

Recommended Practice for Design, Installation, and Maintenance of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Zone 0, Zone 1, and Zone 2 Locations

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Design, Installation, and Maintenance of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Zone 0, Zone 1, and Zone 2 Locations

1 General

1.1 Scope

1.1.1 This document recommends minimum requirements and guidelines for the design, installation, and maintenance of electrical systems on fixed and floating petroleum facilities located offshore. For facilities classified as Division 1 or Division 2, reference API 14F. These facilities include drilling, producing and pipeline transportation facilities associated with oil and gas exploration and production. This recommended practice (RP) is not applicable to Mobile Offshore Drilling Units (MODUs) without production facilities. This document is intended to bring together in one place a brief description of basic desirable electrical practices for offshore electrical systems. The recommended practices contained herein recognize that special electrical considerations exist for offshore petroleum facilities. These include:

- a) inherent electrical shock possibility presented by the marine environment and steel decks;
- b) space limitations that require that equipment be installed in or near hazardous (classified) locations;
- c) corrosive marine environment;
- d) motion and buoyancy concerns associated with floating facilities.

1.1.2 This RP applies to both permanent and temporary electrical installations. The guidelines presented herein should provide a high level of electrical safety when used in conjunction with well-defined area classifications. This RP emphasizes safe practices for hazardous (classified) locations on offshore petroleum facilities but does not include guidelines for classification of areas; for guidance on the classification of areas refer to API 505.

1.1.3 Advantages of area classification using zones are as follows.

1.1.3.1 Often, particularly for new installations and for installations that are subject to upgrade or revision, it is advantageous to classify locations as “Zones” in accordance with Article 505 of the *NEC* versus “Divisions” as per Article 500. These advantages may include reduced initial capital expenditures, enhanced safety, or facilities that are more easily and more economically maintained.

1.1.3.2 In the Zone classification system, locations classified as Division 1 in the Division classification system can now be classified and further divided into Zone 0 and Zone 1 locations. Electrical equipment suitable for Zone 1 locations is not required to be suitable for locations where flammable gases and vapors may be present continuously or for long periods of time, i.e. Zone 0 locations. Thus, the protection techniques for equipment to be installed in Zone 1 locations can be less demanding than the protection techniques for equipment to be installed in Division 1 locations. This may result in more cost effective installations or equipment that is more easily maintained.

1.1.3.3 Due to the application of increased safety (protection Type “e”) equipment, fewer field-installed sealing fittings are required for Zone 1 and Zone 2 equipment than for Division 1 and Division 2 equipment. Fewer field-installed sealing fittings reduce the chance for installation errors, enhancing safety. Much of the equipment approved for Zone 1 and Zone 2 uses plastics (versus metals), reducing corrosion, which can result in reducing maintenance costs and enhancing safety. Also, since the most hazardous locations (Zone 0 locations) are identified, such locations can be avoided for the installation of most electrical equipment. This also can enhance safety.

1.2 Applicability of *National Electrical Code*

1.2.1 Electrical systems for offshore petroleum facilities shall be designed and installed in accordance with the *National Electrical Code*, 2011 edition, except where specific departures are noted.

2 Normative References

2.1 General

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.2 Industry Codes, Guides, and Standards

Various organizations have developed numerous codes, guides and standards that have substantial acceptance by industry and governmental bodies. Codes, guides, and standards useful in the design and installation of electrical systems are listed below as references only. These are not considered to be a part of this RP except for those specific sections of documents referenced elsewhere in this RP.

API Recommended Practice 2L, *Planning, Designing, and Constructing Heliports for Fixed Offshore Platforms*

API Recommended Practice 11S3, *Recommended Practice for Electrical Submersible Pump Applications*

API Recommended Practice 14C, *Analysis, Design, Installation and Testing of Basic Surface Safety Systems on Offshore Production Platforms*

API Recommended Practice 14F, *Design, Installation, and Maintenance of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Division 1 and Division 2 Locations*

API Recommended Practice 14G, *Fire Prevention and Control on Open Type Offshore Production Platforms*

API Recommended Practice 14J, *Design and Hazards Analysis for Offshore Production Facilities*

API Recommended Practice 55, *Conducting Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide*

API Recommended Practice 75, *Development of a Safety and Environmental Management Program for Outer Continental Shelf Operations and Facilities*

API Recommended Practice 500, *Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2*

API Recommended Practice 505, *Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, and Zone 2*

API Recommended Practice 540, *Electrical Installations in Petroleum Processing Plants*

API Specification 17E, *Specifications for Subsea Umbilicals*

API Standard 541, *Form-wound Squirrel-Cage Induction Motors, 500 HP and Larger*

API Standard 546, *Brushless Synchronous Machines, 500 kVA and Larger*

API Standard 547, *General Purpose Form-Wound Squirrel Cage Induction Motors—250 HP and Larger*

API Recommended Practice 2003, *Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents*

API Publication 2216, *Ignition Risk of Hydrocarbon Vapors by Hot Surfaces in the Open Air*

API Publication 2218, *Fireproofing Practices in Petroleum and Petrochemical Processing Plants*

ANSI C37.06 ¹, *American National Standard Guide for High-Voltage Circuit Breakers Rated on Symmetrical Current Basis Designated "Definite Purpose for Fast Transient Recovery Voltage Rise Times"*

ANSI C37.12, *For AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis—Specification Guide*

ANSI C37.20.1, *Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear*

ANSI C37.20.2, *Standard for Metal-Clad and Station-Type Cubicle Switchgear*

ANSI C57.12.70, *Terminal Markings and Connections for Distribution and Power Transformers*

ANSI C84.1, *Voltage Ratings for Electric Power Systems and Equipment (60 Hz)*

ANSI Y32.9, *Graphic Symbols for Electrical Wiring and Layout Diagrams used in Architecture and Building Construction*

ASME A17.1 ², *Safety Code for Elevators and Escalators*

ASME A17.1A Addenda to ANSI/ASME A17.1, *Safety Code for Elevators and Escalators*

ASME A17.5, *Elevator and Escalator Electrical Equipment*

ASTM B117 ³, *Standard Practice for Operating Salt Spray (Fog) Apparatus*

ASTM D178, *Standard Specification for Rubber Insulating Matting*

ASTM D4066, *Standard Specification for Nylon Injection and Extrusion Materials (PA)*

ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*

ASTM SI10-2002, *Standard for Use of the International System of Units (SI): The Modern Metric System*

CSA C22.1 ⁴, *Canadian Electrical Code, Part I*

CSA C22.2 No. 30, *explosionproof Enclosures for Use in No. 30 Class I, Hazardous Locations*

CSA C22.2 No. 157, *Intrinsically Safe and Nonincendive Equipment for Use in Hazardous Locations*

CSA C22.2 No. 245, *Marine Shipboard Cable*

¹ American National Standards Institute, 25 West 43rd Street, 4th floor, New York, New York 10036, www.ansi.org.

² American Society of Mechanical Engineers, 3 Park Avenue, New York, New York 10016, www.asme.org.

³ American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959, www.astm.org.

⁴ Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, L4W 5N6, Canada, www.csa.ca.

CSA Plus 2203, *Hazardous Locations—Guide for the Design, Testing, Construction, and Installation of Equipment in Explosive Atmospheres*

FF-844 ⁵, *Foundation Fieldbus Specification H1 Cable Test Specification September 27, 2007*

FM 3600 ⁶, *Electrical Equipment for Use in Hazardous (Classified) Locations, General Requirements*

FM 3610, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II and III, Division 1, Hazardous (Classified) Locations*

FM 3611, *Nonincendive Electrical Equipment for Use of Class I, Division 2, Class II, Division 2, and Class III, Divisions 1 and 2, Hazardous (Classified) Locations*

FM 3615, *explosionproof Electrical Equipment General Requirements*

FM 3620, See NFPA No. 496

FM 3810, *Electrical Equipment for Measurement, Control, and Laboratory Use*

IADC IADC-DCCS-1-91 ⁷, *Guidelines for Industrial System DC Cable for Mobile Offshore Drilling Units*

ICEA P-32-382 ⁸, *Short Circuit Characteristics of Insulated Cables*

ICEA P-45-482, *Short Circuit Characteristics of Metallic Shields and Sheaths of Insulated Cable*

IEC 60050-426 ⁹, *International Electrotechnical Vocabulary (IEV)—Chapter 426—Electrical Apparatus for Explosive Atmospheres*, 2008

IEC 62271-100, *Switchgear and Controlgear – Part 100: Alternating Current Circuit Breakers*, 2008

IEC 68-2-52, *Basic Environmental Testing Procedures, Part 2: Tests Test KB: Salt Mist, Cyclic (Sodium Chloride Solution)*, 1996

IEC 61158-2, *Industrial communication networks – Fieldbus Specifications – Part 2*, 2007

IEC 62271-200, *A.C. Metal-Enclosed Switchgear and Controlgear for Rated Voltages Above 1 kV and Up to and Including 52 kV*, 2011

IEC 60331, Part 11 and Part 21, *Tests for electric cables under fire conditions-circuit integrity*, 2009 and 1999

IEC 60363, *Short-Circuit Current Evaluation with Special Regard to Rated Short-Circuit Capacity of Circuit Breakers in Installations in Ships*, 1972

IEC 60529, *Degrees of Protection Provided by Enclosures (IP Code)*, 2001

IEC 60533, *Electromagnetic Compatibility of Electrical and Electronic Installations in Ships*, 1999

IEC 60947-2, *Low-Voltage Switchgear and Controlgear, Part 2: Circuit Breakers*, 2009

⁵ Fieldbus Foundation, 9005 Mountain Ridge Drive, Bowie Bldg - Suite 200, Austin, TX 78759-5316, www.fieldbus.org.

⁶ Factory Mutual Research Corporation, 1151 Boston-Providence Turnpike, Norwood, Massachusetts 02062, www.fmgglobal.com.

⁷ International Association of Drilling Contractors, P.O. Box 4287, Houston, Texas 77210, www.iadc.org.

⁸ Insulated Cable Engineers Association, P.O. Box P, South Yarmouth, Massachusetts 02664, www.icea.net.

⁹ International Electrotechnical Commission, 3 rue de Varembé, P.O. Box 131, CH-1211, Geneva 20, Switzerland, www.iec.ch.

IEEE C37.04 INT 1¹⁰, *Rating Structure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis*, 2010

IEEE Standard C37.010, *Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis*, 2005

IEEE Standard C37.13, *Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures*, 2008

IEEE Standard C37.14, *Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures*, 2002

IEEE Standard C37.27, *Application Guide for Low-Voltage AC Power Circuit Breakers Applied with Separately Mounted Current-Limiting Fuses*, 2008

IEEE Standard C37.102, *Guide for AC Generator Protection*, 2006

IEEE Standard 45, *Recommended Practice for Electrical Installations on Shipboard*, 2002

IEEE Standard 100, *The Authoritative Dictionary of IEEE Standard Terms, Seventh Edition*, 2000

IEEE Standard 141, *Electric Power Distribution for Industrial Plants, Red Book*, 1993

IEEE Standard 142, *Grounding of Industrial and Commercial Power Systems, Green Book*, 2007

IEEE Standard 242, *Protection and Coordination of Industrial and Commercial Power Systems, Buff Book*, 2001

IEEE Standard 303, *Auxiliary Devices for Rotating Electrical Machines in Class I, Division 2 and Zone 2 Locations*, 2004

IEEE Standard 315, *Graphic Symbols for Electrical and Electronics Diagrams*, 1993

IEEE 446, *Emergency and Standby Power Systems for Industrial and Commercial Applications*, 2000

IEEE Standard 450, *Maintenance, Testing, and Replacement of Vented Lead-Acid Storage Batteries for Stationary Applications*, 2002

IEEE Standard 484, *Installation Design and Installation of Vented Lead-Acid Storage Batteries for Stationary Applications*, 2008

IEEE Standard 485, *Sizing Lead-Acid Storage Batteries for Stationary Applications*, 1997

IEEE Standard 515, *Testing, Design, Installation, and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications*, 2011

IEEE Standard 835, *Standard Power Cable Ampacity Tables*, 2006

IEEE Standard 841, *Standard for the Petroleum and Chemical Industry—Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel-Cage Induction Motors-Up to and Including 500 hp*, 2009

