

## CHAPTER 8 INCREASED SAFETY TYPE 'e' PROTECTION DESIGN CONCEPTS

*"Because of the requirements for separation of conductors, it is unlikely that wire nuts will be acceptable under the increased safety standard. This will prevent their use in the Zone concept using increased safety wiring techniques which is a major departure from current wiring methods in North America."*

— PCIC 1996 General Session Paper

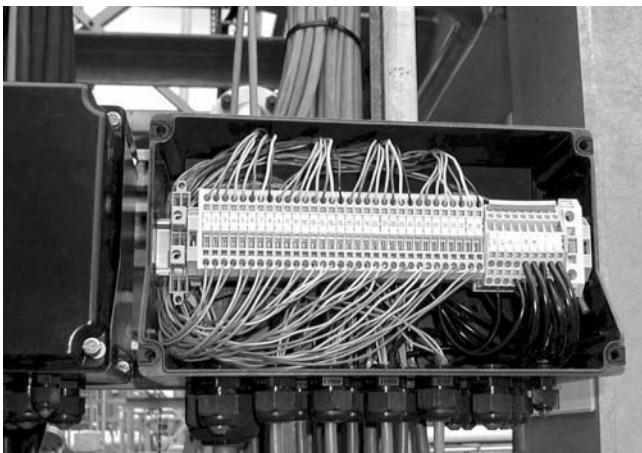
### 8.1 Ex-e ENCLOSURES

General requirements for increased safety, Ex-e, enclosures are: ingress protection to at least IP 54 and additional tests for nonmetallic parts including thermal endurance, resistance to solvents, ultraviolet light, surface conductivity and mechanical resistance to impact of either 4 or 7 joules depending on the size of the enclosure. The increased safety concept is only suitable for non-sparking apparatus and is commonly used in Zone 1 and 2 designated hazardous areas.

### 8.2 Ex-e TERMINALS

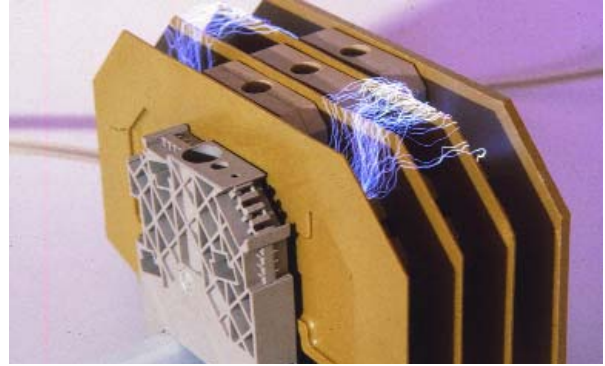
General requirements for terminals are:

- They must be designed to allow the conductor to be easily inserted and clamped, so that contact pressure is maintained without reducing the cross sectional area of the conductor and shall incorporate a positive locking device to prevent conductors working loose by vibration.
- Specified creepage distances as detailed in EN 50-019 and IEC 60079-7 for the grade of insulation material (CTI) and subsequent maximum voltage rating.
- Temperature limitation
- Current de-rating of the terminals (and conductors)

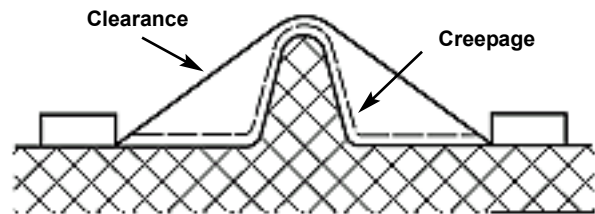


Cooper Crouse-Hinds SpecOne GHG 74 series of Ex-e terminal boxes house between 1 and 300 terminal blocks.

Tracking occurs when the insulation surface deteriorates or becomes contaminated causing a leakage current flow between live terminals to earth. Leakage currents causes minute arcs on the insulator surface which degrades the material until failure. In the example below, the voltage applied to the terminals is several thousand volts higher than the terminal maximum voltage rating to illustrate the possible effect of tracking between live parts.



