have the same type of insulation
- All conductors must be terminated in the same manner

In addition, electrical codes stipulate that only cables in sizes #1/0 AWG and larger may be run in paralleled configurations.

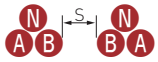
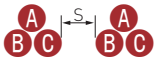
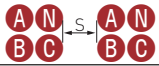
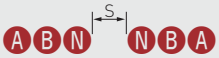
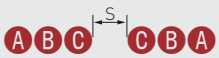
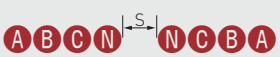
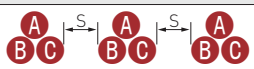
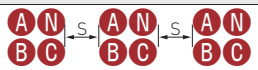
Balancing of inductive reactance is, in general, more difficult as the effects of cable spacing, relative position, and number of conductors per phase on the interacting magnetic fields can cause large differences in reactance that will measurably affect the division of current among conductors.

In all instances, it is necessary that the current balance be checked immediately after the cables begin to carry load. Load imbalances between conductors of up to 10% are tolerable and are to be expected. Greater imbalances between conductors of the same phase are of concern and warrant investigation.

It is recommended that single conductor cables be installed in the configurations shown in Fig. 7. These cable arrangements will result in the best overall impedance balance and consequently in the best possible current division when used in conjunction with the requirements of the electrical codes.

In reviewing Fig. 7, note that the neutral conductor may be located within or outside the cable group and that the spacing between groups of bundled cables should be at least 2.15 cable diameters in accordance with the NEC (US) and CEC (Canada) to maintain free air ratings without applying de-rating factors for number of conductors in contact. Most importantly, note that each group of cables must contain one conductor from each phase so as to minimize the resulting magnetic field encircling each bundle.

Few problems are normally encountered in dealing with three or fewer conductors per phase as long as recommended configurations are utilized.

	Single Phase	Three-Phase • 3 Wire	Three-Phase • 4 Wire
Single circuit (preferred)			
Single circuit (alternative)			
Two cables in parallel per phase (preferred)			
Two cables in parallel per phase (alternative)			
Three or more cables in parallel per phase (preferred)			
Three or more cables in parallel per phase (alternative)			

Note: For free air ampere ratings, the spacing "S" between bundles should be a minimum of 2.15 cable diameters in the U.S. (NEC), and Canada (CEC). For magnetic effect purposes, the neutral may be located as shown, or outside groups in the most convenient location.

Fig. 7 Installation configurations

ENGINEERING SPECIFICATION FOR THERMAL MANAGEMENT

Pentair Thermal Management web site www.pentairthermal.com.

For U.S.

- CSI Model Specification: Fire-Rated Wiring System (U.S.) MI H57821

For Canada

- CSI Model Specification: Fire-Rated Wiring System (Canada) MI H57824

The general format of the specification is shown below.

1 GENERAL

1.1 References

1.2 Submittals

1.3 Qualifications

1.4 Regulatory Requirements

2 PRODUCTS

2.1 Cable

2.2 Components

3 EXECUTION

3.1 Examination

3.2 Storage

3.3 Handling

3.4 Wiring methods

3.5 Installation

3.6 Field quality control

PENTAIR

PYROTENAX SYSTEM 1850 SIZE CHART

Cable reference
NEC Current Rating 75°C/90°C
CEC Current Rating 75°C/90°C
Termination size