IEEE Recommended Practice 1100, *Recommended Practice for Powering and Grounding Electronic Equipment, Emerald Book*, 2005

IEEE 1120, *Guide for the Planning, Design, Installation, and Repair of Submarine Power Cable Systems*

¹⁰ Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08854, www.ieee.org

IEEE Standard 1202, *Standard for Flame Propagation Testing of Wire and Cable*, 2006

IEEE Standard 1242, *Guide for Specifying and Selecting Power, Control and Special Purpose Cable for Petroleum and Chemical Plants*, 2005

IEEE Standard 1566, *Standard for Performance of Adjustable Speed AC Drives Rated 375 kW and Larger*, 2005

IEEE Recommended Practice 1580, *Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Marine Platforms*, 2010

IES RP-1¹¹, *American National Standard Practice for Office Lighting*, 2004

IES RP-7, *American National Standard Practices for Industrial Lighting*, 2001

IES, *Lighting Handbook*

IMCA-AODC 035¹², *Code of Practice for Safe use of Electricity Underwater*

IMO¹³, *International Convention for the Safety of Life at Sea, SOLAS 1974*, as amended

IP 15¹⁴, *Model Code of Safe Practice in the Petroleum Industry, Part 15: Area Classification Code for Petroleum Installations*

ISA-5.1¹⁵, *Instrumentation Symbols and Identification*, 2009

ISA-51.1, *Process Instrumentation Technology*, 1979 (R1993)

ISA-92.00.01, *Performance Requirements for Toxic Gas-Detection Instruments*, 2010

ISA-RP92.0.02, Part II, *Installation, Operation, and Maintenance of Toxic Gas-Detection Instruments: Hydrogen Sulfide*, 1998

ISA-12.20.01, *General Requirements for Electrical Ignition Systems for Internal Combustion Engines in Class I, Division 2 or Zone 2, Hazardous (Classified) Locations*, 2009

ISA-TR12.13.03, *Guide for Combustible Gas Detection as a Method of Protection*, 2009

ANSI/ISA-60079-0, *Explosive Atmospheres – Part 0: Equipment – General Requirements*, 2009

ANSI/ISA-12.12.01, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, 2011

ANSI/ISA-12.27.01, *Requirements for Process Sealing Between Electrical Systems and Flammable or Combustible Process Fluids*, 2011

ANSI/ISA-60079-2, *Explosive Atmospheres—Part 2: Equipment Protection by Pressurized Enclosures “p”*, 2012

¹¹ Illuminating Engineering Society, 120 Wall Street 17th Floor, New York, New York 10005-40001, www.iesna.org.

¹² International Marine Contractors Association, 52 Grosvenor Gardens, London, SW1W 0AU, United Kingdom, www.imca-int.com

¹³ International Maritime Organization, 4 Albert Embankment, London, England, SE17BP, United Kingdom, www.imo.org.

¹⁴ Institute of Petroleum, 61 New Cavendish Street, London W1M8AR, United Kingdom, www.energyinst.org.uk.

¹⁵ The Instrumentation, Systems, and Automation Society, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, North Carolina 27709, www.isa.org.

ANSI/ISA-12.01.01, *Definitions and Information Pertaining to Electrical Equipment in Hazardous (Classified) Locations*, 2009

ANSI/ISA-12.10.05, (IEC 61241-10 Mod) *Electrical Apparatus for Use in Zone 20, Zone 21 and Zone 22 Hazardous (Classified) Locations—Classification of Zone 20, Zone 21 and Zone 22 Hazardous (Classified) Locations*, 2004

ANSI/ISA-12.13.01, (IEC 61779-1 through 5 Mod), *Performance Requirements for Combustible Gas Detectors*, 2002

ANSI/ISA-RP12.13.02, (IEC 61779-6 Mod), *Recommended Practice for the Installation, Operation, and Maintenance of Combustible Gas Detection Instruments*, 2003

ANSI/ISA-60079-1, *Explosive Atmospheres – Part 1: Equipment Protection by Flameproof Enclosures “d”*, 2009

ANSI/ISA-60079-5 (12.25.01), *Explosive Atmospheres – Part 5: Equipment Protection by Powder Filling “q”*, 2009

ANSI/ISA-60079-6 (12.26.01), *Explosive Atmospheres – Part 6: Equipment Protection by Oil Immersion “o”*, 2009

ANSI/ISA-60079-7 (12.16.01), *Explosive Atmospheres – Part 7: Equipment protection by increased safety “e”*, 2008

ANSI/ISA-60079-11 (12.02.01), *Electrical Apparatus for Use in Class I, Zone 0, 1, and 2 Hazardous (Classified) Locations—Intrinsic Safety “i”*, 2011

ANSI/ISA-60079-15 (12.12.02), *Electrical Apparatus for Use in Class I, Zone 2 Hazardous (Classified) Locations—Type of Protection “n”*, 2009

ANSI/ISA-60079-18 (12.23.01) 2009, *Electrical Apparatus for Use in Class I, Zone 1 Hazardous (Classified) Locations: Type of Protection—Encapsulation “m”*

ANSI/ISA-RP12.06.01, *Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety*, 2003

ISA-RP12.12.03, *Recommended Practice for Portable Electronic Products Suitable for Use in Class I and II, Division 2, Class I Zone 2 and Class III, Division 1 and 2 Hazardous (Classified) Locations*, 2011

ANSI/ISA-TR12.21.01, *Use of Fiber Optic Systems in Class I Hazardous (Classified) Locations*, 2004

ANSI/ISA-TR12.24.01 (IEC 60079-10 Mod), *Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2*, 1998

ANSI/ISA-12.27.01, *Requirements for Process Sealing Between Electrical Systems and Potentially Flammable or Combustible Process Fluids*, 2003

ANSI/ISA-TR12.06.01, *Electrical Equipment in a Class I, Division 2/Zone 2 Hazardous Locations*, 1999

NACE SP0176 ¹⁶, *Corrosion Control of Steel, Fixed Offshore Platforms Associated with Petroleum Production*, 2007

NEMA 250 ¹⁷, *Enclosures for Electrical Equipment (1,000 Volts Maximum)*

NEMA FG 1, *Fiberglass Cable Tray Systems*

¹⁶ NACE International (formerly the National Association of Corrosion Engineers), 1440 South Creek Drive, Houston, Texas 77218-8340, www.nace.org.

¹⁷ National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1752, Rosslyn, Virginia 22209, www.nema.org.

NEMA MG 1, *Motors and Generators*

NEMA MG 2, *Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators*

NEMA MG 10, *Energy Management Guide for Selection and Use of Fixed-Frequency Medium AC Squirrel-Cage Polyphase Induction Motors*

NEMA ICS 1, *Standards for Industrial Control and Systems General Requirements*

NEMA ICS 2.1, *Seismic Testing of Motor Control Centers*

NEMA 2.3, *Instructions for the Handling, Installation, Operation, and Maintenance of Motor Control Centers*

NEMA 2.4, *NEMA and IEC Devices for Motor Service—A Guide for Understanding the Differences*

NEMA ICS 6, *Industrial Controls and Systems Enclosures*

NEMA VE 1, *Metal Cable Tray Systems*

NEMA VE 2-2006, *Cable Tray Installation Guidelines*

NEMA WC 70, *Power Cables rated 200 Volts or Less for the Distribution of Electrical Energy*

NEMA WC 71, *Standard for Non-Shielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy* (Supersedes WC 3, WC 5, WC 7, & WC 8)

NEMA WC 74, *5 – 46 KV Shielded Power Cables for Use in the Distribution of Electric Energy* (Supersedes WC 3, WC 5, WC 7, & WC 8)

NFPA 30¹⁸, *Flammable and Combustible Liquids Code*

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Turbines*

NFPA 54, *National Fuel Gas Code*

NFPA 69, *Explosion Prevention Systems*

NFPA 70, *National Electrical Code*

NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*

NFPA 70E, *Standard for Electrical Safety in the Workplace*

NFPA 77, *Recommended Practice on Static Electricity*

NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Non-particulate Solids*

¹⁸ National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02169-7471, www.nfpa.org

NFPA 99, *Standard for Health Care Facilities*

NFPA 101, *Life Safety Code*

NFPA HAZ01, *Fire Protection Guide to Hazardous Materials (Replaces NFPA 325)*

NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment in Hazardous (Classified) Locations*

NFPA 497, *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*

NFPA 780, *Standard for the Installation of Lightning Protection Systems*

NFPA, *Electrical Installations in Hazardous Locations*

UL 13 ¹⁹, *Power Limited Circuit Cables*

UL 44, *Thermoset-Insulated Wire and Cable*

UL 50, *Enclosures for Electrical Equipment*

UL 62, *Flexible Cords*

UL 83, *Thermoplastic-Insulated Wires and Cables*

UL 347, *High Voltage Industrial Control Equipment*

UL 489, *Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures*

UL 508, *Industrial Control Equipment*

UL 514A, *Metallic Outlet Boxes*

UL 514B, *Conduit, Tubing, and Cable Fittings*

UL 514C, *Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers*

UL 515, *Electrical Resistance Heat Tracing for Commercial and Industrial Applications*

UL 583, *Electric-Battery-Powered Industrial Trucks*

UL 595, *Marine-Type Electric Lighting Fixtures*

UL 674 *Safety Standard for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations, Class I, Groups C and D*

UL 698, *Safety Standard for Electric Industrial Control Equipment for Use in Hazardous (Classified) Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G*

UL 698A, *Industrial Control Panels Relating to Hazardous (Classified) Locations*

¹⁹ Underwriters Laboratories, 333 Pfingsten Road, Northbrook, Illinois 60062, www.ul.com.

UL 781, *Portable Electric Lighting Units for Use in Hazardous (Classified) Locations*

UL 783, *Electrical Flashlights and Lanterns for Use in Hazardous (Classified) Locations, Class I, Groups C and D*

UL 823, *Electric Heaters for Use in Hazardous (Classified) Locations*

UL 844, *Electric Lighting Fixtures for Use in Hazardous (Classified) Locations*

UL 845, *Motor Control Centers*

UL 877, *Circuit Breakers and Circuit-Breaker Enclosures for Use in Hazardous (Classified) Locations*

UL 891, *Safety—Dead Front Switchboards*

UL 894, *Switches For Use in Hazardous (Classified) Locations*

UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III Division 1 Hazardous (Classified) Locations*

UL 1002, *Electrically Operated Valves for Use in Hazardous (Classified) Locations*

UL 1008, *Transfer Switch Equipment*

UL 1010, *Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations*

UL 1042, *Electric Baseboard Heating Equipment*

UL 1072, *Medium-Voltage Power Cables*

UL 1096, *Electric Central Air Heating Equipment*

UL 1104, *Marine Navigation Lights*

UL 1203, *Explosionproof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations*

UL 1277, *Power and Control Tray Cable with Optional Optical-Fiber Members*

UL 1309, *Marine Shipboard Cable*

UL 1558, *Switchgear Assemblies, Metal Enclosed Low Voltage Power Circuit Breaker Type*

UL 1569, *Metal-Clad Cables*

UL 1570, *Fluorescent Lighting Fixtures*

UL 1571, *Incandescent Lighting Fixtures*

UL 1572, *High Intensity Discharge Lighting Fixtures*

UL 1574, *Track Lighting Systems*

UL 1581, *Reference Standard for Electrical Wires, Cables, and Flexible Cords*

UL 1604, *Electrical Equipment for Use in Hazardous Locations, Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*

UL 1709, *Rapid Rise Fire Tests of Protection Materials for Structural Steel*

UL 1836, *Outline for Electric Motors and Generators for Use in Class I, Division 2 and Class II, Division 2 Hazardous (Classified) Locations*

UL 2196, *Tests for Fire Resistive Cables*

UL 2225, *Metal-Clad Cables and Cable-Sealing Fittings for Use in Hazardous (Classified) Locations*

UL 2250, *Instrumentation Tray Cable*

UL 60947-1, *Low Voltage Switchgear and Controlgear—Part 1 General Rules*

UL 60947-4-1, *Low Voltage Switchgear and Controlgear—Part 4-1 Contactors and Motor Starters*

2.3 Government Codes, Rules, and Regulations

Federal regulatory agencies have established certain requirements for the design, installation, and operation of facilities on offshore production platforms. These requirements may influence the design, installation, and operation of the electrical systems. In addition to federal regulations, certain state, municipal, and local regulations may be applicable. The following documents may pertain to offshore oil and gas producing operations and should be used when applicable.