IP ratings are important so to prevent water ingress and other contaminants from causing terminal blocks to arc.



*Creepage Distance: The shortest distance between live parts, or live parts to earth over the surface of the insulation material. Creepage distance follows the contour of the groove. Clearance distance: the shortest distance in air between live parts or live parts to earth. Clearance distance is the "line of sight" distance.*

### 8.3 LIGHTING CIRCUITS IN EX-e ENCLOSURES

There are other commonly used terminals such as "U" slotted type which permit more than one conductor per clamp. These are commonly used for lighting circuits. It is not advisable to insert conductors of different cross sectional areas in the same terminal clamp. It is permitted to combine different cross sectional areas of two conductors with the use of a ferrule designed for this purpose.

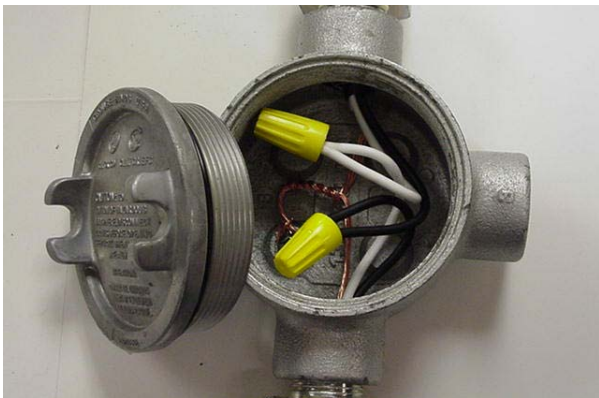


*The Crouse-Hinds eZAK box with U-slotted terminals is ideal for lighting circuits.*

*Wire nuts and twist-on connectors are not allowed in Ex-e installations.*

### 8.4 NEW INCREASED SAFETY WIRING PRACTICES

Presently, Ex-e connections are made at Ex-e terminal blocks fastened in junction boxes. While this method is a common practice in Europe, it is only used in North America for instrumentation, control and telecom installations. The most common termination method is made via twist on connectors or "wire nuts." There exists an opportunity for the construction market and with OEMs for an Ex-e type wire nut. For example, to obtain a Zone 1 light fixtures, a manufacturer would have to redesign the internal wiring by eliminating wire nuts and installing Ex-e terminal blocks. The fixture would have to be redesigned to gain extra room and additional material costs.



*Wire nuts are not allowed in Ex-e applications,*

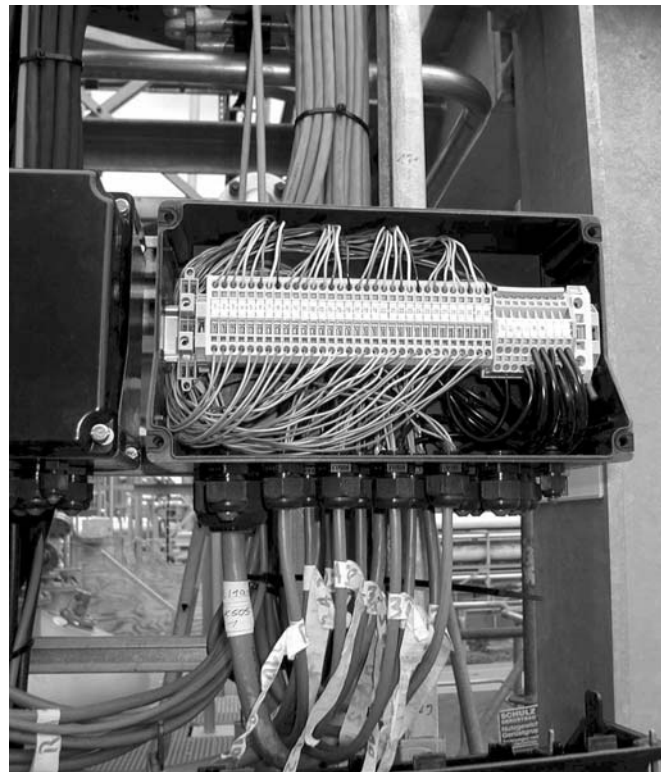


*Conductors must be terminated at Ex-e connections*

*For instrumentation circuits and other low current applications (not exceeding 8 amps), it is highly unlikely that there will be any significant temperature rise under normal operating conditions.*