16 AWG	**1/16-215** **–/24** –/– 1/2"	**2/16-340** **–/18** –/– 1/2"	**3/16-355** **–/18** –/– 1/2"	**4/16-387** **–(–)/18(14)*** –(–)/–(–) 1/2"	**7/16-449** **–(–)/14(13)*** –(–)/–(–) 3/4"
14 AWG	**1/14-230** **30/35** 30/35 1/2"	**2/14-371** **20/25** 20/25 1/2"	**3/14-387** **20/25** 20/25 1/2"	**4/14-465** **20(16)/25(20)*** 20(16)/25(20)* 3/4"	**7/14-496** **16(14)/20(18)*** 16(14)/20(18)* 3/4"
12 AWG	**1/12-246** **35/40** 35/40 1/2"	**2/12-402** **25/30** 25/30 1/2"	**3/12-480** **25/30** 25/30 3/4"	**4/12-465** **25(20)/30(24)*** 25(20)/30(24)* 3/4"	**7/12-543** **20(18)/24(21)*** 20(18)/24(21)* 3/4"
10 AWG	**1/10-277** **50/55** 50/55 1/2"	**2/10-449** **35/40** 35/40 3/4"	**3/10-480** **35/40** 35/40 3/4"	**4/10-590** **35(28)/40(32)*** 35(28)/40(32)* 3/4"	**7/10-621** **28(25)/32(28)*** 28(25)/32(28)* 1"
8 AWG	**1/8-298** **70/80** 70/80 1/2"	**2/8-512** **50/55** 50/55 3/4"	**3/8-590** **50/55** 50/55 3/4"	**4/8-590** **50(40)/55(44)*** 50(40)/55(44)* 3/4"	**7/8-710** **40(35)/44(39)*** 40(35)/44(39)* 1-1/4"
6 AWG	**1/6-340** **95/105** 95/105 1/2"	**2/6-590** **65/75** 65/75 3/4"	**3/6-621** **65/75** 65/75 3/4"	**4/6-730** **65(52)/75(60)*** 65(52)/75(60)* 1-1/4"	
4 AWG	**1/4-402** **125/140** 125/140 1/2"	**2/4-684** **85/95** 85/95 1"	**3/4-746** **85/95** 85/95 1-1/4"		
3 AWG	**1/3-449** **145/165** 145/165 3/4"	**2/3-768** **100/115** 100/115 1-1/4"	**3/3-834** **100/115** 100/115 1-1/4"		
2 AWG	**1/2-449** **170/190** 170/190 3/4"	**2/2-865** **115/130** 115/130 1-1/4"			
1 AWG	**1/1-496** **195/220** 195/220 3/4"	**2/1-975** **130/145** 130/145 1-1/4"			

* On 4 and 7 conductor cable, the higher ampacity applies if one conductor is used as a neutral.

Notes:
1. Current ratings are based on 30°C (86°F) ambient. For ambients in excess of 30°C (86°F), refer to electrical codes for the derating factors.
2. For 14 AWG, 12 AWG 10 AWG, refer to appropriate sections of NEC and CEC governing conductor overcurrent protection limitations.

Fig. 1 600 V power and control cables

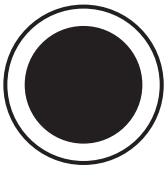
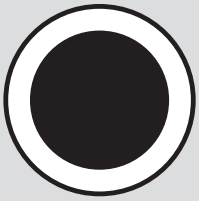
	Cable reference **NEC Current Rating 75°C/90°C** CEC Current Rating 75°C/90°C Termination size	
1/0 AWG	**1/1/0-512** **230/260** 230/260 3/4"	
2/0 AWG	**1/2/0-580** **265/300** 265/300 3/4"	
3/0 AWG	**1/3/0-621** **310/350** 310/350 3/4"	
4/0 AWG	**1/4/0-684** **360/405** 360/405 1"	
250 kcmil	**1/250-746** **405/455** 405/455 1-1/4"	
350 kcmil	**1/350-834** **505/570** 505/570 1-1/4"	
500 kcmil	**1/500-1000** **620/700** 620/700 1-1/4"	

Fig. 2 600 V power and control cables (continued)

	Cable reference Termination size	
	Twisted pair	**Shielded twisted pair**
18 AWG	**2/18-215T** 1/2" 	**2/18-324TS** 3/4" 
16 AWG	**2/16-246T** 1/2" 	**2/16-364TS** 3/4" 

Fig. 3 300 V twisted pair and shielded twisted pair cables

LIFE SAFETY ELECTRICAL CIRCUITS

This table shows the critical circuit to be protected, gives a summary of the relevant code requirements, and provides specific code article and clause references.