2.4 Code of Federal Regulations (CFR)

DOI/Bureau of Mines Bulletin 627 ²⁰, *Flammability Characteristics of Combustible Gases and Vapors*

NOTE No longer available from Bureau of Mines, but published in ANSI/ISA-TR12.13.01.

DOI/BSEE 30 CFR Part 250 ²¹, *Oil and Gas and Sulphur Operation in the Outer Continental Shelf*

DOL/OSHA 29 CFR Part 1910 ²², *Subpart H. Process Safety Management of Highly Hazardous Chemicals*

DOL/OSHA 29 CFR Part 1910, *Subpart S. Electrical (Occupational Safety and Health Administration)*

DOL/OSHA 29 CFR Part 1926, *Subpart K. Electrical Construction (Occupational Safety and Health Administration)*

DOT 49 CFR Parts 190, 191, 192, 193, and 195 ²³, *Pipeline Safety Regulations*

DOT/FAA ²⁴, *Heliport Design (Advisory Circular 150/5390-2A)*

²⁰ U.S. Department of the Interior, Bureau of Mines. The *Code of Federal Regulations* is available from the U.S. Government Printing Office, Washington, D.C. 20402.

²¹ U.S. Department of the Interior, Bureau of Safety and Environmental Enforcement. The *Code of Federal Regulations* is available from the U.S. Government Printing Office, Washington, D.C. 20402.

²² Occupational Safety and Health Administration. U.S. Department of Labor, The *Code of Federal Regulations* is available from the U.S. Government Printing Office, Washington, D.C. 20402.

²³ U.S. Department of Transportation. The *Code of Federal Regulations* is available from the U.S. Government of Printing Office, Washington, D.C. 20402.

²⁴ U.S. Department of Transportation, Federal Aviation Administration. The *Code of Federal Regulations* is available from the U.S. Government Printing Office, Washington, D.C. 20402.

DOT/FAA, *Obstruction Marking and Lighting* (Advisory Circular 70/7460-1F)

DHS/USCG 33 CFR Parts 140 – 147 ²⁵, *Subchapter N. Outer Continental Shelf Activities*

DHS/USCG 33 CFR Part 67, *Subchapter C. Aids to Navigation*

DHS/USCG 46 CFR Part 58, *Subchapter F, Main and Auxiliary Machinery and Related Systems*

DHS/USCG 46 CFR Parts 107 – 109, *Shipping Subchapter I-A. Mobile Offshore Drilling Units*

DHS/USCG 46 CFR Parts 110 – 113, *Shipping Subchapter J. Electrical Engineering*

LADOTD/HSAC ²⁶, *Offshore Heliport Design Guide*, APT No. 5100-R223

2.5 Classification Society Rules and Regulations

Classification societies have also established certain requirements for the design and installation of facilities on offshore production platforms. In addition to statutory requirements, these requirements may also influence the design and installation of the electrical systems. The following documents pertain to offshore oil and gas producing operations and may be applicable:

ABS ²⁷, *Rules for Building and Classing Steel Vessels*

ABS, *Rules for Building and Classing Mobile Offshore Drilling Units*

DNV ²⁸, *Rules for Classification of Mobile Offshore Units*

DNV, *Rules for Classification of Fixed Offshore Installations*

LR ²⁹, *Rules and Regulations for the Classification of Mobile Offshore Units*

LR, *Rules and Regulations for the Classification of Floating Offshore Installations at a Fixed Location*

LR, *Rules and Regulations for the Classification of Fixed Offshore Installations*

3 Acronyms, Terms, and Definitions

3.1 Acronyms

For the purposes of this document, the following acronyms apply.

ABS	American Bureau of Shipping
AFCI	arc-fault circuit interrupter
AHJ	authority having jurisdiction
ANSI	American National Standards Institute

²⁵ U.S. Department of Homeland Security, United States Coast Guard,. The *Code of Federal Regulations* is available from the U.S. Government Printing Office, Washington, D.C. 20402.

²⁶ Louisiana Department of Transportation and Development, Helicopter Safety Advisory Committee.

²⁷ American Bureau of Shipping, 16855 Northchase Drive, Houston, Texas 77060, www.eagle.org.

²⁸ Det Norske Veritas, Veritasveien 1, 1322, Hovik, Oslo, Norway, www.dnv.com.

²⁹ Lloyd's Registrar, 71 Fenchurch Street, London EC3M4BS, United Kingdom, www.lr.org.

API	American Petroleum Institute
ASD	adjustable speed drive
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWG	american wire gauge
BSSE	Bureau of Safety and Environmental Enforcement of the U.S. Department of the Interior
CSA	Canadian Standards Association
EP	explosionproof
EPR	ethylene propylene rubber
FA	forced air
FP	flameproof
FM	factory mutual research corporation
FPS	floating production system
FPSO	floating production storage offloading
FPU	floating production unit
GFCI	ground fault circuit interrupter
HMWPE	high molecular weight polyethylene
HP	horsepower
Hz	hertz (cycles per second)
IADC	International Association of Drilling Contractors
IEC	International Electrotechnical Commission
IECEX	The IECEX System (see 3.2.60)
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society of North America
IEV	International Electrotechnical Vocabulary
IMCA	International Marine Contractors Association
IMMS	Integrated Marine Monitoring System
IMO	International Maritime Organization
ISA	The International Society for Measurement and Control (formerly Instrument Society of America)
kVA	kilovolt-ampere
kW	kilowatt
LEL	lower explosive limit (LFL preferred)
LFL	lower flammable limit
MODU	mobile offshore drilling unit
MMS	Minerals Management Service, U.S. Department of the Interior (superceded by BSEE)
NACE	National Association of Corrosion Engineers
NEC	National Electrical Code

NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NRTL	Nationally Recognized Testing Laboratory
OA	open air
PA	public address
PE	polyethylene
PVC	polyvinyl chloride
SALM	single anchor leg mooring (buoy)
TEFC	totally enclosed fan cooled
TLP	tension leg platform
TENV	totally enclosed non-ventilated
UL	Underwriters Laboratories Inc.
USCG	United States Coast Guard
XLPE	crosslinked polyethylene

3.2 Definitions, Abbreviated

For the purposes of this document, the following definitions apply.

3.2.1

accessible (as applied to equipment)

Admitting close approach: not guarded by locked doors, elevation, or other effective means. (See **accessible, readily**.)

3.2.2

accessible, readily

Capable of being reached quickly for operation, renewal, or inspections, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, etc. [See **accessible (as applied to equipment)**.]

3.2.3

accessible (as applied to wiring methods)

Capable of being removed or exposed without damaging the building structure or finish, or not permanently closed in by the structure or finish of the building.

3.2.4

adjustable speed drive

ASD

A device that is used to control the speed of an AC motor by varying the frequency of the voltage supplied to it. These are also known as variable frequency drives, adjustable frequency drives and other, similar, names.

3.2.5

AEx

Required marking prefix for electrical apparatus to be installed in hazardous (classified) locations meeting one or more types of protection in accordance with harmonized American National (ANSI) Standards as defined in Article 505 of the *NEC*.

3.2.6

aluminum, copper-free (or low copper content)

Aluminum alloys containing 0.4 % or less copper.

3.2.7

apparatus, intrinsically safe

Apparatus in which all the circuits are intrinsically safe.

3.2.8

approved

Acceptable to the authority having jurisdiction. [Electrical devices that are listed or approved by a NRTL (e.g. UL, FM or CSA) normally are acceptable].

NOTE The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

3.2.9

area, enclosed (room, building, or space)

A three-dimensional space enclosed by more than two-thirds of the possible projected plane surface area and of sufficient size to allow personnel entry. For a typical building, this would require that more than two-thirds of the walls, ceiling, and/or floor be present (see API 505).

3.2.10

area, safe

See location, nonhazardous (unclassified).

3.2.11

arc-fault circuit interrupter

AFCI

A device intended to provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected.

3.2.12

associated apparatus

Apparatus used in intrinsically safe systems in which the circuits are not necessarily intrinsically safe themselves but affect the energy in the intrinsically safe circuits and are relied on to maintain intrinsic safety, see *NEC* Articles 504.4 and 505.8 for additional details.

3.2.13

atmosphere, explosive

A mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapor, mist, or dust in which, after ignition, combustion spreads throughout the unconsumed mixture.

3.2.14

bus, cable

An approved assembly of insulated conductors with fittings and conductor terminations in a totally enclosed protective metal housing, see *NEC* Article 370.

3.2.15

busway

A grounded metal enclosure containing bare or insulated conductors that usually are copper or aluminum bars, rods or tubes, see *NEC* Article 368.

3.2.16**cable, circuit integrity**

Cable that is used for critical circuits to ensure survivability for continued circuit operation for a specified time under fire conditions. See 6.7.8 for recommended applications and cable selection.

3.2.17**cable, impervious sheathed**

Cable constructed with an impervious metallic or nonmetallic overall covering that prevents the entrance of gases, moisture or vapors into the insulated conductor or cable.

3.2.18**cable, ITC**

Type ITC instrumentation tray cable is a factory assembly of two or more 300V insulated copper conductors, Nos. 22 through 12 AWG, with or without grounding conductor(s), and enclosed in a nonmetallic sheath with or without an armor as defined by *NEC* Article 727.

3.2.19**cable, ITC-ER**

Type ITC instrumentation tray cable is a factory assembly of two or more 300V insulated copper conductors, Nos. 22 through 12 AWG, with or without grounding conductor(s), and enclosed in a nonmetallic sheath with or without an armor as defined by *NEC* Article 727. This cable is suitable for exposed runs (ER) between cable tray and utilization equipment where the cables are supported and secured.

3.2.20**cable, ITC-HL**

Type ITC instrumentation tray cable is a factory assembly of two or more 300V insulated copper conductors, Nos. 22 through 12 AWG, with or without grounding conductor(s), and enclosed in a nonmetallic sheath with or without an armor as defined by *NEC* Article 727. This cable is suitable for use in Class I Zones 1 and 2. Reference *NEC* Article 505 for installation details.

3.2.21**cable, jacketed**

Cable with a nonmetallic protective covering.

3.2.22**cable, marine**

Same as cable, marine shipboard.

3.2.23**cable, marine shipboard**

Impervious sheathed armored or non-armored cable constructed in accordance with UL 1309/CSA C22.2 No. 245, or IEEE-1580, except that an overall impervious sheath is required over the armored construction, and listed as "Shipboard Cable, Marine" by a Nationally Recognized Testing Laboratory (NRTL).

3.2.24**cable, MC**

Metal-clad cable as defined by *NEC* Article 330.

3.2.25**cable, MC-HL**

Metal-clad cable for hazardous locations as defined in UL 2225.

3.2.26

cable, MI

Mineral-insulated metal-sheathed cable as defined by *NEC* Article 332.

3.2.27

cable, MV

Medium voltage single or multiphase solid dielectric insulated conductor or cable rated 2001 Volts or higher as defined by *NEC* Article 328.

3.2.28

cable, PLTC

Type PLTC nonmetallic-sheathed, power-limited tray cable. Suitable for cable trays and consisting of a factory assembly of two or more insulated copper (solid or stranded) conductors suitable for 300 Volts, Nos. 22 through 12 AWG, under a nonmetallic jacket. The cable is resistant to the spread of fire, and the outer jacket is sunlight- and moisture-resistant as defined by *NEC* Article 725.

3.2.29

cable, PLTC-ER

Type PLTC nonmetallic-sheathed, power-limited tray cable. Suitable for cable trays and consisting of a factory assembly of two or more insulated copper (solid or stranded) conductors suitable for 300 Volts, Nos. 22 through 12 AWG, under a nonmetallic jacket. The cable is resistant to the spread of fire, and the outer jacket is sunlight- and moisture-resistant as defined by *NEC* Article 725. This cable is suitable for exposed runs (ER) between cable tray and utilization equipment where the cables are supported and secured. Reference *NEC* Article 725 for installation details.