### 8.5 COMBINATION OF TERMINALS & WIRING – WATCH FOR HEAT DISSIPATION

The combination of wire and terminals in an enclosure will produce a temperature rise under load conditions. Care must be taken during installation to ensure that the heat dissipated by this combination does not exceed the maximum temperature classification of the enclosure. The maximum wattage of the enclosure should be clearly marked on the enclosure.



*Each Crouse-Hinds SpecOne terminal box has maximum heat dissipation tables embossed on the inside cover.*

For instrumentation circuits and other low current applications (not exceeding 8 amps), it is highly unlikely that there will be any significant temperature rise under normal operating conditions. For power circuits care must be taken not to exceed the manufacturers installation instructions by following the manufacturer's tables of permitted terminal population relative to the load current.

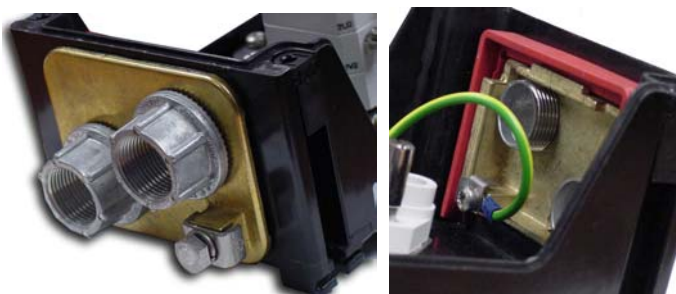


*Excessive heat from high current will damage enclosures*

**8.6 GROUNDING (EARTHING) OF EX-e TERMINAL BOXES**

Certified Ex-e terminal boxes must be provided with an internal or external ground connection of an adequate size for the wiring configuration. (Ex-e terminal boxes are not designed to carry earth fault currents.) The main internal/external ground connection must be connected to the main system earth with the correct coded wire of adequate size but not less than 4 mm<sup>2</sup>. All exposed metal parts must be grounded together and to the main ground terminal. Guidance on the ground conductor size is detailed below:

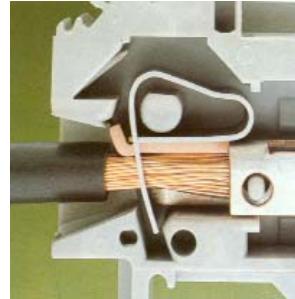
<b>Cross-sectional area of area phase conductor S (mm<sup>2</sup>)</b>	<b>Minimum cross-sectiona of ground conductor S (mm<sup>2</sup>)</b>
S ≤ 16	S
16 ≤ S ≤ 35	16
S ≥ 35	0.5 S



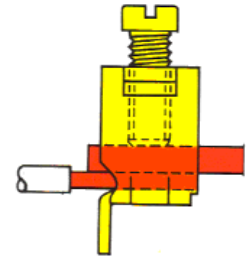
*Cooper Crouse-Hinds provides internal and external ground lugs on brass plate inserts.*

**8.7 TERMINAL CONNECTION SYSTEM**

The primary function of a connection system is an efficient electrical and mechanical connection of the conductor. Ex-e terminals employ a clamping yoke or clamp that holds the conductor firmly in the clamping unit. The yoke systems are screwed in while the clamp system is referred as cage clamps. Both perform equally well to ensure a secure vibration resistant connection of conductors.



*Terminal clamp system*



*Terminal screw system*

**8.7.1 TERMINATING SPARE CONDUCTORS**

The termination of spare conductors is handled differently under the IEC and North American wiring methods.

IEC 60079-14 (Installations), subclause 9.1.2 states "In hazardous areas each unused core in multi-core cables shall either be connected to earth or be adequately insulated by means of suitable terminations. Insulation by tape alone is not recommended." Terminating the spare conductor onto an Ex-e terminal is recommended since the conductor could be used later as an active terminal.