TABLE 1 CODE REFERENCES

Type of electrical circuit	NFPA requirements	2010 National Building Code (Canada)
Emergency Power Supply Generator to transfer switch, transfer switch to emergency distribution switch board	" ...be a listed electrical circuit protective system with a minimum 2-hour fire rating" NEC Article 700	"...all buildings within 3.2.6" Ref 3.2.7.8(3)(b)(i) 3.2.7.8(3)(b)(ii) 3.3.2.7.10(1 to 9)
Firefighter's elevator	"...be a listed electrical circuit protective system with a minimum 2-hour fire rating" NEC Article 700	"...all buildings within 3.2.6. over 36 m in height" Ref. 3.2.6.5(6)(a) & (b) 3.2.7.9(1)(a) 3.3.2.7.10(1) "...buildings designed for barrier free access – nonsprinklered"
Fire pumps	" ...be a listed electrical circuit protective system with a minimum 2-hour fire rating" NEC Article 695, NFPA 20	"...all buildings within 3.2.6." Ref 3.2.5.7. 3.3.2.7.10(1) Chapters 6 & 7 of NFPA 20
Pressurizing fans and smoke dampers	"...be a listed electrical circuit protective system with a minimum 2-hour fire rating" NEC Article 700 NFPA 101, Life Safety Code	"...all buildings within 3.2.6." Ref. 3.2.6.2(2) & (3) 3.2.7.9(1)(c) 3.3.2.7.10(1)
Smoke venting fans	" ...be a listed electrical circuit protective system with a minimum 2-hour fire rating" NEC Article 700 NFPA 101, Life Safety Code	"...all buildings within 3.2.6." Ref. 3.2.6.6 3.2.7.9(1)(d) 3.2.7.10(1)
Emergency power for lighting and exit signs	"...for safe egress... must also be sufficiently illuminated..." NEC Article 700.16 NFPA 101, Life Safety Code	"...all buildings within 3.2.6." Ref. 3.2.7.4(1)(a) & (b)(i) 3.2.7.10(1) 3.4.5.1(4)
Fire alarm	"...survivability... notification appliance circuit... a 2-hour rated cable or cable system..." NEC Article 760 NFPA 101, Life Safety Code NFPA 72, National Fire Alarm Code	"...all buildings within 3.2.6." Ref. 3.2.7.8(1), (3)(a) & (3)(b)(i) 3.2.7.10(1)

TABLE 1 CODE REFERENCES

Type of electrical circuit	NFPA requirements	2010 National Building Code (Canada)
Voice communication and firefighter's handsets	"...survivability... notification appliance circuit...a 2-hour rated cable or cable system..." NEC Article 760 NFPA 101, Life Safety Code NFPA 72, National Fire Alarm Code	"...all group B occupancies within 3.2.6." "...all other buildings within 3.2.6. over 36 m in height" Ref. 3.2.6.8 Ref 3.2.6.9(1)(2); 3.2.7.10(1) 3.2.7.8.(1)(3)(a), & (3)(b)(i)

TRADITIONAL FIRE PROTECTION METHODS

PROTECTION METHODS OF EMERGENCY ELECTRICAL CONDUCTORS

Introduction

Protection of the emergency electrical conductors is required by Building and Electrical Codes for high-rise buildings to ensure the provision of electrical power to emergency equipment in the event of a fire. The operation of these systems is critical to the life safety of the occupants of the building as well as for firefighting purposes. This protection is necessary due to:

- extended evacuation time in high-rise buildings
- reliance on building equipment for firefighting operations in high-rise buildings
- need to maintain operation of fire alarm systems and pressurization equipment

Fire-resistance ratings of 1-hour or 2-hours are required depending on national and local codes, the type of circuit, and the environment. In order to ensure that these systems will be provided with electrical power for the required period, the conductors providing emergency power must also be operational during this time.

