ELECTRICAL ENCLOSURE Selection guide

http://waterheatertimer.org/Safe-electric-wiring.html

XL CATLIN

GAPS Guidelines

GAP.5.13.1

A Publication of Global Asset Protection Services LLC

INTRODUCTION

Electrical enclosures that are poorly maintained, unsuited to the environment, or inadequately ventilated or cooled are hazardous. They can lead to injury, electrical breakdown and severe property damage. Enclosures built to National Electrical Manufacturers Association (NEMA) specifications and maintained by comprehensive electrical preventive maintenance (EPM) programs protect electrical components within and safeguard system performance.

Descriptive names for electrical enclosures include junction boxes, cutout boxes, disconnect enclosures, pushbutton enclosures, consoles, electrical cabinets, industrial control panels, motor control centers, wireways, troughs, instrument enclosures, electronic rack enclosures, secondary bus enclosures, and hazardous location enclosures. Most are metallic, although molded plastic enclosures are used where high corrosion resistance characteristics are required.

This guideline introduces basic property loss control considerations for selecting and maintaining common nonrotating equipment enclosures. Many of the principles also apply to the other types of enclosures.

POSITION

Use electrical enclosures that conform to the National Electrical Code® (NEC), meet NEMA specifications and are listed or classified by a suitable independent testing laboratory.

Locate electrical enclosures in clean, dry, noncorrosive and nonflammable atmospheres unless enclosures are specifically designed for these adverse conditions. Make sure the ambient temperature is suitable for all components and the enclosures are mechanically secure. If enclosures are accessible to unauthorized personnel, ensure that the construction of the enclosures deters tampering. Shut down, clean, inspect and test each electrical system every three years. Service conduit seals and gaskets as necessary to keep them functional. Refinish or replace corroded parts. Follow other electrical preventive maintenance recommendations as described by manufacturers and NFPA 70B. In general, make sure the area and equipment are free from:

- Condensation
- Ice buildup
- Corrosion
- Contamination
- Explosive gases
- Unauthorized access
- Entry by animals, including rats, snakes, birds and squirrels

Provide all enclosures with appropriate conductor entry fittings, as recommended by the manufacturer, to maintain environmental capability and protect conductors. Such information is usually available on product information sheets.

Keep enclosure covers and doors closed when equipment is operating. There are three exceptions. This recommendation does not apply:

- When performing IR surveys
- When performing inspections
- When manufacturers instructions permit otherwise, as is the case with equipment having a second stated power rating based on running the equipment with covers removed.

GAP.1.3.1 recommends annual, quarterly and weekly infrared (IR) surveys of electrical equipment. During these surveys, electrical equipment is opened and thermographically scanned while the equipment is being operated so that hot spots and thermal trends can be identified. Construction and hazardous conditions will rule out opening some enclosures.

Open enclosures having covers that can be safely and readily opened during IR surveys to look for loose connections, poor contacts, phase imbalance and overloads. While covers are open, inspect these devices visually.

Adequately ventilate or cool electrical enclosures. Keep vent openings clean, maintain adequate free space for natural air circulation and cooling, and keep heat transfer systems operable. Follow manufacturer's installation and operating instructions.

Never operate electrical equipment beyond design ratings. When doing maintenance surveys, view certain operating conditions with suspicion. Perform an analysis if equipment is operating while an enclosure door is left open, or while a portable fan blows air across electrical components, or while other unusual methods, not specified by the manufacturer, are used to keep equipment cool. These measures might have been taken because equipment is occasionally operated overloaded.

Maintain the integrity of enclosures designed for use in hazardous (classified) locations described in the NEC by providing a program that includes periodic inspections, testing and servicing. Make sure only personnel specially trained in maintaining hazardous location electrical equipment perform such work. Special maintenance tasks include: analyzing the potential for ignition caused by surface temperatures, energized equipment and stored electrical energy; using special nonsparking tools; examining seals that prevent the spread of hazardous atmospheres; and performing repairs following manufacturer's guidelines. Pay special attention to enclosures of explosion-proof electrical equipment. Usually, foreign objects on mating surfaces, missing bolts, improper torque on bolts, or dents or abrasions on enclosure surfaces make this equipment unsafe.

Whenever possible, repair enclosures designed for use in hazardous locations outside the hazardous area. For fixed or permanent installations:

- Disconnect the electric power supply using lock out, tag out procedures.
- Remove vapor and gas sources to allow reclassifying the area while maintenance is performed. Make the work area atmosphere suitable for using ordinary electric equipment.
- Reinstall enclosures and seals before introducing vapor and gas sources.
- Reconnect power only when it is safe to do so when the work is complete.

