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NEMA Enclosures & Chromalox Equivalents

NEMA Enclosures for Non-Hazardous Areas

The National Electrical Manufacturer's Association (NEMA) publishes a classification system for electrical enclosures. The NEMA classification or type indicates the exposure or environment for which the enclosure was designed. While Chromalox E1, E2, E3 and E4 enclosures are designed for applications similar to the NEMA types, they are not identical due to modifications required to adapt the housings to heater configurations. Condensed descriptions of the NEMA non-hazardous enclosure types are listed below with the Chromalox equivalents indicated. The condensed descriptions are not intended to be complete representations of the National Electrical Manufacturers Association standards for electrical enclosures. For complete details on NEMA enclosure requirements refer to NEMA Std. No. 250.

Type 1 Enclosures — are for indoor use in locations where unusual service conditions do not exist. Intended primarily to provide protection against contact with the enclosed equipment and limited amounts of falling dirt. **(Chromalox E1 or General Purpose enclosures.)**

Type 2 Enclosures — are for indoor use providing protection against limited amounts of falling water and dirt.

Type 3 Enclosures — are for outdoor use providing protection against windblown dust, rain, and sleet and damage from external ice formation on the enclosure.

Type 3R Enclosures — are similar to Type 3 except Type 3R provides protection against falling rain.

Type 3S Enclosures — are for outdoor use protecting against windblown dust, rain, and sleet and providing for operation of external mechanisms when ice laden.

Type 4 Enclosures — are for indoor or outdoor use providing protection against windblown dust and rain, splashing water, and hose-directed water and remain undamaged by the formation of ice on the enclosure. **(Chromalox E4 Moisture Resistant or E2 Moisture and Explosion Resistant enclosures.)**

Type 4X Enclosures — are similar to Type 4 except Type 4X also protects against corrosion.

Type 5 Enclosures — are for indoor use and protects against dust and falling dirt.

Type 6 Enclosures — are for indoor or outdoor use providing protection against the entry of water during temporary submersion at a limited depth and remain undamaged by ice on the enclosure.

Type 6P Enclosures — are similar to Type 6 except Type 6P protects against the entry of water during prolonged submersion at a limited depth.

Type 12 Enclosures — are intended for indoor use providing protection against dust, falling dirt and dripping non-corrosive liquids. **(Chromalox E2 and E4 enclosures.)**

Type 12K Enclosures (knockouts) — are similar to Type 12 except they are provided with knockouts. Knockouts only permitted in either or both the top or bottom walls.

Type 13 Enclosures — are for indoor use providing protection against lint, dust, spraying of water, oil and non-corrosive coolant. **(Chromalox E2 enclosures may be used.)**

The table below lists a comparison of the characteristics of NEMA and Chromalox enclosures for Non-Hazardous areas.

Note — For Classified (Hazardous) Location enclosures, refer to NEMA Enclosures and Hazardous Location Heaters elsewhere in this section.

Comparison of Specific Applications of Enclosures for Non-Hazardous Locations

Provides a Degree of Protection Against the following Environmental Conditions	Type of Enclosure														Chromalox®			
	1	2	3	3R	3S	4	4X	5	6	6P	11	12	12K	13	E1	E2	E3	E4
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Falling dirt	X	X				X	X	X	X	X	X	X	X	X	X	X	X	X
Falling liquids and light splashing		X				X	X		X	X	X	X	X	X		X	X	X
Dust, lint, fibers and flyings — Not Class III						X	X	X	X	X		X	X	X		X	X	X
Hosedown and splashing water						X	X		X	X						X		X
Oil and coolant seepage												X	X	X		X	X	X
Oil or coolant spraying and splashing														X		X		
Windblown dust			X		X	X	X		X	X						X	X	X
Rain, snow and sleet			X	X	X	X	X		X	X						X		
Sleet					X													
Corrosive agents							X			X	X							
Occasional temporary submersion									X	X								
Occasional prolonged submersion										X								

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NEMA Enclosures & Hazardous Location Heaters

NEMA Enclosures for Classified Locations (Hazardous)

The following are condensed descriptions of the NEMA enclosure types for Classified (Hazardous) Locations. The Chromalox enclosures equivalent to the NEMA description are indicated. The Chromalox enclosure may not be indentical to the NEMA description due to modifications required to adapt the housing to heater configurations. The NEMA enclosure descriptions are not intended to be complete representations of the National Electrical Manufacturers Association standards for electrical enclosures. For complete details on NEMA enclosure requirements, refer to NEMA Std. No. 250.