The evaluation of construction methods was prompted by the fact that several fires in high-rise buildings have involved failure of emergency electrical conductors. While the electrical conductors were not directly involved in the fire, they were affected by exposure to the effects of fire from within the building. The failure of the emergency conductors resulted in an increased demand on the firefighting operations and endangered the lives of the occupants.

General

There are several methods used for the protection of emergency electrical conductors in high-rise buildings. These include the following:

- concrete encasement
- drywall, gypsum board
- concrete block
- UL/ULC fire-rated cables

Raceways Embedded in Concrete

This method of protection involves the installation of a raceway for the emergency conductors within the concrete such as in the floor or shear wall. Factors which affect the fire-resistance rating of this protection method are:

- type of concrete used
- thickness of concrete cover achieved in the field

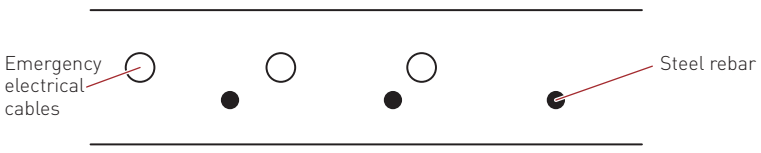


Fig. 1 Section through reinforced concrete slab

Traditional concrete floor slabs in high buildings range in thickness from 6 to 8 inches depending on the span and the type of concrete used. In Canada, for example, the National Building Code (NBC) requires that a minimum fire-resistance rating of 2 hours be provided for floor assemblies in high-rise buildings. In order to achieve this 2-hour rating, Table D-2.2.1.B. of the 1995 NBC requires a minimum cover to reinforcement of one inch (25 mm) for Type S, N, L40S, or L concrete. However, this cover to reinforcement may not provide the protection required for emergency electrical conductors which are exposed to fire.

When a concrete slab is exposed to a standard time-temperature curve (ASTM E-119), which is the basis of the fire-resistance ratings in North America, a grading similar to that shown in Fig. 2 (taken from the NFPA Fire Protection Handbook 17th edition) is achieved. From this figure, it can be seen that the temperature at the point approximately two inches below the exposed surface of the concrete, which would be the potential location of the emergency electrical conductors, has a temperature of approximately 357°C (675°F). While this may satisfy the requirements for a fire separation, it is unlikely that emergency conductors will withstand exposure to this heat. As such, the protection of emergency conductors by embedding raceways in concrete is dependent on the location of the conductors within the concrete itself. As well, the protection by concrete is subject to the spalling of concrete when a hot concrete slab is subjected to cold water from a firefighters' hose.

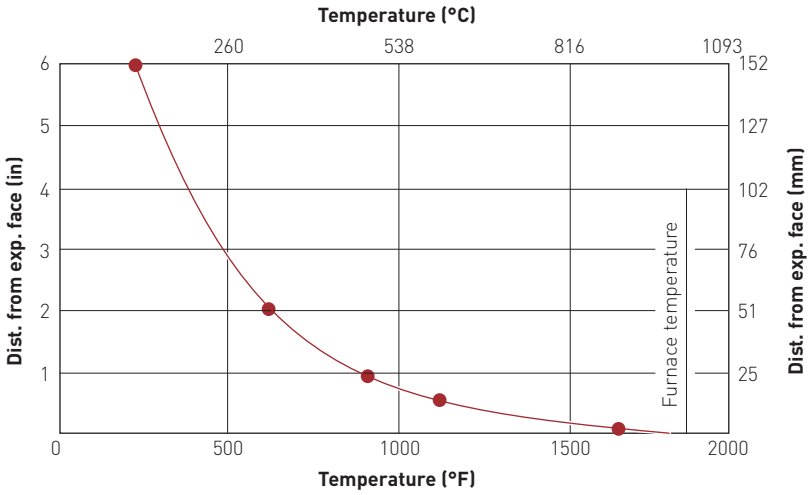


Fig. 2 Thermal gradient in a 6-in slab after 2-hour fire exposure

Drywall/Gypsum

Gypsum wallboard enclosures are used to protect emergency conductors in both the vertical and horizontal configurations. For example, in Canada, designers utilize a 2-hour listed wall such as ULC W404, or W406, or a shaft wall assembly which has been tested to CAN/ULC S101-M89 "Standard Methods of Fire Endurance Tests of Building Construction and Materials" to provide the 2-hour protection. To achieve a 2-hour fire rating, the conductors must be located within a shaft created by the wall, not within the cavity space of the wall, Fig. 3. If the installer places the conductors within the wall cavity space, the conductors are only protected by two layers of drywall rather than the entire tested wall assembly.