3.2.30

cable, TC

Power and control tray cable as defined by *NEC* Article 336.

3.2.31

cable, TC-ER

Power and control tray cable as defined by *NEC* Article 336. This cable is suitable for exposed runs (ER) between cable tray and utilization equipment where the cables are supported and secured. Reference *NEC* Article 336 for installation details.

3.2.32

circuit, intrinsically safe

A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions prescribed by ANSI/UL 913 and ANSI/ISA-60079-11.

3.2.33

classified locations

A hazardous (classified) location is a location classified as Division 1 or Division 2, or Zone 0, Zone 1, or Zone 2.

3.2.34

Class I location

A Class I location is one in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. (See *NEC* Article 500 and *NEC* Article 505 and API 500 and API 505.)

3.2.35

Class I, Division 1 location

A Class I, Division 1 location is a location: 1) in which ignitable concentrations of flammable gases or vapors exist continuously, intermittently, or periodically under normal operating conditions; or 2) in which ignitable concentration of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or 3) in which breakdown or faulty operation of equipment or processes might release ignitable concentrations of

flammable gases or vapors, and might also cause simultaneous failure of electrical equipment (see *NEC* Article 500 and API 500).

3.2.36

Class I, Division 2 location

A Class I, Division 2 location is a location: 1) in which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the hazardous liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only if accidental rupture or breakdown of such containers or systems or abnormal operation of equipment occurs; or 2) in which hazardous concentrations of gases or vapors are normally prevented by positive mechanical ventilation but that might become hazardous through failure or abnormal operation of the ventilating equipment; or 3) that is adjacent to a Class I, Division 1 location, and to which hazardous concentration of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided. (See *NEC* Article 500 and API 500.)

3.2.37

code of practice

A term referring to a document that describes basic safety features and methods of protection and recommends, e.g. the selection, installation, inspection, and maintenance procedures that should be followed to ensure the safe use of electrical apparatus.

3.2.38

component, make/break

Components having contacts that can interrupt a circuit (even if the interruption is transient in nature). Examples of make/break components are relays, circuit breakers, servo potentiometers, adjustable resistors, switches, connectors, and motor brushes.

3.2.39

component, protective (as applied to intrinsic safety)

A component that is so unlikely to become defective in a manner that will lower the intrinsic safety of the circuit that it may be considered not subject to fault when analyses or tests for intrinsic safety are made.

3.2.40

conditions, normal

Equipment is generally considered to be under normal conditions when it conforms electrically and mechanically with its design specifications and is used within the limits specified by the manufacturer.

3.2.41

control drawing

A drawing or other document provided by the manufacturer of intrinsically safe or associated apparatus that details the allowed interconnections between the intrinsically safe and associated apparatus.

3.2.42

device, arcing

A device that, during its normal operation, produces an arc with sufficient energy to cause ignition of an ignitable mixture.

3.2.43

device, hermetically sealed

Equipment sealed against the entrance of an external atmosphere where the seal is made by fusion, for example, soldering, brazing, welding, or the fusion of glass to metal.

3.2.44**device, high-temperature**

A device whose maximum operating temperature exceeds 80 % of the autoignition temperature in degrees Celsius (°C) of all the gas or vapor involved see 4.2.

3.2.45**device, sealed**

A device so constructed that it cannot be opened during normal operational conditions or operational maintenance and is sealed to restrict entry of an external atmosphere. Such devices may be incorporated into equipment having the type of protection referred to as "nC."

3.2.46**dilution, continuous**

The technique of supplying a protective gas flow continuously to an enclosure containing an internal potential source of flammable gas or vapor for the purpose of diluting any flammable gas or vapor that could be present to a level below its LFL/LEL.

3.2.47**EEx**

Designation of explosion-protected electrical apparatus complying with harmonized CENELEC Standards.

3.2.48**Encapsulation**

A type of protection in which the parts that could ignite an explosive atmosphere by either sparking or heating are enclosed in an encapsulant in such a way that this explosive atmosphere cannot be ignited. This type of protection is referred to as "m."

3.2.49**enclosure, electrical**

The case or housing of electrical apparatus provided to prevent personnel from accidentally contacting energized parts, and/or to protect the equipment from physical damage and the environment. Also, certain enclosures serve to prevent electrical equipment from being a source of ignition of flammable mixtures outside the enclosure.

3.2.50**enclosure, explosionproof**

An enclosure that is capable of withstanding an explosion of a gas or vapor within it and of preventing the ignition of an explosive gas or vapor that may surround it, and that operates at such an external temperature that a surrounding explosive gas or vapor will not be ignited thereby.

3.2.51**enclosure, NEMA type**

A United States (NEMA) system of rating standard levels of protection provided to electrical apparatus by enclosures for 1) the protection of persons against contact with live or moving parts inside the enclosure, 2) the protection provided by the enclosure against ingress of solids and/or liquids, 3) the protection provided by the enclosure against the deleterious effects of corrosion, and 4) the protection provided by the enclosure against damage to the formation of external ice. This enclosure type is in addition to (and not an alternative to) the types of protection necessary to ensure protection against ignition in hazardous (classified) locations, see Table 10.

3.2.52**enclosure, purged and pressurized**

An enclosure supplied with clean air or an inert gas at sufficient flow and positive pressure to reduce to an acceptably safe level any flammable gas or vapor concentration initially present, and to maintain this safe level by positive pressure with or without continuous flow, see 4.3.5.

3.2.53**entity concept**

A concept that allows interconnection of intrinsically safe apparatus to associated apparatus not specifically examined in such a combination. The criteria for interconnection is that the voltage ($V_{\max}$) and current ($I_{\max}$) which intrinsically safe apparatus can receive and remain intrinsically safe, considering faults, should be equal to or greater than the voltage (V_{oc} or V_t) and current (I_{sc} or I_t) levels which can be delivered by the associated apparatus, considering faults and applicable factors. In addition, the maximum unprotected capacitance (C_i) and inductance (L_i) of the intrinsically safe apparatus, including interconnecting wiring, should be equal to or less than the capacitance (C_a) and inductance (L_a) that can safely be connected to the associated apparatus. If these criteria are met, then the combination may be connected without compromising intrinsic safety. For additional information refer to ANSI/ISA-RP12.06.01.

3.2.54**entry, cable (cable gland)**

A device permitting the introduction of an electric cable into an electrical apparatus.

3.2.55**entry, direct**

A method of connection of an electrical apparatus to the external circuits by means of the connecting facilities inside the main enclosure or in a terminal compartment having a free opening to the main enclosure see IEC 60050, IEV 426-04-07.

3.2.56**entry, indirect**

A method of connection of an electrical apparatus to the electrical circuits by means of a terminal box or a plug and socket connection which is external to the main enclosure, see IEC 60050, IEV 426-04-08.

3.2.57**equipment, oil-immersed**

Equipment immersed in electrical insulating oil for the purpose of preventing an ignitable or corrosive gas or vapor from coming in physical contact with the equipment or for the purpose of reducing arcing of circuit breaking devices.

3.2.58**Ex**

Designation of explosion-protected electrical apparatus complying with IEC standards.

3.2.59**Ex component**

Part of electrical apparatus for explosive atmospheres which is not to be used alone in such atmospheres and which requires additional evaluation of any electrical apparatus with which it is used.

3.2.60**Ex scheme**

An international system of certification for explosion-protected electrical apparatus administered by the IEC and known as the *IEC System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres* (IECEx System) as described by IECEx-01. The eventual goal of this scheme is that a manufacturer of hazardous location electrical apparatus would be able to obtain a single 'Ex' Certificate of Conformity from one Certification Laboratory and provide that product in any participating country without legal or technical obstacle and without the need to get it recertified locally.

3.2.61**explosive limits**

The explosive limits of a gas or vapor are the lower and upper percentages by volume of concentration of gas in a gas-air mixture that will form an ignitable mixture, see Appendix to ANSI/ISA-RP12.13.02 for U.S. Bureau of Mines Bulletin 627, *Flammability Characteristics of Combustible Gases and Vapors*.

3.2.62**exposed (as applied to live parts)**

Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to all parts that are not suitably guarded, isolated, or insulated; see accessible and concealed (*NEC*).

3.2.63**exposed (as applied to wiring methods)**

On or attached to the surface or behind panels designed to allow access; see accessible: as applied to wiring methods (*NEC*).

3.2.64**facility, manned**

A facility on which people are routinely accommodated for more than 12 hours per day.

3.2.65**Flameproof**

A type of protection of electrical apparatus in which an enclosure will withstand an internal explosion of a flammable mixture which has penetrated into the interior, without suffering damage and without causing ignition, through any joints or structural openings in the enclosure, of an external explosive atmosphere consisting of one or more of the gases or vapors for which it is designed. This type of protection is referred to as "d."

NOTE See also enclosure, explosionproof.

3.2.66**Flammable**

Capable of igniting easily, burning intensely or having a rapid rate of flame spread.

3.2.67**gas, protective**

The gas used for pressurization or for the dilution of flammable gases to a level well below their lower explosive limit, usually below 25 % LFL/LEL. The protective gas may be air, nitrogen, other nonflammable gas, or a mixture of such gases.

3.2.68**gas groups (division classification method)**

For purposes of testing, approval, and area classification, various air mixtures (not oxygen enriched) are grouped as shown below.

3.2.69**Group A**

Atmospheres that do or may contain acetylene.

3.2.70**Group B**

Atmospheres that do or may contain hydrogen, or other substances specified by NFPA 497.

3.2.71**Group C**

Atmospheres that do or may contain hydrogen sulfide (H₂S), or other substances specified by NFPA 497.

3.2.72**Group D**

Atmospheres that do or may contain natural gas, hydrocarbons or other substances specified by NFPA 497.

3.2.73**gas, Group I**

A term used by ANSI/ISA-TR-12.24.01 (IEC 60079-10 MOD) to describe atmospheres containing firedamp (a mixture of gases, composed mostly of methane, found underground, usually in mines). Since this RP does not apply to installations underground in mines, this term is not used further.

3.2.74**gas, Group II**

The group used to describe gases found aboveground and subdivided into IIC, IIB, and IIA, as noted below, according to the nature of the gas or vapor, for protection techniques “d,” “ia,” and “ib” and, where applicable, “n” and “o.”

3.2.75**gas, Group IIA**

Atmospheres containing acetone, ammonia, ethyl alcohol, gasoline, methane, propane, or flammable gas, flammable liquid produced vapor, or combustible liquid produced vapor mixed with air that may burn or explode having either a maximum experimental safe gap (MESG) value greater than 0.90 mm or a minimum igniting current ratio (MIC ratio) greater than 0.80, see NFPA 497.

3.2.76**gas, Group IIB**

Atmospheres containing acetaldehyde, ethylene, or flammable gas, flammable liquid produced vapor, or combustible liquid produced vapor mixed with air that may burn or explode having either a MESG value greater than 0.50 mm and less than or equal to 0.90 mm or a MIC ratio greater than 0.45 and less than or equal to 0.80, see NFPA 497.

3.2.77**gas, Group IIC**

Atmospheres containing acetylene, hydrogen, or flammable gas, flammable liquid produced vapor, or combustible liquid produced vapor mixed with air that may burn or explode, having either a MESG value less than or equal to 0.50 mm or a MIC ratio less than or equal to 0.45, see NFPA 497.

3.2.78**grounded (earthed)**

Connected to earth or to some conducting body that serves in place of earth.

3.2.79**ignition capable**

Apparatus or wiring that under normal conditions, or under specified abnormal conditions, can release sufficient electrical or thermal energy to cause ignition of a specific explosive atmosphere.

3.2.80**increased safety**

A type of protection applied to electrical apparatus that does not produce arcs or sparks in normal service and under specified abnormal conditions, in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks. This type of protection is referred to as “e.”

3.2.81**ingress protection (IP), degree of**

A system of rating standard levels of protection provided by apparatus for the protection of persons against contact with live or moving parts inside the apparatus, as well as the protection provided by apparatus against ingress of

solids and/or liquids. This type of protection classification is in addition to (and not an alternative to) the types of protection necessary to ensure protection against ignition in hazardous (classified) locations. Definitions are found in IEC 60529, also see **enclosure type**.