Type 7 Enclosures — are intended for indoor use in locations classified as Class I, Groups A, B, C and D as defined in the National Electrical Code. **(Chromalox E2, E3 or Explosion Resistant enclosures.)**

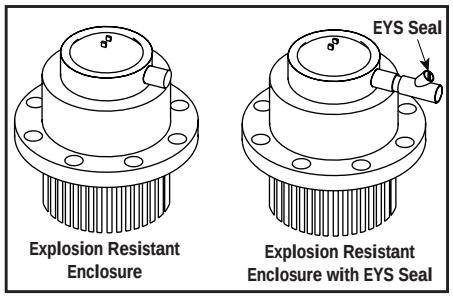
Type 8 Enclosures — are intended for indoor or outdoor use in locations classified as Class I, Groups A, B, C and D as defined in the National Electrical Code. **(Chromalox E2 enclosures.)**

Type 9 Enclosures — are intended for indoor use in locations classified as Class II, Groups E, F and G as defined in the National Electrical Code. **(Chromalox E2, E3 or Explosion Resistant enclosures.)**

Type 10 Enclosures (MSHA) shall be capable of meeting the requirements of the Mine Safety and Health Administration, 30 C.F.R., Part 18.

Chromalox Enclosures for Electric Heaters in Classified Locations

Chromalox has terminal enclosures specifically designed for use on electric heaters installed in Classified (Hazardous) areas. These enclosures are identified as Type E2 and E3. Typical flange heaters with E2 hazardous area terminal enclosures are shown below.



E2 enclosures are supplied with gaskets and are suitable for both indoor and outdoor locations. E2 enclosures meet the moisture and explosion-resistant requirements for NEMA 4, 12, 7, 8 and 9 applications. E3 enclosures are usually not furnished with gaskets and are intended primarily for indoor and dry locations. See table below.

Electric Heaters for Hazardous Locations

Chromalox provides a wide variety of electric immersion and air heaters for use in hazardous locations. These heaters are listed by Underwriters Laboratories (UL) or certified by Canadian Standards Association (CSA). Heaters designed and certified for Class I or II Division I hazardous locations can be used in Division 2 areas in the same class.

Immersion Heaters — Screw plug and flanged immersion heaters are available with terminal enclosures CSA or CSA NRTL/C certified for Class I, Groups B, C and D and Class II Groups E, F and G. Supplemental low-liquid level controls are required for maximum safety and equipment protection when immersion heaters are used in hazardous locations.

Circulation Heaters — Many water and oil circulation heaters are available with terminal enclosures CSA or CSA NRTL/C certified Class I, Groups B, C and D and Class II, Groups E, F and G. Supplemental controls are required for maximum safety and equipment protection when circulation heaters are used in hazardous locations

Air Heaters — Blower type air heaters (CXH-A) are available for Class I, Division I, Groups C and D and Class II, Division I, Groups E, F and G with UL, UL-C, and/or CSA certification. Convection type air heaters (CVEP) are available for use in Class I, Division I, Groups B, C and D hazardous locations. Convection type air heaters (FPEP and CEP) are available for use in Class I, Division I, Groups C and D and Class II, Division I Groups E, F and G.

Specialty Products & Components — Chromalox has designed, manufactured and provided certification on a large number of specialty products for hazardous areas and other special applications. These products include UL Recognized Components (finned tubular elements), duct heaters and special aircraft ground support equipment. Contact your Local Chromalox Sales office for assistance in designing equipment or solving any unique electric heating application for hazardous areas.

Comparison of Specific Applications of Enclosures for Indoor Hazardous Locations

Atmospheres Containing	Class	Group	NEMA 7	NEMA 8	NEMA 9	NEMA 10	Chromalox® E2	Chromalox® E3
Acetylene	I	A	X	X				
Hydrogen, Manufactured Gas	I	B	X	X			X[1]	X[1]
Diethel Ether, Ethylene, Cyclopropane	I	C	X	X			X	X
Gasoline, Hexane, Butane, Naptha, Propane, Acetone Toluene or Isoprene	I	D	X	X			X	X
Metal Dust	II	E			X		X	X
Carbon Black, Coal Dust, Coke Dust	II	F			X		X	X
Flour, Starch, Grain Dust	II	G			X		X	X
Fibers, Flyings	III	G			X		X	X
Methane with or without Coal Dust	MSHA					X		

1. Requires seals in the conduit adjacent to the terminal enclosure.

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Hazardous Locations & Electric Heater Applications

Hazardous Locations (NEC)[5]

Articles 500 to 504 in the National Electrical Code (NEC) define the requirements for electrical and electronic equipment and wiring in locations where fire or explosion hazards may exist. In Article 500, hazardous locations are categorized by class. Classes are defined as follows:

Class I — Groups A, B, C & D - Division 1 or 2 Temperature Rating T1 - T6

Class II — Groups E, F & G - Division 1 or 2 Temperature Rating T1 - T6

Class III — Division 1 or 2

Class I, II & III (NEC 500)

Hazardous location classes are identified based on the explosive material present. The following information is an interpretation and summary of each class and a discussion of some of the conditions to be considered when using electric heaters in these areas. Refer to the National Electrical Code and local authorities for the proper classification and requirements of a specific hazardous location.