A plastic enclosure may be used without overhead sprinkler protection if:

- The enclosure is not directly exposed to any combustible construction or occupancy that can become a severe ignition source.
- The enclosure is listed or classified for electrical system use.
- The electrical service is at 600 V or less.
- The quantity and arrangement of plastics in the electrical system is not likely to spread or sustain combustion.

DISCUSSION

Enclosures Specified by the NEC

To safeguard people and property, the NEC requires enclosing certain electrical devices, including those that arc or spark. NEC further requires some enclosures to be listed, some to be grounded and all to be sized based on the spacing required for components. NEC requires certain enclosures to be "dead front." These enclosures have no uncovered live parts to expose operating personnel. Although NEC has these and other specific requirements, it generally allows manufacturers and listing agencies to set their own criteria for enclosure performance and construction.

NEMA Enclosures

NEMA, a large U.S. trade association of electrical equipment manufacturers, sets and publishes voluntary standards for electrical equipment manufactured and used in the U.S. The standards define minimum equipment construction requirements and manufacturing tests, and they provide a reliable method of describing enclosure capabilities.

One such document is NEMA 250. NEMA 250 describes an electrical enclosure as a surrounding case to protect enclosed electrical equipment against specified environmental conditions, and to also protect personnel against contact with internal electrical parts and operating mechanisms. NEMA 250 enclosures come in various sizes, shapes and constructions to serve specific applications. These enclosures may contain fuses, switches, wires, cables, microprocessors, terminal strips, instruments and various other electrical devices or connections.

NEMA 250 does not describe enclosures for rotating machines or for major assemblies. The enclosing tank of an oil-insulated transformer is part of a major assembly and is covered by a specific product standard for the complete unit.

NEMA enclosures meet the design, labeling and testing requirements of the appropriate NEMA standard. A "type" category listed on NEMA nonrotating equipment enclosures describes built-in protection against an external environment. As an example, Type 4X enclosures may be used outdoors where exposed to windblown dust and rain. Table 1 provides further examples based on definitions in NEMA 250.

A NEMA rating is a manufacturer's statement that the manufacturer followed NEMA construction specifications. A NEMA enclosure will not always protect equipment against the environment, because manufacturing and listing tests do not weigh the extreme limits of perils. For example, windblown rain can descend at a more damaging angle than the directed waterspray specified for the qualifying test in the NEMA standard. As another example, ice buildup during a storm can be more severe than icing conditions the designer originally envisioned when designing the enclosure.

TABLE 1
Capabilities of Qualified NEMA Enclosures

NEMA 250 Enclosure Type	Use	Provides Limited Protection For Enclosed Equipment Against:
1*	Indoor	Contact (incidental contact with enclosed equipment); limited amounts of falling dirt if enclosure is not ventilated.
2*	Indoor	Contact; limited amounts of falling water and dirt; light splashing. (Enclosure may have vent openings and still meet requirements.)
3	Outdoor	Contact; windblown dust; rain; snow; sleet; external ice formation. (External mechanisms may not be operable when ice covered.)
3R*	Outdoor	Contact; rain; snow; sleet; external ice formation. (External mechanisms may not operate when ice covered.) (Enclosure may have vent openings and still meet requirements.)
3S	Outdoor	Contact; windblown dust; rain; snow; sleet; external ice formation. (External mechanisms will be operable when ice covered.)
4	Indoor/Outdoor	Contact; windblown and settling dust; limited amounts of falling dirt; rain; snow; sleet; external ice formation; splashing water; hose streams. (External mechanisms may not operate when ice covered.)
4X	Indoor/Outdoor	Contact; corrosion; windblown and settling dust; limited amounts of falling dirt; rain; snow; sleet; external ice formation; splashing water; hose streams. (External mechanisms may not operate when ice covered.)
5	Indoor	Contact; settling airborne dust; limited amounts of falling dirt; dripping noncorrosive liquids and light splashing.
6	Indoor/Outdoor	Occasional temporary submersion in water at a limited depth; all items listed for Type 4.
6P	Indoor/Outdoor	Occasional temporary or prolonged submersion in water at a limited depth; all items listed for Type 4X.
7**	Indoor	Hazardous (Classified) locations: Class I, Groups A, B, C, or D.
8**	Indoor/Outdoor	Hazardous (Classified) locations: Class I, Groups A, B, C, or D.
9**	Indoor	Hazardous (Classified) locations: Class II, Groups E, F, or G.
10	Special use	Environments associated with mines.
12	Indoor	Contact; windblown and settling dust; limited amounts of falling water and dirt; light splashing; dripping noncorrosive liquids.
12K	Indoor	All items listed for Type 12. (Knockouts are provided in these enclosures; protection is not assured at the knockouts.)
13	Indoor	All items listed for Type 12; spraying and splashing of water, oil, and noncorrosive coolants.