3.2.82

intrinsic safety

A type of protection in which a portion of the electrical system contains only intrinsically safe apparatus, circuits, and wiring that is incapable of causing ignition in the surrounding atmosphere. No single device or wiring is intrinsically safe by itself (except for battery-operated, self-contained apparatus such as portable pagers, transceivers, gas detectors, etc., which are specifically designed as intrinsically safe self-contained devices) but is intrinsically safe only when employed in a properly designed intrinsically safe system. This type of protection is referred to as “i.”

NOTE See also associated apparatus.

3.2.83

intrinsic safety barrier

A component containing a network designed to limit the energy (voltage and current) available to the protected circuit in the hazardous (classified) location under specified fault conditions.

3.2.84

intrinsic safety ground bus

A grounding system that has a dedicated conductor separate from the power system so that ground currents will not normally flow and that is reliably connected to a grounding electrode. (For further information, refer to Article 504 of NEC and ANSI/ISA-RP12.06.01.)

3.2.85

intrinsically safe circuit

A circuit in which any spark or thermal effect, produced either normally or in specified fault conditions, is incapable, in the specified test conditions, of causing ignition of a given explosive atmosphere.

3.2.86

intrinsically safe electrical apparatus

Electrical apparatus in which all the circuits are intrinsically safe circuits.

3.2.87

intrinsically safe system

An assembly of interconnected intrinsically safe apparatus, associated apparatus, other apparatus, and interconnecting cables in which those parts of the system that may be used in hazardous (classified) locations are intrinsically safe circuits.

3.2.88

Labeled

Equipment or materials with a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

NOTE Some testing agencies use the term approved, listed, or certified to indicate compliance with the applicable standard.

3.2.89

lighting fixtures, enclosed and gasketed

Lighting fixtures (formerly referred to as “vapor-tight”) designed to prevent the entrance of gas and vapors. Such enclosures will not absolutely prevent the entrance of gases and vapors, as such tend to “breathe” as they are heated and cooled.

3.2.90**listed**

Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets appropriate designated standards or has been tested and found suitable for use in a specified manner.

NOTE The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

3.2.91**maintenance, corrective**

Any maintenance activity that is not normal in the operation of equipment and requires access to the equipment's interior. Such activities are expected to be performed by a qualified person. Such activities typically include locating causes of faulty performance, replacement of defective components, adjustment of internal controls, and the like.

3.2.92**maintenance, operational**

Any maintenance activity, excluding corrective maintenance, intended to be performed by the operator and required in order for the equipment to serve its intended purpose. Such activities typically include the correcting of zero on a panel instrument, changing charts, record keeping, adding ink, and the like.

3.2.93**minimum ignition energy****MIE**

The smallest amount of energy that can ignite the most easily ignitable mixture of a specific gas or vapor-in-air mixture or dust-in-air mixture.

3.2.94**maximum experimental safe gap****MESG**

The maximum clearance between two parallel metal surfaces that has been found, under specified test conditions, to prevent an explosion in a test chamber from being propagated to a secondary chamber containing the same gas or vapor at the same concentration.

3.2.95**minimum igniting current ratio****MIC ratio**

The ratio derived by dividing the minimum current required from an inductive spark discharge to ignite the most easily ignitable mixture of a gas or vapor by the minimum current required from an inductive spark discharge to ignite methane under the same test conditions.

3.2.96**mixture, ignitable (flammable)**

A gas-air mixture that is capable of being ignited by an open flame, electric arc or spark or high temperature. See **explosive limits**.

3.2.97**nonincendive circuit**

A circuit, other than field wiring, in which any arc or thermal effect produced, under intended operating conditions of the equipment, is not capable, under specified test conditions, of igniting the flammable gas-, vapor-, or dust-air mixture. See also **nonincendive field wiring**.

3.2.98**nonincendive component**

A component having contacts for making or breaking an incendive circuit, and the contacting mechanism is constructed so that the component is incapable of igniting the specified flammable gas or vapor-air mixture. The housing of a nonincendive component is not intended to exclude the flammable atmosphere or contain an explosion. Such devices may be incorporated into equipment having the type of protection referred to as "nC."

3.2.99**nonincendive equipment**

Equipment having electrical/electronic circuitry and components that are incapable, under normal conditions, of causing ignition of the flammable gas-, vapor-, or dust-air mixture due to arcing or thermal effect. Such devices may be incorporated into equipment having the types of protection referred to as "nA," "nC," or "nR."

3.2.100**nonincendive field wiring**

Wiring that enters or leaves an equipment enclosure and, under normal operating conditions of the equipment, is not capable, due to arcing or thermal effects, of igniting the flammable gas-, vapor-, or dust-air mixture. Normal operation includes opening, shorting, or grounding the field wiring. See also **nonincendive circuit**.

3.2.101**number, temperature identification (T Code/Temperature Class)**

A system of classification by which one of 14 temperature classes (for zones, six temperature classes) is allocated to apparatus. The temperature class represents the maximum surface temperature of any part of the apparatus that may come in contact with the flammable gas or vapor mixture.

3.2.102**oil-resistant**

Ability to withstand exposure to oil as defined by ANSI C-33.80, see UL Std 83.

3.2.103**oil sealed**

See **equipment, oil immersed**.

3.2.104**oil-immersion**

Type of protection in which the electrical apparatus or parts of the electrical apparatus are immersed in a protective liquid in such a way that an explosive atmosphere which may be above the liquid or outside the enclosure cannot be ignited. This type of protection is referred to as "o."

3.2.105**panelboard**

A single panel or group of panel units designed for assembly in the form of a single panel; including buses, automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front.

3.2.106**potting**

The encapsulation of electrical components with epoxy, elastomeric, silicone or asphaltic or similar compounds for the purpose of excluding moisture or vapors. Potted components are not necessarily hermetically sealed.

3.2.107**powder filling**

A type of protection in which the parts capable of igniting an explosive atmosphere are fixed in position and completely surrounded by filling material to prevent the ignition of an external explosive atmosphere. This type of protection is referred to as “q.”

NOTE This type of protection may not prevent the surrounding explosive atmosphere from penetrating into the apparatus and Ex components and being ignited by the circuits. However, due to the small free volumes in the filling material and due to the quenching of a flame which may propagate through the paths in the filling material, an external explosion is prevented.

3.2.108**pressurization**

The technique of guarding against the ingress of the external atmosphere into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere. This type of protection is referred to as “p.”

3.2.109**pressurization, Type X**

A method of reducing the classification within an enclosure from Division 1/Zone 1 to nonhazardous (unclassified).

3.2.110**pressurization, Type Y**

A method of reducing the classification within an enclosure from Division 1/Zone 1 to Division 2/Zone 2.

3.2.111**pressurization, Type Z**

A method of reducing the classification within an enclosure from Division 2/Zone 2 to nonhazardous (unclassified).

3.2.112**protection, special**

An IEC protection technique other than those that have been standardized. This type of protection is referred to by IEC 60079-0 as “s.”

3.2.113**protection, type of**

The specific measures applied to electrical apparatus to avoid ignition of a surrounding explosive atmosphere. Examples are “e” and “n.”

3.2.114**purging**

In a pressurized enclosure, the operation of passing a quantity of protective gas through the enclosure and ducts, so that the concentration of the explosive gas atmosphere is brought to a safe level.

3.2.115**restricted breathing**

A protection technique in which the gas- or vapor- tight integrity of an enclosure is assured so that short-term presence of a flammable gas or vapor cloud around the enclosure will not cause the concentration inside the enclosure to reach the LFL/LEL because of breathing or diffusion. This type of protection is referred to as “nR.”

3.2.116**seal, environmental**

A seal that uses O-rings, epoxy, molded elastomer, silicone compound, or potting compound to prevent corrosion due to moisture or vapors.

3.2.117

seal, explosionproof cable

A cable termination fitting filled with compound and designed to contain an explosion in the enclosure to which it is attached or to minimize passage of flammable gases or vapors from one location to another. An explosionproof conduit seal may also be used in combination with a cable termination fitting as an explosionproof cable seal.

3.2.118

seal, explosionproof conduit

A sealing fitting, filled with a poured potting compound, designed to contain an explosion in the enclosure to which it is attached and to minimize passage of flammable gases or vapors from one location to another.

3.2.119

seal, factory

A construction where components capable of initiating an internal explosion due to arcing, sparking, or thermal effects under normal conditions are isolated from the wiring system by means of factory installed flame-proof seal or joint for the purpose of eliminating the need for an external, field-installed conduit seal and, in some cases, a field-installed cable seal.

3.2.120

seal, hermetic

See device, **hermetically sealed**.

3.2.121

simple apparatus (as applied to intrinsic safety)

A device that will not generate or store more than 1.2 V, 0.1 A, 25 mW, or 20 μ J. Examples are switches, thermocouples, light-emitting diodes, connectors, and resistance temperature detectors (RTDs). Apparatus reliant on voltage or current limiting or suppression devices for remaining within the limits given in the definition, and sensors (e.g. certain gas detector sensors) that utilize catalytic reaction or other electrochemical mechanisms are excluded by IEC 60079-11 from the category of "simple apparatus". Temperature limitations as described in 4.2 are applicable to simple apparatus.

3.2.122

source of release

A point from which flammable gases or vapors, flammable liquid, combustible dusts, or ignitable fibers or flyings may be released into the atmosphere.

3.2.123

sunlight-resistant

Ability to withstand exposure to direct sunlight as defined by UL Std 1581.

3.2.124

system, intrinsically safe

An assembly of interconnected intrinsically safe apparatus, associated apparatus, and interconnecting cables in which those parts of the system that may be used in hazardous (classified) locations are intrinsically safe circuits. An intrinsically safe system may include more than one intrinsically safe circuit.

3.2.125

temperature, autoignition (AIT)

The minimum temperature required to initiate or cause self-sustained combustion of a solid, liquid, or gas independently of the heating or heated element.

3.2.126**ventilation, adequate**

Ventilation (natural or artificial) that is sufficient to prevent the accumulation of significant quantities of vapor-air mixtures in concentrations above 25 % of their lower flammable (explosive) limit, LFL (LEL). See 6.3.2 of API 500 or 6.6.2 of API 505, as applicable.

3.2.127**ventilation, inadequate**

Ventilation that is less than adequate. See 6.3.3 of API 500 or 6.6.3 of API 505, as applicable.

3.2.128**type of protection**

See **protection, type of**.

3.2.129**unclassified location**

An unclassified location is a location not classified as Division 1 or Division 2, or Zone 0, Zone 1, or Zone 2.

NOTE Within this document, the term unclassified location is used synonymously with the term nonclassified location.

3.2.130**zone**

A method of specifying the probability that a location is made hazardous by the presence, or potential presence, of flammable concentrations of gases and vapors, or combustible mixtures of dusts.

3.2.131**Zone 0 (IEC)**

An area in which an explosive gas atmosphere is present continuously or for long periods. (See IEC 60050, IEC 426-03-03.)

3.2.132**Zone 0, Class I (NEC)**

A Class I, Zone 0 location is a location 1) in which ignitable concentrations of flammable gases or vapors are present continuously; or 2) in which ignitable concentrations of flammable gases or vapors are present for long periods of time, see *NEC* Section 505.5(B)(1)

3.2.133**Zone 1 (IEC)**

An area in which an explosive gas atmosphere is likely to occur in normal operation, see IEC 60050, IEC 426-03-04.

3.2.134**Zone 1, Class I (NEC)**

A Class I, Zone 1 location is a location 1) in which ignitable concentrations of flammable gases or vapors are likely to exist under normal operating conditions; or 2) in which ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or 3) in which equipment is operated or processes are carried on, of such a nature that equipment breakdown or faulty operations could result in the release of ignitable concentrations of flammable gases or vapors and also cause simultaneous failure of electrical equipment in a mode to cause the electrical equipment to become a source of ignition; or 4) that is adjacent to a Class I, Zone 0 location from which ignitable concentrations of vapors could be communicated, unless communication is prevented by adequate positive-pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided, see *NEC* Article 505.5(B)(2).

3.2.135**Zone 2 (IEC)**

An area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it does occur, is likely to do so only infrequently and will exist for a short period only, see IEC 60050, IEV 426-03-05.