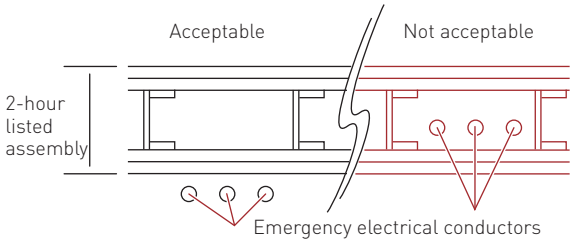


Fig. 3 Protection of emergency conductors using drywall/gypsum

In the event that a horizontal shaft wall is used for protection of conductors in a horizontal orientation, the protection must be by a horizontal shaft wall with drywall on both sides of the steel channels rather than just by two layers of drywall. As well, consideration must be given to the fire-stopping of the drywall on both the inside and outside joints of a horizontal shaft wall assembly.

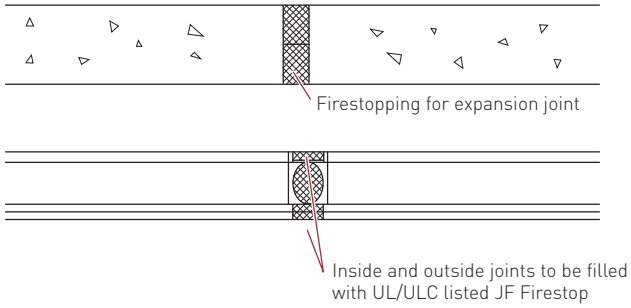


Fig. 4 Protection of expansion, and inside and outside joints

When using drywall protection, the following items must be taken into account:

- location of conductors inside of a shaft created by the entire drywall assembly (Fig. 3 left side) rather than within the wall cavity space (Fig. 3 right side).
- fire stopping of joints in the drywall
- electrical conductors crossing expansion joints in drywall assemblies which are subject to expansion and contraction
- protection of doors and access doors within these drywall enclosures; while walls and floors which are fire separations must not exceed an average temperature rise on the unexposed side of 140°C (284°F), access doors are not tested for temperature rise on the unexposed surface of the door

Concrete Block

When concrete block is used for protection of emergency conductors, it must be ensured that the conductors are located within a vertical service space created by the concrete block rather than within the block cavity itself, Fig. 5. If the conductors are located within the block cavity, the fire-resistance rating provided by half of the block will not provide the minimum protection required by the NBC (Canada).

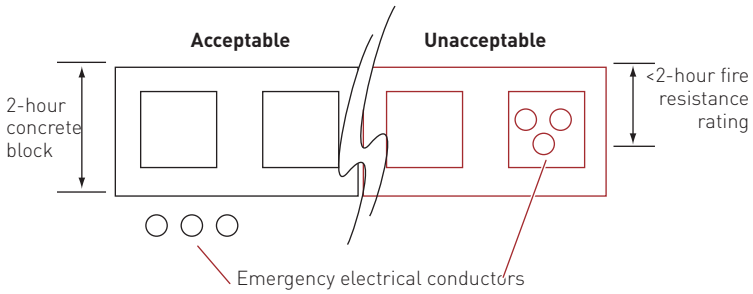


Fig. 5 Protection of emergency conductors using concrete block

UL/ULC Fire-Rated Mineral Insulated Cable

This cable is manufactured using only inorganic materials, copper and magnesium oxide. It does not burn, contribute fuel, or produce smoke when exposed to fire conditions. MI cable may be directly mounted, using clips and straps available from Pentair Thermal Management, on noncombustible surfaces such as concrete or masonry, or supported by steel rod and channel (trapeze) systems. The cable, clips, and straps have been subjected to the 2-hour fire test. In this test, the cables are required to maintain the voltage for the listed time. No additional protection is required for this cable, Fig. 6.