Class I Locations (Gases) are areas where flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures (NEC 500-5).

Class II Locations (Dust) are areas where the presence of combustible dust presents a fire or explosion hazard (NEC 500-6).

Class III Locations (Fibers) are areas made hazardous because of the presence of easily ignitable fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures (NEC 500-7).

Group Classification, Class I & II[6]

Certain chemicals create higher explosive pressures and more heat than others when ignited. In Class I and II hazardous locations, chemical families are further classified by Groups. Group classification involves determination of the maximum explosion pressures, the maximum safe clearance or gap between clamped enclosure joints and the minimum ignition temperature of the atmospheric mixture for a particular chemical.

NEC requires that any electrical equipment approved for use in a hazardous location must be approved for the class and for the specific group (gas or dust) that will be present. Groups are identified as A, B, C, D, E, F and G and are explained as follows:

Class I — Gases[6] (NEC 500-3a)

Combustible and flammable gases and vapors in Class I are sub-divided into four groups A, B, C and D. Group A gases create the most explosive pressure and therefore are the most difficult to contain. Group B is next, then Group C with Group D being the lowest. Third party listings of electrical equipment for Group A or B are more difficult to obtain than Group C or D. Individual gases are further defined by ignition temperature (see Temperature Ratings).

Group A —

Gases include:	Ignition Temperature °C	Ignition Temperature °F
Acetylene	305	581

Group B —

Gases include:	Ignition Temperature °C	Ignition Temperature °F
Butadiene[1]	420	788
Ethylene oxide[2]	429	804
Hydrogen & mfg gases > 30% hydrogen (by volume)	400	752
Propylene oxide[3]	449	840

Group C —

Gases include:	Ignition Temperature °C	Ignition Temperature °F
Acetaldehyde	175	347
Cyclopropane	500	932
Diethyl ether	160	320
Ethylene	490	914
Dimethyl hydrazine	249	480

Group D — is the largest group and includes many of the common petroleum products.

Gases include:	Ignition Temperature °C	Ignition Temperature °F
Acetone	465	869
Alcohol's		
1-butanol (butyl)	365	689
Amyl alcohol	300	572
Butyl alcohol (ter)	480	896
Ethanol (ethyl)	356	689
Isobutyl alcohol	427	800
Isopropyl alcohol	399	750
Methanol (methyl)	385	725
Propyl alcohol	440	824
Ammonia[3]	651	1204
Benzene	560	1040
Butane	405	761
Ethane	515	959
Ethyl acetate	427	800
Ethylene dichloride	413	775
Gasoline		
(56 - 60 octane)	280	536
(100 octane)	456	853
Heptanes	280	536
Hexanes	225	437
Isobutyl acetate	421	790
Isoprene	220	428
Methane (Nat. gas)	482/632	900/1170
Methyl ethyl ketone	516	960
Petroleum naphtha[4]	288	550
Octanes	220	428
Pentanes	260	500
Propane	450	842
Vinyl acetate	427	800
Vinyl chloride	472	882
Xylenes	530	986

Notes —

1. **Group D** equipment may be used for this atmosphere if isolated in accordance with Section 501-5(a) by sealing all conduit(s) 1/2 inch or larger (within 18 inches of the enclosure).
2. **Group C** equipment may be used for this atmosphere if isolated in accordance with Section 501-5(a) by sealing all conduit(s) 1/2 inch or larger (within 18 inches of the enclosure).
3. **For Classification of Ammonia Atmospheres** see Safety Code for Mechanical Refrigeration (ANSI/ASHRAE 15-1992) and Safety Requirements for the Storage and Handling of Anhydrous Ammonia (ANSI/CGA G2.1-1989).
4. **Also Known By** the synonyms benzine, ligroin, petroleum ether or naphtha.
5. **NEC and National Electrical Code** are registered trademarks of the National Fire Protection Association.
6. **For a Complete List** defining properties of flammable liquids, gases, solids or dusts, refer to the latest edition of **NFPA 325, NFPA 497 or NFPA 499.**

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Hazardous Locations & Electric Heater Applications

Class II — Dust[1] (NEC 500-3b)

Groups E, F and G (Class II) — Combustible dusts are divided into Groups E, F and G. Classification involves investigation and testing of the assembled enclosure including the clamped joints, clearances and shaft openings. The blanketing effect of layers of dust, the electrical conductivity and the ignition temperature of the dust are also evaluated.