3.2.136**Zone 2, Class I (NEC)**

A Class I, Zone 2 location is a location 1) in which ignitable concentrations of flammable gases or vapors are not likely to occur in normal operation, and if they do occur, will exist only for a short period; or 2) in which volatile flammable liquids, flammable gases, or flammable vapors are handled, processed, or used, but in which the liquids, gases, or vapors normally are confined within closed containers or closed systems from which they can escape only as a result of accidental rupture or breakdown of the containers or system, or as the result of the abnormal operation of the equipment with which the liquids or gases are handled, processed, or used; or 3) in which ignitable concentrations of flammable gases or vapors normally are prevented by positive mechanical ventilation, but which may become hazardous as the result of failure or abnormal operation of the ventilation equipment; or 4) that is adjacent to a Class I, Zone 1 location, from which ignitable concentrations of flammable gases or vapors could be communicated, unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided, see *NEC* Section 505.5(B)(3).

3.3 Definitions Specific to Floating Facilities**3.3.1****Cargo**

A flammable gas or vapor or combustible liquid, flammable liquid, or liquefied flammable gas with a (closed cup) flash point below 60 °C (140 ° F).

3.3.2**cargo handling room**

Any enclosed space where cargo is pumped, compressed, or processed. Examples of cargo handling rooms are cargo pump rooms, cargo compressor rooms, and cargo valve rooms.

3.3.3**cargo tank**

Any tank or vessel, located in the below deck area, designed to contain cargo.

3.3.4**corrosion-resistant material or finish**

A term used to describe any material or finish that meets the testing requirements of ASTM B117 or Test Kb in IEC 68-2-52 for 200 hours and does not show pitting, cracking, or other deterioration more severe than that resulting from a similar test on passivated AISC Type 304 stainless steel.

3.3.5**corrosive location**

A location exposed to the weather, salt water, or other corrosive substances such as drilling fluids.

3.3.6**drip-proof**

Equipment enclosed so that it meets at least a NEMA 250 Type 1 with a drip shield, NEMA 250 Type 2, or IEC IP 32 rating.

3.3.7**embarkation station**

A location from which persons embark into survival craft or are assembled prior to embarking into survival craft.

3.3.8**space, machinery**

An enclosed area that contains rotating equipment or internal combustion machinery with a total aggregate power is at least 500 brake horsepower or a place containing internal combustion machinery, thermal fluid heaters, or fired boilers that use fuel gas or a liquid fuel that has a flash point of less than 43.3 °C (110 °F).

3.3.9**location not requiring an exceptional degree of protection**

A location that is not exposed to the environmental conditions outlined in the definition of 3.3.9. These locations include: a) accommodation spaces such as quarters buildings, b) dry store rooms, and c) other locations with similar environmental conditions.

3.3.10**location requiring an exceptional degree of protection**

A location exposed to weather, seas, splashing, pressure-directed liquids, or similar moisture conditions. These locations include a) on-deck areas; b) machinery spaces; c) cargo spaces; d) locations within a galley or pantry area, laundry, or water closet that contains a shower or bath; and e) other spaces with similar environmental conditions.

3.3.11**water-tight**

Equipment so enclosed that it meets at least a NEMA 250 Type 4 or 4X or an IEC IP 55 or 56 rating.

4 Electrical Equipment for Hazardous (Classified) Locations

4.1 General

4.1.1 The selection of proper electrical equipment for offshore petroleum facilities depends directly on whether a particular area is classified or not, and whether a classified area is Class I, Zone 0, Zone 1, or Zone 2. Because the safety of an installation is highly sensitive to equipment selection, it is very important to have a clear understanding of the reasons behind the classification of areas and of the different methods employed by electrical equipment manufacturers to make their equipment suitable for the different hazardous (classified) locations.

4.1.2 Through design engineering judgment in planning electrical installations for offshore petroleum facilities, most equipment may be placed in lower classified or unclassified locations to reduce the amount of special equipment required. The degree of classification may be reduced or eliminated by purging, as described in 4.3.5, or with the use of gas detection as allowed in API 505, section 6.8. The use of a gas detection system as a method of protection shall be designed, installed and maintained in accordance with ISA-TR 12.13.03. For electrical equipment installed in buildings in unclassified locations, see 12.6.

4.1.3 *Use of Division rated equipment in Zone classified locations.* Equipment listed and marked in accordance with 4.6 for Class I, Division 1 hazardous (classified) locations may be used in Class I, Zone 1 or 2 locations for the same gas and with a suitable temperature rating. Equipment listed and marked in accordance with 4.6 for Class I, Division 2 hazardous (classified) locations may be used in Class I, Zone 2 locations for the same gas and with a suitable temperature rating.

4.1.4 The "Definitions" section of this RP includes brief definitions of hazardous (classified) locations and various types of equipment used in hazardous (classified) locations. This section expands upon certain of these definitions and provides guidance to proper application of electrical equipment. For specific guidance on classification of petroleum facilities, refer to API 505.

4.1.5 Dual classification. In instances of areas within the same facility classified separately, Class I, Zone 2 locations may abut but shall not overlap, Class I, Division 2 locations. Class I, Zone 0 or 1 locations shall not abut Class I, Division 1 or 2 locations.

4.1.6 Reclassification. Class I, Division 1 or 2 locations may be reclassified as Class I, Zone 0, 1, or 2 locations provided that all of the space classified due to a single flammable source is reclassified.

4.2 High-temperature Devices

4.2.1 High-temperature devices are defined as those devices whose maximum operating temperature exceed 80 % of the autoignition temperature in degrees Celsius (°C) of the gas or vapor involved. The maximum operating temperature refers to the skin temperature of components in the interior of enclosures and to the surface temperature of lamps inside lighting fixtures. For offshore applications, the most commonly encountered explosive gas is natural gas, composed primarily of methane. The autoignition temperature of natural gas is usually considered to be 900 °F (482 °C) and any device whose operating temperature exceeds 726 °F (386 °C) in natural gas environments should be considered a high-temperature device. The autoignition temperature of hydrogen sulfide is usually considered to be 500 °F (260 °C) and any device whose operating temperature exceeds 406 °F (208 °C) in H₂S environments should be considered a high-temperature device. A review of production installations should be made to determine the presence of other gases with lower autoignition temperatures.

4.2.2 High temperature devices shall be installed in flameproof, explosionproof, or purged and pressurized enclosures unless they have been determined to be suitable for the location by a nationally recognized testing laboratory.

4.2.3 Certain equipment (Zone-rated equipment) is tested by nationally recognized testing laboratories and given one of 6 temperature classification numbers ("T" ratings). This equipment may exceed the temperature determined by the "80 % rule," but the "T" rating shall be below the autoignition temperature of the specific gas or vapor involved. As an example, equipment rated T1 has been verified not to exceed 450 °C (842 °F), and therefore is suitable for most natural gas applications. Reference *NEC* Table 505.9(D)(1).

4.2.4 Certain other equipment (Division-rated equipment) is given one of 14 Temperature classes (also known as "T" ratings). Reference *NEC* Table 500.8(C). The remarks made under 4.2.3, apply also to this equipment.

4.3 Protection Techniques Related To Equipment Suitable for use in Locations Classified as Division 1 or Division 2

NOTE This section is included in Recommended Practice 14FZ because equipment approved for Division-classified locations may, in certain cases, be installed in Zone-classified locations (see 6.4.1.5).

4.3.1 Explosionproof Equipment

4.3.1.1 An explosionproof assembly is electrical equipment packaged in an enclosure that is capable of withstanding an internal explosion and preventing its propagation to the external atmosphere. Such explosionproof equipment is suitable for use in both Division 1 and Division 2 locations.

4.3.1.2 Explosionproof enclosures breathe when the ambient temperature changes and, therefore, may accumulate flammable gases within. If an explosion occurs within, the enclosure should withstand a very rapid buildup of pressure. The gases escaping will relieve the pressure buildup. These gases should be cooled sufficiently before they reach the surrounding atmosphere to prevent ignition if the surrounding atmosphere is flammable. Three methods are widely used to achieve this cooling:

- a) precision ground flanges or joints machined to specific widths and narrow tolerances;
- b) threaded joints; and

c) precision serrated joints.

4.3.1.3 In addition, the surface temperature of the enclosure shall not be higher than 80 % of the autoignition temperature in °C of the gas or vapor involved or the assembly should be determined to be suitable for the specific area by a recognized testing laboratory ("T-rated"). See 4.2.3.

4.3.1.4 It is important that explosionproof enclosures be installed and maintained in accordance with the manufacturer's instructions. If covers are not installed with the number and specified types of bolts, properly torqued, or other specified securing devices, internal explosions can discharge insufficiently cooled gasses that are capable of igniting external flammable atmospheres. Additionally, external flammable atmospheres can be ignited if precision ground flanges or joints are damaged by mechanical means or corrosion or if all entries are not provided with approved entry methods or specified stopping plugs. See 12.1.1.

4.3.2 Hermetically Sealed Devices

Hermetically sealed devices are designed to prevent hazardous gases from coming in contact with sources of ignition such as arcing contacts. These devices are suitable for use in Division 2 and unclassified locations. The materials employed to accomplish the hermetic sealing should be resistant to mechanical abuse and durable enough to withstand normal aging, exposure to hydrocarbons and any other chemicals and the effects of severe weather. The bond between the different materials employed should be permanent, mechanically strong, and capable of withstanding the surrounding environment.

NOTE Hermetically sealed enclosures are sealed through glass-to-metal or metal-to-metal fusion at all joints and terminals. Enclosures whose seals are accomplished by O-rings, epoxy, molded elastomer, potting or silicone compounds are not to be considered hermetically sealed unless such equipment has been determined to be suitable for the specific Division 2 location by a NRTL.

4.3.3 Intrinsically Safe Systems

4.3.3.1 Intrinsically safe circuits are incapable of releasing sufficient electrical or thermal energy under prescribed test conditions (as specified by ANSI/UL 913) to cause ignition of a specific hazardous atmospheric mixture in its most easily ignitable concentration. Test conditions include both normal and abnormal operating conditions. Abnormal equipment conditions include accidental damage to or failure of the equipment, wiring, insulation, or other components and exposure to overvoltage. Normal conditions include periods of adjustment and maintenance. The most common applications are found in the fields of instrumentation and communications.

4.3.3.2 Intrinsically safe apparatus is apparatus in which all the circuits are intrinsically safe. Associated apparatus are apparatus in which the circuits are not necessarily intrinsically safe themselves, but are apparatus that affect the energy in the intrinsically safe circuits and are relied upon to maintain intrinsic safety. Typically, associated apparatus are shunt diode safety barriers (frequently referred to as intrinsically safe barriers) that limit the transfer of energy to a level that cannot ignite flammable atmospheres. The devices are connected in series with signal conductors to transducers and other devices in process plants. Associated apparatus shall be installed in an unclassified location or provided an alternate type protection (e.g. an explosionproof enclosure) suitable for the area in which it is installed.

4.3.3.3 An intrinsically safe system is an assembly of interconnected intrinsically safe apparatus, associated apparatus, and interconnecting cables in which those parts of the system that may be used in hazardous (classified) locations are intrinsically safe circuits. Intrinsically safe systems are suitable for use in unclassified, Division 1 or Division 2 locations. However, such systems may require that specific equipment items, such as controllers or panel instruments, be located in an unclassified location. Where a nationally recognized testing laboratory has rated such equipment (apparatus) intrinsically safe, it may be employed with various end devices to form an intrinsically safe system. No end device is intrinsically safe by itself, but is intrinsically safe only when employed in a properly designed intrinsically safe system. Proper design of an intrinsically safe system requires adherence to strict rules, detailed mathematical analysis, and, in most cases, laboratory testing. UL 913, ANSI/ISA-60079-11, and NEC Article 504 should be followed closely when designing and installing an intrinsically safe system. Also, control drawings should

be followed closely. Control drawings are drawings or other documentation provided by the manufacturer of the intrinsically safe or associated apparatus that detail the allowed interconnection between the intrinsically safe and associated apparatus.

4.3.3.4 The two most important advantages of intrinsically safe equipment are as follows.

4.3.3.4.1 Safety

Intrinsically safe apparatus does not require explosionproof enclosures. Thus, missing bolts and covers, open enclosures during maintenance and testing operations, corroded conduit systems, etc., do not impair the safety of the systems from the standpoint of igniting gas or vapors. The low voltages and currents involved may reduce the hazard of electrical shock.

