EATON | Electrical

The Power Sheet

Consulting Engineer Edition

ENCLOSED MOTOR CONTROL

INTRODUCTION

Enclosed motor control is used extensively in commercial buildings, industrial facilities and wastewater treatment plants. The applications and uses vary greatly and thousands of project specific designs are manufactured every year. This article will define standards and specification issues to assure your project is manufactured to your requirements.

CHICAGO SERVICE CENTER

The Eaton Electrical main motor control center (MCC) plant is located in Fayetteville, NC. In addition to this main assembly plant, eight "mini" MCC plants, known as **Service Centers**, are located throughout the United States. The service center helping the Wisconsin and Upper Peninsula of Michigan is located Des Plaines, Illinois (a northern suburb of Chicago). The Service Center is highly responsiveness and flexible to specific customer needs.

Complete assembly and testing of all motor control needs are performed. This includes:

- Freedom Motor Control Centers
- IT 24 volt DC Motor Control Centers
- Standard Enclosed Control
- Specialty Enclosed Control
- Existing retrofit of Cutler-Hammer and Westinghouse MCC buckets

The Chicago Service Center specializes in custom motor control designs. Further, this is a UL rated manufacturing facility. No application design is beyond the service center's capabilities.

UL STANDARDS

The governing standard for enclosed motor control is **UL 508** which defines the requirements for industrial control panels. The scope of this UL standard covers industrial devices used for "starting, stopping, controlling, regulating, and protecting electric motors". Specifically, this includes motor starters, overload relays, selector switches, pilot lights, controls relays, control switches (floats, pressure, etc), and proximity switches.

In 1999, UL added the **698A** standard. This standard was created to define requirements for general use industrial control panels mounted in unclassified locations with intrinsically safe circuits extending into UL defined Hazardous Locations of Classes I, II, or III.

An example application of this panel definition is a waste treatment plant where a panel is mounted in a control room, but has a float switch extending into a raw waste well. The waste well will have flammable gases where the float switch is mounted.

The **UL 698A** standard requires that intrinsically safe wiring be segregated or in a separate raceway from the control ***and*** power wiring within the panel. The intent is to prevent currents and voltages from igniting the hazardous gases/vapors/liquids in the safe area.

Special attention given to the devices connected with intrinsically safe circuits in a hazardous location, assuring that the devices do not exceed the ratings of the intrinsically safe barriers, as specified a panel control drawing.

In addition to the UL Listing Mark, manufacturers covered under UL 698A are required to label panels **"Enclosed Industrial Control Panel Relating to Hazardous Locations with Intrinsically Safe Circuit Extensions."**

EATON ELETRICAL BUILDS CUSTOM ENCLOSED CONTROL at SERVICE CENTERS LOCATED THROUGHOUT the US and CANADA

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CLASS I FLAMMABLE GASES, VAPORS or LIQUIDS		CLASS II COMBUSTIBLE DUSTS	CLASS III IGNITABLE FIBERS and FLYINGS
Division 1 **Ignitable concentrations of gases/vapor/liquids are present under normal working conditions**	**Zone 0** **Flammable gases/ vapor/liquids are *continuously* present during normal operation** **Zone 1** **Flammable gases/ vapor/liquids are *likely* to exist during normal operation**	**Division 1** **Ignitable dust concentrations *are present* under normal operating conditions**	**Division 1** **Easily ignitable fibers producing combustible flyings are manufactured, handled, or used**
Division 2 **Ignitable concentrations of gases/vapor/liquids are *not* present under normal working conditions**	**Zone 2** **Flammable gases/ vapor/liquids are *not likely* present during normal operation**	**Division 2** **Ignitable dust concentrations are *not likely* present under normal operating conditions**	**Division 2** **Easily ignitable fibers are stored or handled**

TABLE 1—UL Hazardous Location Service Classifications

To define and classify the hazardous locations, UL defines three classes, with subdivisions, to describe the level of hazard. These are detailed in **Table 1** above.

Further, UL has defined protection requirements for electrical control panels for service in hazardous locations.

As detailed in Table 2 (on the following page), the enclosure and wiring requirements follow the hazardous classification and subdivision. These general requirements are then applied to define the specific NEMA enclosure and NEC requirements.

INTRISICALLY SAFE CIRCUITS

In simple terms, **intrinsically safe equipment** limits the allowable electrical energy below levels that can cause an explosion within a control panel. This is accomplished either by, first, separating the wiring using barriers between control panel wiring and wiring extending to areas where flammable/combustible materials are present.

A second means to accomplish an intrinsically safe barrier is to provide a grounded barrier. The rules for intrinsically safe grounding are:

- Ground path must have a resistance of less than one (1) Ohm
- Ground conductor must be 12 AWG or greater
- Grounding paths must be permanent, visible, and able to be inspected
- Ground must be separate, isolate, and of different potential from the normal system ground

One note, Intrinsically safe circuits and NEC Class 2 are not the same. Further, an intrinsically safe circuit is necessarily an NEC Class 2 circuit. Class 2 wiring requires both shock protection for personal ***and*** not be a source of ignition should a fault occur, where intrinsically safe circuits only require the latter.