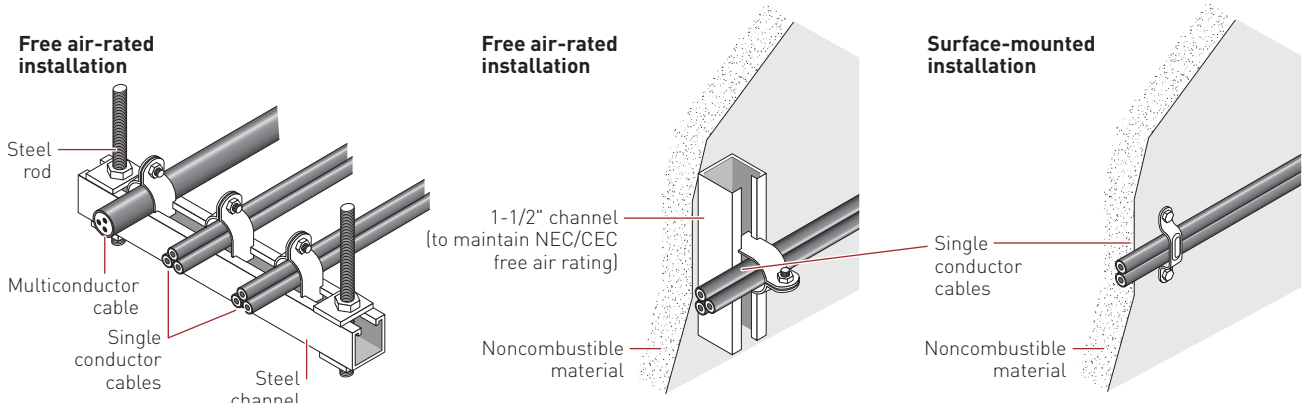


Fig. 6 MI cable installed on noncombustible surface

PYROTENAX MI SHEATH BONDING AND GROUNDING

The following tables present sheath resistance data for Pyrotenax System 1850 MI cables. Resistance values are given in ohms per thousand feet at 25°C (77°F). The last column in each table lists the equivalent grounding conductor size based on the sheath resistance.

Both the Canadian Electrical Code (Rule 10-804) and the National Electrical Code (Section 250.118(9) and Section 332.108) allow the sheath of copper sheathed mineral insulated cables to be employed as an equipment grounding conductor.

TABLE 1 SINGLE CONDUCTOR CABLE

Cable reference	Conductor size (AWG/kcmil)	Nominal sheath resistance (ohms per 1000 ft)	Equivalent grounding conductor size (AWG)
1/14-230	14	0.706	10
1/12-246	12	0.618	8
1/10-277	10	0.562	8
1/8-298	8	0.438	8
1/6-340	6	0.355	6
1/4-402	4	0.222	4
1/3-449	3	0.179	3
1/2-449	2	0.171	3
1/1-496	1	0.147	2
1/1/0-512	1/0	0.149	2
1/2/0-580	2/0	0.117	1
1/3/0-621	3/0	0.093	1/0
1/4/0-684	4/0	0.103	1/0
1/250-746	250	0.087	1/0
1/350-834	350	0.102	1/0
1/500-1000	500	0.073	2/0

TABLE 2 TWO CONDUCTOR CABLE

Cable reference	Conductor size (AWG)	Nominal sheath resistance (ohms per 1000 ft)	Equivalent grounding conductor size (AWG)
2/14-371	14	0.327	6
2/12-402	12	0.247	4
2/10-449	10	0.242	4
2/8-512	8	0.188	3
2/6-590	6	0.142	2
2/4-684	4	0.116	1
2/3-768	3	0.092	1/0
2/2-865	2	0.071	2/0
2/1-975	1	0.057	3/0