4.3.3.4.2 Convenience

Wiring for intrinsically safe systems needs only to meet the requirements of *NEC* Article 504, eliminating the requirement for bulky, explosionproof enclosures. Intrinsically safe apparatus and wiring may be installed using any of the wiring methods suitable for unclassified locations. Maintenance and calibration operations can be performed in hazardous (classified) locations without de-energizing the equipment or shutting down process equipment.

4.3.4 Nonincendive Equipment

4.3.4.1 Nonincendive equipment shall not be capable of igniting a hazardous mixture under normal circumstances, but ignition is not necessarily prevented under abnormal circumstances. Such equipment is suitable for use only in Division 2 and unclassified locations. Nonincendive equipment is similar in design to other equipment suitable for Division 2 locations; however, in nonincendive equipment, sliding or make-and-break contacts need not be explosionproof, oil-immersed, or hermetically sealed, as such contacts are incapable of releasing sufficient energy to cause ignition under normal operating conditions.

4.3.4.2 Because portions of the system may operate at energy levels potentially capable of causing ignition, wiring methods used shall conform to area classification requirements. Nonincendive equipment is normally limited to instrumentation and communications systems. When employing nonincendive systems, extreme care should be exercised.

4.3.5 Purged Enclosures

4.3.5.1 Purging (also referred to as pressurizing) is a method of installing electrical equipment in a hazardous (classified) location without using explosionproof enclosures. NFPA 496 provides information for the design of purged enclosures and purging methods to reduce the classification of the area within an enclosure:

- a) from Division 1 to unclassified (Type X purging);
- b) from Division 1 to Division 2 (Type Y purging);
- c) from Division 2 to unclassified (Type Z purging).

4.3.5.2 NFPA 496 discusses the different requirements for purging of small enclosures, power equipment enclosures, and large volume enclosures such as control rooms. On an offshore platform, the use of humid salt air for purging may cause corrosion damage to equipment; thus, use of inert gas or dehydrated clean air should be considered where practicable. The source of clean air should be from an unclassified location.

4.4 Protection Techniques Related to Equipment Approved for Zone 0, Zone 1, or Zone 2 Locations

4.4.1 General

Acceptance of Protection Techniques related to equipment approved for zones may vary between AHJs. Specific requirements may have to be addressed for AHJ approvals.

4.4.2 Flameproof “d”

Flameproof is a type of protection of electrical equipment in which the enclosure will withstand an internal explosion of a flammable mixture that has penetrated into the interior, without suffering damage and without causing ignition, through any joints or structural openings in the enclosure, of an external explosive atmosphere consisting of one or more of the gases or vapors for which it is designed. This protection technique is permitted for equipment in Class I, Zone 1 locations for which it is approved. For further information, see ANSI/ISA-60079-1 2009, *Explosive Atmospheres—Part 1: Equipment Protection by Flameproof Enclosures “d”*.

4.4.3 Pressurization “p”

4.4.3.1 In some cases, hazards may be reduced or hazardous (classified) locations limited or eliminated by adequate positive-pressure ventilation from a source of clean air in conjunction with effective safeguards against ventilation failure. Pressurization “p” is a type of protection of electrical equipment that uses the technique of guarding against the ingress of the external atmosphere that may be explosive, into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere. This protection technique is permitted for equipment in those Class I, Zone 1 or Zone 2 locations for which it is approved. For further information, see *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, ANSI/NFPA 496. For further information, see *Electrical Apparatus for Explosive Gas Atmospheres—Part 2: Electrical Apparatus, Type of Protection “p”*, IEC 60079-2; and *Electrical Apparatus for Explosive Gas Atmospheres—Part 13: Construction and Use of Rooms or Buildings Protected by Pressurization*, IEC 60079-13.

4.4.3.2 From Zone 1 to unclassified (Type px pressurization).

4.4.3.3 From Zone 1 to Zone 2 (Type py pressurization).

4.4.3.4 From Zone 2 to unclassified (Type pz pressurization).

4.4.4 Intrinsic Safety “ia”, “ib”, and “ic”

4.4.4.1 Intrinsically safe circuits are incapable of releasing sufficient electrical or thermal energy under prescribed test conditions to cause ignition of a specific hazardous atmospheric mixture in its most easily ignitable concentration. Test conditions include both normal and abnormal operating conditions. Abnormal equipment conditions include accidental damage to or failure of the equipment, wiring, insulation, or other components and exposure to overvoltage. Normal conditions include periods of adjustment and maintenance. The most common applications are found in the fields of instrumentation and communications. Intrinsic safety is designated as Type “i” protection. Type “i” protection is subdivided into categories “ia”, “ib”, and “ic.”

4.4.4.1.1 “Intrinsic Safety” suitable for use in Zones 0, 1, and 2 locations is designated category “ia” by ANSI/ISA-60079-11 (12.02.02)-2002.

4.4.4.1.2 “Intrinsic Safety” suitable for use in Zones 1 and 2 locations is designated category “ib” by ANSI/ISA-60079-11 (12.02.02)-2002.

4.4.4.1.3 “Intrinsic Safety” suitable for use in Zone 2 locations is designated category “ic” by ANSI/ISA-60079-11 (12.02.02)-2002.

NOTE For further information, see *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Hazardous Locations*, ANSI/UL 913; and *Electrical Apparatus for Explosive Gas Atmospheres—Part 11: Intrinsic Safety “i.”*

4.4.4.2 Simple apparatus incorporated in intrinsically safe circuits is permitted in Class I, Zone 0 or Zone 1 locations, according to the category of the associated apparatus. Such apparatus need not be listed, certified, or approved, provided that the associated apparatus is suitably listed, certified, or approved and provided that neither the capacitance nor the inductance of the simple apparatus, considered together with the electrical parameters of the field cabling, exceeds the relevant limits given in the documentation or marking of the associated apparatus.

4.4.4.3 Intrinsically safe associated apparatus, designated by [ia], [ib], or [ic], is connected to intrinsically safe equipment (“a”, “ib”, or “ic,” respectively), but is located outside the hazardous (classified) location unless also protected by another type of protection (such as flameproof).

4.4.5 Type of Protection “n”

Type “n” protection is a type of protection applied to electrical equipment such that, in normal operation, the electrical equipment is not capable of igniting a surrounding explosive gas atmosphere and a fault capable of causing ignition is not likely to occur. This protection technique is permitted for equipment in Class I, Zone 2 locations for which it is approved. Type of protection “n” is further subdivided into nA, nC, nL, and nR. See Table 1 for the descriptions of subdivisions for type of protection “n.” For further information, see ANSI/ISA-60079-15 (12.12.02)-2009, *Electrical Apparatus for Use In Class I, Zone 2 Hazardous (Classified) Locations Type of Protection —“n”*, ISA-S12.12.01.

NOTE The use of nL protection technique is a departure from the *NEC* as the type of protection nL is not listed in the 2011 edition of the *NEC*.

4.4.6 Oil Immersion “o”

Oil Immersion is a type of protection in which the electrical equipment or parts of the electrical equipment are immersed in a protective liquid in such a way that an explosive atmosphere that may be above the liquid or outside the enclosure cannot be ignited. This protection technique is permitted for equipment in Class I, Zone 1 locations for which it is approved. For further information, see ANSI/ISA-60079-6, *Explosive Atmospheres—Part 6: Equipment Protection by Oil Immersion “o”*.

4.4.7 Increased Safety “e”

Increased Safety is a type of protection applied to electrical equipment that does not produce arcs or sparks in normal service and under specified abnormal conditions, in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks. This protection technique is permitted for equipment in Class I, Zone 1 locations for which it is approved. For further information, see ANSI/ISA-60079-7 (12.16.01) 2008, *Explosive Atmospheres—Part 7: Equipment protection by increased safety “e”*.

4.4.8 Encapsulation “ma” and “mb”

Encapsulation is a type of protection in which the parts that could ignite an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way that this explosive atmosphere cannot be ignited. This protection technique is permitted for equipment in Class I, Zone 1 locations for which it is approved. For further information, see ANSI/ISA-60079-18, *Electrical Apparatus for Use In Class I, Zone 1 Hazardous (Classified) Locations Type of Protection—Encapsulation “m”*. Encapsulation suitable for use in Zone’s 0, 1 and 2 locations is designated category “ma”. Encapsulation suitable for use in Zones 1 and 2 locations is designated category “mb”.

4.4.9 Powder Filling “q”

Powder Filling is a type of protection in which the parts capable of igniting an explosive atmosphere are fixed in position and completely surrounded by filling material (glass or quartz powder) to prevent the ignition of an external

Table 1—Types of Protection Designation

Designation	Technique	Zone ^a
d	Flameproof enclosure	1,2
e	Increased safety	1,2
ia	Intrinsic safety	0,1,2
ib	intrinsic safety	1,2
ic	Intrinsic safety	2
[ia] ^b	Intrinsically safe associated apparatus	Non-hazardous
[ib] ^b	Intrinsically safe associated apparatus	Non-hazardous
[ic] ^b	Intrinsically safe associated apparatus	Non-hazardous
ma	Encapsulation	0,1,2
mb	Encapsulation	1,2
nA	Non-sparking equipment	2
nC	Sparking equipment in which the contacts are suitably protected other than by restricted breathing enclosure.	2
nL	Energy Limited – Limit the energy of sparks and surface temperatures	2
nR	Restricted breathing enclosure	2
o	Oil immersion	1,2
px	Pressurization	1
py	Pressurization	1
pz	Pressurization	2 ^c
q	Powder-filled	1,2
^a Does not address use where a combination of techniques is used. ^b See 4.4.4.2. ^c Dependent upon factors such as the provision of automatic shutdown or alarm only on loss of pressurization, the arrangement for the exhaust of the protective gas, the inclusion of sparking/arcing or high temperature devices within the enclosure, etc.		

explosive atmosphere. This protection technique is permitted for equipment in Class I, Zone 1 locations for which it is approved. For further information, see ANSI/ISA-60079-5, *Explosive Atmospheres—Part 5: Equipment Protection by Powder Filling “q”*.

4.5 General Purpose Equipment

General purpose equipment or equipment in general purpose enclosures is permitted in Zone 2 locations if the equipment does not constitute a source of ignition (arcing, sparking, or high-temperature devices) under normal operating conditions.

4.6 Listing, Marking and Documentation

4.6.1 Listing

Equipment that is listed for a Zone 0 location is permitted in a Zone 0, Zone 1, or Zone 2 location of the same gas or vapor. Equipment that is listed for a Zone 1 location is permitted in a Zone 1 or Zone 2 location of the same gas or vapor.

4.6.2 Marking

4.6.2.1 Equipment for use in locations classified by the Zone classification system shall be marked in accordance with (a) or (b) below:

a) **Division Equipment.** Equipment approved for Class I, Division 1 or Class I, Division 2 locations shall be marked to show the class, group and operating temperature or temperature range (see "temperature identification number") referenced to a 40 °C (104 °F) ambient as follows:

- 1) Class I, Division 1 or Class I, Division 2, as applicable.
- 2) Applicable gas classification group(s).
- 3) Temperature classification.

NOTE 1 The "Class I, Division 1" marking is allowed in Class I, Zone 1 or Class I, Zone 2 locations. Such equipment may also be marked as Class I, Zone 1.

NOTE 2 The "Class I, Division 2" marking is allowed in Class I, Zone 2 locations. Such equipment may also be marked as Class I, Zone 2.

NOTE 3 Equipment suitable for ambient temperatures between -20 °C to +40 °C shall require no ambient temperature marking. Equipment suitable for ambient temperatures other than -20 °C to +40 °C shall additionally be marked with the maximum and minimum ambient temperature in degrees Celsius. The marking shall include either the symbol "Ta" or "Tamb".

NOTE 4 It is recommended that the end user specify that the marking on dual-marked equipment used in Class I, Zone 1 or Class I, Zone 2 classified locations contain the information required by 4.6.2.1(b).

b) **Zone Equipment.** Equipment approved for Class I, Zone 0, Zone 1, or Zone 2 locations shall be marked as follows:

- (i) Class
- (ii) Zone
- (iii) Symbol "AEx"
- (iv) Protection technique(s)
- (v) Applicable gas classification group(s)
- (vi) Temperature classification

An example of such a required marking is "Class I, Zone 0 AEx ia IIC T6."