* NEMA Enclosure Types 1, 2, and 3R may be ventilated. Filters or piped ventilation supplying clean and dry air or inert gas can be used to prevent dust from entering the enclosure.

** NEMA Enclosure Types 7, 8, and 9 meet manufacturer's design criteria for use in hazardous (classified) locations. Such typing does not imply that independent laboratory testing, listing, and follow up service (e.g., UL listing) exists.

Listed and Classified Enclosures

Manufacturers can submit devices to a testing lab to verify enclosure performance. These independent testing agencies list or classify enclosures that pass their own performance qualification tests.

Underwriters Laboratories (UL) Inc. is one major independent testing lab that lists and classifies equipment based on UL's own tests and examinations. Consumers can safely use "listed" and "classified" equipment as long as they comply with the specified requirements. These qualifying conditions may be documented by the testing agency or included in the manufacturer's product literature.

Once enclosures are listed, internal components cannot be changed. Alternately, enclosures can be tested for use with unspecified field-installed devices. These enclosures are classified rather than listed.

Plastic Enclosures

Listed or classified plastic enclosures are not easily ignited, but they will burn when subjected to high energy ignition sources. These ignition sources are likely to damage metallic enclosures too, but generally, their fuel contribution and smoke generation characteristics would be minimal.

Firefighting Water

Deenergized electrical equipment that becomes wet during firefighting can usually be dried and returned to service. Sometimes, the equipment is washed first to remove contaminants, then a corrosion-preventive coating is applied. Generally, the enclosure itself prevents significant water damage.

Electrical equipment is not specifically tested to operate under fire conditions or with the discharge of sprinkler or hose stream water. Generally NEMA 4, 4X, 6, 6P enclosures can withstand automatic sprinkler discharges and a limited application of hose streams. NEMA 6 and 6P can withstand flooding. NEMA 2, 3, 3R, 3S, 12, 12K, and 13 can withstand limited sprinkler discharges. NEMA 11 equipment is no longer manufactured, but it, too, can withstand limited discharges.

In general, firefighters disconnect power to noncritical electrical systems when fire protection systems operate. This action is generally part of the emergency plan. Critical systems that cannot be disconnected are designed, located and installed to avoid exposing them to fire and firefighting water. Barriers are sometimes used.

Maintenance

"Keeping equipment cool" generally means effectively dissipating heat, rather than lowering the equipment temperature below ambient. To get the most out of the service life of any equipment, it is important to keep equipment cool by getting the heat out. Overheating any electrical component can shorten its life and lead to an electrical breakdown and catastrophic failure.

An enclosure offers some degree of protection against an external environment, but generally is not 100% effective, and sometimes contributes to breakdowns. Enclosures can "trap" heat within their walls to cause overheating. Enclosures that conduct and radiate heat can spread heat to susceptible components. Enclosures can draw in or "breathe" contaminated air. Moisture and other contaminates can accumulate and be trapped inside enclosures as insulation ages and decomposes. In general, enclosures and contained equipment should be kept cool, clean and dry. A maintenance inspection verifies these conditions and looks at the overall physical conditions.

The temperature rise in a metallic enclosure is proportional to the total wattage of the enclosed components and is inversely proportional to its exposed surface area. A metallic enclosure acts as a heat sink; the larger its exposed surface area, the faster the heat dissipates by radiant energy. Thus, the temperature rise and the maximum attained temperature are lower for larger enclosures containing identical components.

However, even a large enclosure used to dissipate heat requires inspections to assure its cooling is not compromised. Internal temperatures will rise if surfaces are painted, if dirt accumulates or if insulated coverings diminish the rate of heat dissipation. Inspections should be thorough to detect poor housekeeping or unauthorized changes.

Heat in electrical enclosures can also be dissipated by other means. Fans and heat exchangers are commonly used. Fans force or draw hot air out of enclosures; the higher the airflow rate, the lower the temperature. Heat exchangers are used where an enclosure must be sealed from the primary cooling environment; air-water heat exchangers are common. Air conditioning chills the air in an enclosure and is highly effective in removing heat. The more complex the method of cooling, the more complex the required maintenance.

Persons performing or directly supervising any electrical equipment maintenance should have special training for the problems and equipment they might encounter. Properly maintaining hazardous location electrical equipment requires special knowledge. This guide only briefly touches on these concerns.