TABLE 3 THREE CONDUCTOR CABLE

Cable reference	Conductor size (AWG)	Nominal sheath resistance (ohms per 1000 ft)	Equivalent grounding conductor size (AWG)
3/14-387	14	0.231	4
3/12-480	12	0.140	2
3/10-480	10	0.140	2
3/8-590	8	0.104	1/0
3/6-621	6	0.102	1/0
3/4-746	4	0.071	2/0
3/3-834	3	0.057	3/0

TABLE 4 FOUR CONDUCTOR CABLE

Cable reference	Conductor size (AWG)	Nominal sheath resistance (ohms per 1000 ft)	Equivalent grounding conductor size (AWG)
4/14-465	14	0.155	2
4/12-465	12	0.217	4
4/10-590	10	0.117	1
4/8-590	8	0.117	1
4/6-730	6	0.075	2/0

TABLE 5 SEVEN CONDUCTOR CABLE

Cable reference	Conductor size (AWG)	Nominal sheath resistance (ohms per 1000 ft)	Equivalent grounding conductor size (AWG)
7/14-496	14	0.168	2
7/12-543	12	0.123	1
7/10-621	10	0.102	1/0
7/8-710	8	0.075	2/0

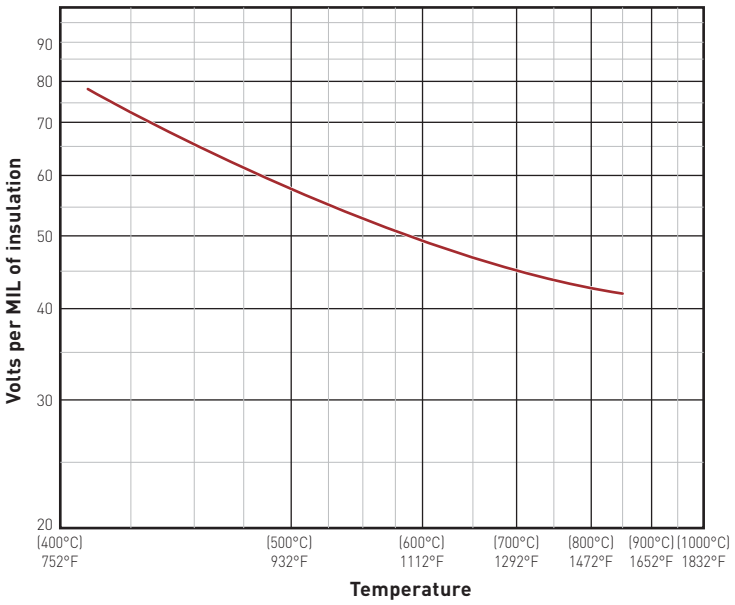
MAGNESIUM OXIDE INSULATION CHARACTERISTICS

MOISTURE PENETRATION

Magnesium oxide is hygroscopic, resulting in the uptake and retention of moisture under certain humidity and temperature conditions. When MI cable is not properly sealed and is subjected to these conditions, moisture penetrates several inches into the insulation, thereby reducing the insulation resistance. Pentair Thermal Management's tests confirm that the moisture will not penetrate further into the cable and can be removed by applying heat to the cable to force the moisture out the open end. The insulation resistance will be restored once the cable has been dried and sealed.