Electrical equipment of types of protection e, m, p, or q (including ma, mb, px, py, or pz) shall be marked Group II. Electrical equipment of types of protection d, ia, ib, [ia], or [ib] (including ic or [ic]) shall be marked Group IIA, or IIB, or IIC, or for a specific gas or vapor. Electrical equipment of types of protection n shall be marked Group II unless it contains enclosed-break devices, nonincendive components, or energy-limited equipment or circuits, in which case it shall be marked Group IIA, IIB, or IIC, or a specific gas or vapor. Electrical equipment of other types of protection shall be marked Group II unless the type of protection utilized by the equipment requires that it shall be marked Group IIA, IIB, or IIC, or a specific gas or vapor. An explanation of marking required is shown below.

4.7 Gas Group

4.7.1 Zone equipment of certain types is allocated to one of three Groups (IIA, IIB, or IIC). Equipment of any of these groups is suitable for use in natural gas environments.

NOTE Group IIC equipment, and equipment marked Group II, without suffix letter, is suitable where gases or vapors of any Group can be present. Group IIB equipment is suitable where gases or vapors of Group IIB or IIA (but not IIC) can be present. Group IIA equipment is suitable only where no flammable gas or vapor other than of Group IIA can be present.

4.7.2 Division equipment of certain types is marked to show one or several of four Gas Groups (A–D). Equipment marked for Group D is suitable for use in natural gas environments.

5 Electric Power Generating Stations

5.1 General

5.1.1 Electric power generating stations discussed in this section consist of one or more generator sets that may be either portable or permanent by design. These recommendations include both sound engineering practices and special considerations for safe and reliable operation on offshore petroleum facilities.

5.1.2 Natural gas fueled prime movers are most practical for the majority of applications, but diesel engines are usually utilized where natural gas is not available or for standby or portable units. Gasoline engines normally are unacceptable.

5.1.3 The location and installation of generating sets should allow access for inspection, maintenance, and repair. There should be sufficient space between the generator set and surrounding objects to provide accessibility. It is recommended that sufficient room and lifting capability be provided to facilitate service and removal of the generator rotor or its armature.

5.1.4 The generator and its driving unit should be mounted on a common rigid sub-base or other means engineered to ensure proper alignment. For reciprocating engine driven generators, it is recommended that any local instrument and electrical control panels be isolated to prevent damage from vibration.

5.2 Prime Movers

5.2.1 Sizing

It is recommended that prime movers for generator applications have a minimum continuous shaft horsepower (HP) output according to Equation (1):

$$HP_{MIN} = \frac{Design\ kw\ Load}{0.746 \times Generator\ Efficiency} \quad (1)$$

The efficiency of 25 kW and larger generators typically ranges from 0.88 to 0.94. Allowing 1.5 HP per kW output yields a conservative prime mover power requirement. All prime mover ratings should be adjusted for the highest

expected ambient temperatures offshore and derated for total system inlet and exhaust pressure losses and end of life degradation. Generally, gas turbines are much more sensitive to these conditions. Special consideration should be made when sizing prime movers for service where large motors will be started across the line. See 5.3.2.1 for further information.

5.2.2 Air Intakes

It is recommended that engine combustion air intakes be located in unclassified locations to minimize the risk of ingestion of flammable mixtures. All diesel-fueled prime movers shall be equipped with an air-intake shutoff valve or other suitable device that operates on an overspeed condition that requires shutdown of the prime mover.

5.2.3 Exhausts

It is recommended that engine exhausts be located in unclassified locations, whenever possible, to minimize the risk of ignition of flammable mixtures.

5.2.4 Speed

Reciprocating engines normally are coupled directly to generators and operate at either 720 rpm, 900 rpm, 1200 rpm or 1800 rpm for 60 Hz generators. For reduced maintenance and increased life, it is recommended that reciprocating-type engines for prime (continuous) power installations be operated at 1200 rpm or less. Reciprocating-type engines for standby (non-continuous) applications often are operated at speeds up to 1800 rpm. Gas turbines normally operate at higher speeds and drive generators through gearbox assemblies.

5.2.5 Reciprocating Engine Controls

5.2.5.1 Automatic controls shall be provided to shut down all reciprocating engines that are driving generators and open generator breaker when any of the following occur:

- a) low lube oil pressure;
- b) high jacket water temperature;
- c) overspeed shutdowns should operate independently of governor controllers and should be set at no more than 115 % of rated speed;
- d) overvoltage, and for generators 500 kW and larger, it is recommended that overvoltage shutdown controls be provided and that generator circuit breakers be tripped and voltage regulators are de-energized;
- e) over crank/fail to start;
- f) high exhaust temperature when applicable, such as turbocharged units.

5.2.5.2 Optional shutdown controls include:

- a) low lube oil level;
- b) low jacket water level;
- c) underspeed, it is recommended to open generator circuit only and leave engine running to facilitate system recovery;
- d) vibration, for generators 250 kW and larger;

- e) high lube oil temperature;
- f) undervoltage, for generators 500 kW and larger, it is recommended to open generator circuit only and leave engine running to facilitate system recovery;
- g) underfrequency, for generators 500 kW and larger, it is recommended to open generator circuit only and leave engine running to facilitate system recovery;
- h) loss of excitation, for generators 950 kW or larger or units that are to be paralleled;
- i) generator differential, for generators 950 kW or larger;
- j) overfrequency, for generators 500 kW or larger.

5.2.6 Gas Turbine Controls

5.2.6.1 Automatic controls shall be provided to shut down gas turbines that are driving generators and open the generator circuit breakers when any of the following conditions occur:

- a) fail to crank, fail-to-start, fail to ignite;
- b) high running exhaust temperature;
- c) high lube oil temperature;
- d) low lube oil pressure;
- e) underspeed;
- f) overspeed, shutdowns should operate independently of governor controllers and should not be set more than 115 % of rated speed;
- g) vibration;
- h) Overvoltage, and for generators 500 kW and larger, it is recommended that overvoltage shutdown controls be provided and that generator circuit breakers be tripped and voltage regulators be de-energized;
- i) high bearing temperature;
- j) high Inlet air filter differential pressure.

5.2.6.2 Optional shut-down controls include:

- a) overfrequency, for generators 500 kW and larger;
- b) loss of excitation, for generators 950 kW and larger or units that are to be paralleled;
- c) generator differential for generators 950 kW and larger;
- d) undervoltage, and for generators 500 kW and larger, it is recommended to open generator circuit only and leave engine running to facilitate system recovery;

e) underfrequency, and for generators 500 kW and larger, it is recommended to open generator circuit only and leave engine running to facilitate system recovery.

5.2.7 Governors

The prime-mover governor performance is critical to satisfactory electric power generation in terms of constant frequency, response to load changes, and the ability to operate in parallel with other generators. Three basic types of governors are discussed below.

5.2.7.1 Mechanical Governors

The mechanical-type governor has the slowest response to load changes and provides the least accuracy in speed control, and, therefore, should be considered only for small generator units where close frequency control is not required. It is not suitable for continuous parallel operation.

5.2.7.2 Hydraulic-mechanical Governors

The hydraulic-mechanical governor provides fast response to load changes and close speed control. This governor can be equipped with an electric motor to allow for remote speed control. The governor is adjustable to operate in either isochronous (constant speed) or droop (speed decreases with load) mode, thus allowing its use for continuous parallel generator operation.

5.2.7.3 Electronic Governors

5.2.7.3.1 The electronic analog or digital governor system provides the highest accuracy and fastest response. It senses engine speed from either the frequency of the generated voltage or a magnetic pickup installed on the engine.

5.2.7.3.2 Automatic load sharing control and automatic synchronization can be incorporated with this type governor and is desirable for multi-unit continuous parallel operation. Generally, load sharing controls for paralleled units ensure that each online generator delivers its proportionate share of total load. Proportionate share is determined according to the nameplate ratings of each online generator.

5.2.7.4 Governor—General Requirements

5.2.7.4.1 The steady state speed variation should not exceed 0.5 % (e.g. 0.3 Hz for a 60 Hz machine) of rated speed at any load condition.

5.2.7.4.2 Each prime mover should be under control of a governor capable of limiting the speed, when full load is suddenly removed, to a maximum of 110 % of the rated speed.

5.2.7.4.3 For emergency generators, the prime mover and regulating governor shall be capable of assuming the sum total of all emergency loads upon closure to the emergency bus. The response time and speed deviation shall be within 5 seconds and 10 % respectively for 50 % load steps.

5.2.8 Starting Systems

Electric motor, compressed air and natural gas pneumatic motor, and hydraulic motor starters are available for both reciprocating engines and small-to-medium-sized gas turbines. All three types of starters may be safely used in hazardous (classified) locations, provided that electric starter systems are approved for the area. It is recommended that engine-starting batteries not be used for control system power because of a potentially significant voltage drop during and immediately following cranking.

5.2.9 Fuel Systems

A fail-closed fuel shut-down valve should be provided on natural gas-fueled prime movers. An air intake shut-off valve should be installed on diesel-fueled prime movers. These valves would be operated under emergency conditions that require prime mover/generator shutdown as identified by a SAFE Chart analysis performed in accordance with API 14C.

5.2.10 Ignition Systems

For prime movers installed in hazardous (classified) locations, ignition systems should be designed and installed to minimize the possibility of the systems being a source of ignition to surrounding flammable gases. All engines with electrical ignition systems should be equipped with a system designed to minimize the potential for the release of sufficient electrical energy to cause ignition of an external, ignitable mixture. Systems verified by a Nationally Recognized Testing Laboratory (NRTL) as suitable for hazardous (classified) locations are recommended. Reference ANSI/ISA- 12.20.01 *General Requirements for Electrical Ignition Systems for Internal Combustion Engines in Class I, Division 2 or Zone 2, Hazardous (Classified) Locations*. Breaker point distributor-type ignition systems should not be used in areas classified as Class I, Zones 0, 1, or 2, by API 505. All wiring should be minimized in length; kept in good condition, clean, clear of hot or rubbing objects; suitable for the voltage; and suitable for the ambient temperature. Supplemental mechanical protection of the wiring (metallic or nonmetallic) is not required.

5.3 Generators

5.3.1 General

Electric generators should be designed to perform in accordance with NEMA Standards Publication MG1. Generators used offshore normally are three-phase, except for small systems that serve only single-phase loads. It is recommended that API/ANSI 546 be considered for the design and testing of medium voltage generators: For testing of synchronous generators, IEEE Std 115 may also be referenced.

5.3.2 Selection and Sizing

5.3.2.1 Sizing

Generators are designed to carry full nameplate rating in kilowatts (kW) provided the nameplate kilovolt ampere (kVA) rating is not exceeded. Generators normally are rated for 0.8 power factor (power factor = kW/kVA) at sea level. Air-cooled units are designed to operate in 40 °C (104 °F) ambient conditions. Generators operated in ambient temperatures in excess of 40 °C (104 °F), such as in unit enclosures, should be properly derated. Where generators are totally enclosed and water cooled (TEWAC), the generator should be designed to operate at the maximum site cooling water temperature. The generator station rating should be at least equal to the highest expected system operating load. It is recommended that each generator should be at least equal to the driver output. A generator operated in excess of its continuous rating will experience a significant reduction in life. If the system load has a large motor or a group of motors starting simultaneously, an analysis of the voltage dip during starting should be performed. It is recommended that this analysis be performed when the total horsepower of the motors being started simultaneously exceeds 20 % of the generator nameplate kVA rating. The generator prime mover rating may also need to be increased to be able to accelerate motor(s) to rated speed. Techniques such as soft starting (e.g. reduced voltage autotransformer starters, electronic soft starters, and adjustable speed drives) may be utilized to reduce the required capacity of generators when motor starting is of concern.

5.3.2.2 Load Analysis

It is recommended that a load analysis be performed to determine the aggregate power requirements of all the electric power consuming devices under the various operating conditions of the facility. Operating load factors should be determined for each individual item of equipment and for conditions of operation. The minimum power requirement is of special importance when diesel-engine prime movers are used to avoid excessive maintenance due to the