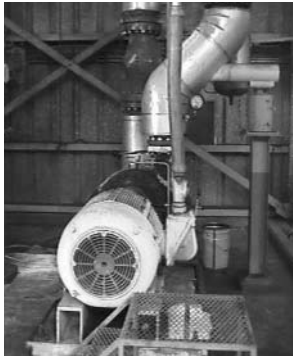
In the NEC, 110.14(B) states, "...All splices and joints and the free ends of conductors shall be covered with the insulation equivalent to that of the conductors or with an insulating device identified for that purpose." The insulation could be a heat-shrink rated for 600V. Electrical tape would not qualify. The device could be a terminal or suitable twist-on connector. This section applies to ordinary locations.

### 8.8 IMPORTANT CONSIDERATIONS OF EX-e TERMINALS

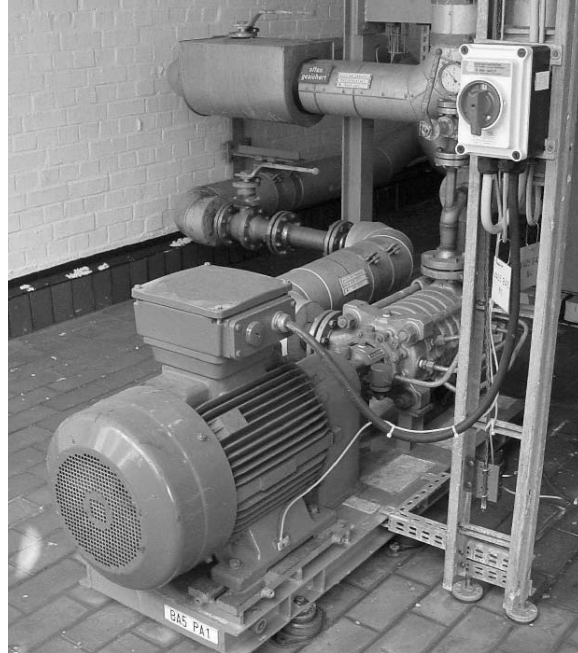
- Use conductors of the appropriate size as designated by the terminal. E.g. for a 2.5 mm<sup>2</sup> terminal, the maximum conductor size is 2.5 mm<sup>2</sup>. Normally, the manufacturers also advise the AWG size of the conductor that is 28-12 AWG for 2.5 mm<sup>2</sup>. If a larger conductor is used, the creepage & clearance distances could be reduced.
- The conductor insulation must be carried right up to the terminal throat within 1 mm of the clamp.
- Normal industrial ratings of the terminal and conductor are derated.
- Unless otherwise specified, only one conductor per terminal clamp is permitted.
- If flexible, fine stranded conductors are used, care must be taken to avoid whiskering of the strands that can reduce the creepage and clearance distances. The use of ferrules is recommended to avoid this problem.

### 8.9 INCREASED SAFETY EX-e MOTORS

The installation of Ex-e motors for Zones 1 & 2 have the same requirements as that for any other type of Ex-e protected apparatus with respect to connecting cables to terminals and connection of the motor frame to ground. The use of flexible conduits is recommended over rigid conduit due to vibration that could crack the threads.



*Cooper Crouse-Hinds ECGJH flexible connectors are used for motor applications rated for hazardous industrial areas.*



*An Ex-de motor in Zone 1, installed with flexible wiring, connected to a Cooper Crouse-Hinds non-metallic Ex-de motor disconnect switch.*

Type 'e' motors are not flameproof or designed to contain or withstand an internal explosion. They are designed to ensure that there is not arcing or sparking in normal operation and that the temperature rise on all parts exposed to the atmosphere are controlled to within specified limits. Only 3-phase induction motors are considered in this section. The T class is normally T2 or T3, and the motors are intended for continuous running operation. They are not suitable for frequent starting or long run-up times. It is important to consider the danger of transient high temperatures if the motor is in a locked rotor condition. During this time the temperature could rise above the designated T number.

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