DIELECTRIC STRENGTH

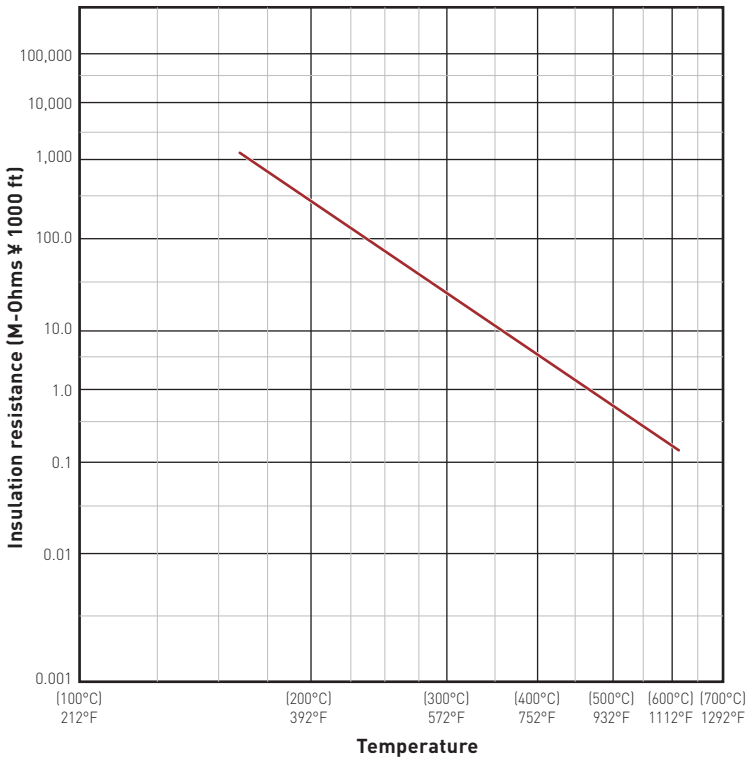
Although the dielectric strength of magnesium oxide insulation decreases with temperature, because of the way MI cables are constructed this decrease has no detrimental effect on cable functionality.



Graph 1 Dielectric strength of MI cable as a function of temperature

INSULATION RESISTANCE

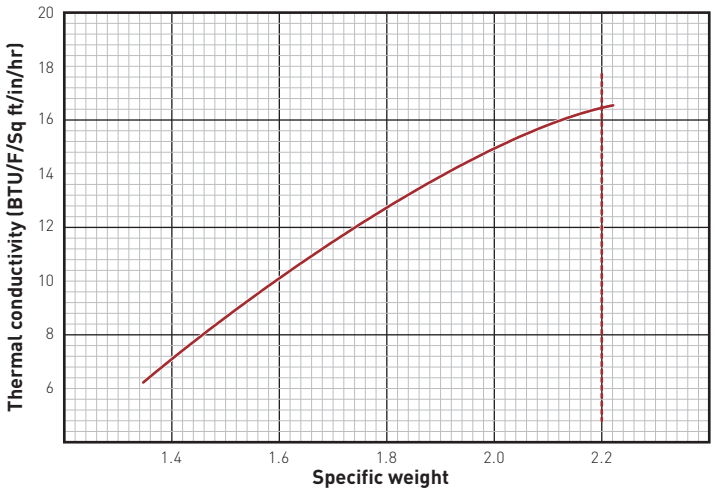
The insulation resistance of magnesium oxide decreases with increasing temperatures as shown. This decrease is unimportant at temperatures up to 250°C (482°F), the maximum continuous operating temperature of MI cable.



Graph 2 Insulation resistance of MI cable as a function of temperature

THERMAL CONDUCTIVITY

Unlike most electrical insulations, magnesium oxide has a relatively high thermal conductivity. This enables the heat to be quickly conducted from the outside sheath and dissipated to the -surrounding air. This conductivity increases when magnesium oxide is compacted. The -manufacturing process produces a specific weight of approximately 2.2 and a thermal conductivity of 16.4 BTU/°F/sq ft/in/hr.



Graph 3 Thermal conductivity of magnesium oxide at different levels of compaction

POWER FACTOR

The power factor of magnesium oxide insulation is very low compared to that of most electrical cable insulations. When measured at room temperature, 60 Hz and 40 volts per mil, it is approximately 0.1%. This value increases with temperature to approximately 1.0% at 250°C (482°F).

DIELECTRIC CONSTANT

The dielectric constant is approximately 4 over a range from 60 Hz to 400 MHz and is relatively constant up to 300°C (572°F).

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