NEC WIRING CLASSIFICATIONS

NEC includes three wiring classifications: Class 1, Class 2, and Class 3. A simplified definition of the three classes of

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CLASS I PROTECTION		CLASS II PROTECTION		CLASS III PROTECTION	
Area	**Protection Method**	**Area**	**Protection Method**	**Area**	**Protection Method**
DIV 1	· Explosion proof · Intrinsically Safe · Purged/Pressurized	**DIV 1**	· Dust Ignition proof · Intrinsically Safe · Pressurized	**DIV 1**	· Dust Tight · Hermetically Sealed · Intrinsically Safe
DIV 2	· Hermetically Sealed · Fire Resistant Enclosure · Non-Sparking · Purge/Pressurized · Or Class I, Div 1	**DIV 2**	· Dust Tight · Hermetically Sealed · Pressurized · Fire Resistant · Or Class II, Div 1	**DIV 2**	· Fire Resistant · Or Class III, Div 1

TABLE 2—UL Hazardous Location Protection Methods

wiring are listed below. This is not a substitute for detailed descriptions.

NEC requirements, rather an understanding of enclosed control panel wiring specifications.

- Class 1 – Power Wiring: Either with or without a power limiting source
- Class 2 – Circuits limited to voltage and current values to prevent shock and fire hazard
- Class 3 – Limited voltage and current values but ***higher*** than the limits allowed by Class 2

Note that Class 1 power wiring cannot share the same raceway as Class 2 wiring.

NEMA CLASSIFICATIONS

Table 3 is a comparison of typical applications for non-hazardous indoor locations. Several clarifications of the NEMA ratings are below:

- NEMA 4X is a non-metallic enclosure
- NEMA 6P provided prolonged submersion protection over NEMA 6
- NEMA 12K is a NEMA 12 enclosure with knockouts

304 STAINLESS STEEL or 316 STAINLESS STEEL?

304 stainless steel is versatile and widely used metal for enclosures. 304 offers good corrosion protection and is durable at low temperatures. However certain chemicals, salts, chlorides and acids will corrode enclosure constructed of 304 stainless steel.

316 stainless steel is a higher grade steel than 304 stainless steel. For most applications, 316 stainless steel offers better corrosion resistance to most chemicals, salts, and acids in addition to marine environments. 316 steel should be considered over 304 steel in wastewater treatment plants, food processing plants, pulp and paper plants, and other industrial facilities where harsh chemicals and wash-down procedures are used.

ENVIROLINE SAFETY SWITCH

The Eaton Electrical **EnviroLine** NEMA 4X stainless steel include a stainless steel operating mechanism as well as a stainless steel enclosure. A non-metallic NEMA 4X version also is available.

An optional feature of the Enviroline is a viewing window allowing personal to verify the position of the safety switch without opening the switch. This adds personal protection in environments where the switch door cannot

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ENVIRONMENTAL CONDITIONS	TYPE of NEMA ENCLOSURE									
	1	2	4	4X	5	6	6P	12	12K	13
Incidental Contact with Enclosed Parts	•	•	•	•	•	•	•	•	•	•
Falling Dirt	•	•	•	•	•	•	•	•	•	•
Falling Liquids and Light Splashing		•	•	•	•	•	•	•	•	•
Circulating Dust, Lint, Fiber			•	•		•	•	•	•	•
Settling Airborne Dust, Lint, Fiber			•	•	•	•	•	•	•	•
Hosedown and Washdown			•	•		•	•			
Oil or Coolant Seepage								•	•	•
Oil or Coolant Spraying/Splashing										•
Corrosive Agents				•			•			
Occasional Temporary Submersion						•	•			
Occasional Prolonged Submersion							•			

TABLE 3— COMPARISON of NEMA ENCLOSUES for INDOOR LOCATIONS

be safely opened, for example wet wash down areas.

The EnviloLine is especially rugged in outdoor environments where condensate is an issue, such as waste water treatment plants.

NEMA 7/9

NEMA 7 and NEMA 9 apply to **Hazardous gas locations (NEMA 7)** and **Hazardous Dust locations (NEMA 9).** Left, Picture 1, is a NEMA 7 and 9 rated enclosed combination starter.

The Eaton Electrical IT 24 VDC starter line offers the smallest enclosure in the industry ***and*** offering Arc Flash safety as control is below the 50 volt threshold required by NFPA 7-0E.

Eaton Electrical is the only manufacturer that makes a NEMA 7/9 **soft start** without special enclosure modifications.

PICTURE 1—NEMA 7/9 COMBO STARTER