Group E Atmospheres contain metal dust, including aluminum, magnesium, their commercial alloys and other metals of similarly hazardous characteristics having resistivity less than 10^5 Ohm-cm.

Group F Atmospheres contain combustible carbonaceous dusts, charcoal, coal or other atmospheres containing these dusts sensitized by other hazardous materials and having resistivity greater than 10^2 through 10^8 Ohm-cm.

Group G Atmospheres contain combustible dusts such as flour, grain, wood and chemicals having resistivity of 10^5 Ohm-cm, or greater.

Class III — Fibers (NEC 500-7a)[1]

Atmospheres containing easily ignitable fibers such as rayon, cotton, flax, jute, hemp, kapok, excelsior and similar materials.

Divisions in Hazardous Locations

The NEC further sub-divides hazardous locations into Divisions (Div. 1 and 2). The requirements for Division 2 are less stringent than for Division 1. The two divisions are discussed in the following paragraphs.

Division I Locations

Class I, Division 1 — NEC 500-5(a) is an area where the hazard can exist under normal operating conditions. Included are areas where flammable or combustible liquids are transferred from one container to another, open vats, paint spray booths or any location where ignitable mixtures are used. Also included are locations where a hazard is caused by frequent maintenance, repair or equipment failure.

Class II, Division 1 — NEC 500-6(a) is an area where combustible dust is normally in the air in sufficient quantities to produce ignitable mixtures or where mechanical failure or abnormal equipment operation might produce ignitable mixtures. Locations also include operations where hazards exist because of frequent mechanical failure of machinery or equipment and where electrically conductive combustible dusts (all Group E and some Group F) are present in hazardous quantities.

Class III, Division 1 — NEC 500-7(a) is an area where easily ignitable fibers or materials producing combustible flyings are handled, manufactured or used.

Division 2 Locations

Class I, Division 2 — NEC 500-5(b) is an area where ignitable gases or vapors are handled, processed or used, but which are normally in closed containers or closed systems from which they can only escape through accidental rupture or breakdown of such containers or systems.

Class II, Division 2 — NEC 500-6(b) is an area where combustible dust is not normally in the air in sufficient quantities to produce ignitable mixtures or interfere with the operation of electrical equipment, or where dust is present as a result of infrequent malfunctioning of processing or handling equipment. Included are situations where combustible dust accumulations may interfere with the safe dissipation of heat from electrical equipment. No electrically conductive dusts as defined in NEC 502-1, (last sentence) are included in Class II, Div. 2 atmospheres.

Note — There is no Division 2 classification for Class II, Group E.

Class III, Division 2 — NEC 500-7(b) is an area where easily ignitable fibers are stored or handled.

Class I — Adjacent Divisions

In most indoor areas with adequate partitions, Div. 1 and 2 are self-contained areas. With partitions, a Div. 1 area may exist adjacent to a non-hazardous area. However, outdoors or in large indoor areas with few or no partitions, Class I, Div. 1 and Class 1, Div. 2 areas usually exist adjacent to each other. The Div. 1 location being near the point of vapor release and Division 2 is at a given distance fromthe release point of the flammable liquid. Where the spread of flammable vapors and gases is not contained by adequate partitions, the area designated as Class I, Div. 2 serves as a "transition zone" between the hazardous and non-hazardous area. Div. 1 is the hazardous area where flammable gases or vapors are released from the liquid. Div. 2 is the area further away from the point of release, where the gases or vapors are not normally of sufficient concentration to produce an ignitable mixture.

Class I & II — Temperature Ratings

Originally, equipment in each group had one maximum temperature rating. The maximum for Groups A, B and D was 280°C (536°F) and Group C was 180°C (356°F). Recognizing that chemicals and gases have different ignition temperatures, NEC revised the temperature ratings accordingly. Heat producing equipment must now be identified by Class, Group, Division and "T" rating. The "T" rating shall not exceed the ignition temperature of the specific gas, vapor or dust present. Values for "T" ratings for Class I and II equipment are shown in the table below:

T-Ratings for Class I and II

Maximum Degrees (°C)	Temperature Degrees (°F)	Identification "T" Number
450	842	T1
300	572	T2
280	536	T2A
260	500	T2B
230	446	T2C
215	419	T2D
200	392	T3
180	356	T3A
165	329	T3B
160	320	T3C
135	275	T4
120	248	T4A
100	212	T5
85	185	T6

Note 1 — For a complete list defining properties of flammable liquids, gases, solids or dusts, refer to the latest edition of NFPA 325, NFPA 497 or NFPA 499.