



Standard Practice for Thermal Rating and Installation of Internal Combustion Engine Packages for use in Hazardous Locations in Marine Applications¹

This standard is issued under the fixed designation F2876; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the method of testing, rating and installation of internal combustion engine packages for use in hazardous areas in marine applications. The thermal rating of the engine is determined by the actual readings of engine and exhaust system temperatures within hazardous areas, as defined by references in 2.2 and 2.3 of this practice, or as designated by the authority having jurisdiction, or both. The goal of this practice is to thermally rate engine packages, and provide additional installation recommendations, in order to reduce the risk of igniting the ignitable mixtures that may be present within the hazardous areas of marine vessels.

1.2 Only a marine engine suitable for the service, designed and constructed in conformance with the requirements of 3.1.2, is considered.

1.3 The system of units in this practice shall be SI (metric) form, along with the standard (English) system equivalent placed in parentheses, for example, 20°C (68°F).

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

F683 Practice for Selection and Application of Thermal Insulation for Piping and Machinery

2.2 *NFPA Standards:*³

NFPA 70 The National Electric Code (NEC), 2008

¹ This practice is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.07 on General Requirements.

Current edition approved May 1, 2015. Published June 2015. Originally approved in 2010. Last previous edition approved in 2010 as F2876 – 10. DOI:10.1520/F2876-10R15.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

2.3 *IEC Standards:*⁴

IEC 60092 Electrical installations in ships—Part 502: Tankers—Special features

2.4 *CFR:*⁵

CFR 46 United States Code of Federal Regulations, Title 46, Shipping

2.5 *EN Standards:*⁴

EN 1834-1 Reciprocating internal combustion engines. Safety requirements for design and construction of engines for use in potentially explosive atmospheres.

3. Terminology

3.1 *Definitions:*

3.1.1 *hazardous location*—area in which an explosive gas atmosphere is or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of electrical apparatus and other potential heat sources. These areas are defined by the authority having jurisdiction, or in accordance with NFPA 70 (NEC) Articles 500, 501 and 504; or NEC Articles 500 and 505; or IEC 60092-502, or a combination thereof.

3.1.2 *marine engine*—a compression-ignition engine designed and constructed for operation in the marine environment, regardless of horsepower, to the applicable standards or rules of a recognized classification society in Title 46, Code of Federal Regulations, Part 8, or a comparable engine design and construction standard.

3.1.3 *ignitable mixture*—a mixture of gas, such as natural gas, or similar volatile hydrocarbon gas with normal air, that will propagate flame or explode when exposed to an ignition source.

3.1.4 *ignition temperature*—(*explosive atmosphere*)—the lowest temperature at which an ignitable mixture may be ignited.

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁵ Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, <http://www.access.gpo.gov>.

3.1.5 *maximum surface temperature*—the highest temperature attained under the most severe operating conditions by any equipment part or surface capable of igniting an ignitable mixture.

4. Summary of Practice

4.1 While there have been great improvements made in the safety of electrical and electronic equipment utilized in hazardous locations, there has been little development concerning reducing the hazards associated with high temperature surfaces of internal combustion engines operating in the same hazardous locations. Several factors have significantly increased the temperature of hot surfaces and exhaust gases of internal combustion engines. Some of these factors are performance related, while others have resulted from compliance with new environmental standards.

4.2 This practice provides guidance for the temperature rating of marine internal combustion engines based on the surface temperature exposures within a hazardous location in the marine environment.

5. General Requirements

5.1 The application of this practice will help reduce the risk of fire, or explosions, caused by ignitable gas mixtures coming in contact with the heated surfaces and hot exhaust gases generated by compression ignition (diesel) engines used in, or near, hazardous locations.

5.2 *Marine Engine Design and Construction Requirements:*

5.2.1 Special consideration should be given to engine accessories such as pumps, fans, and starter motors such that they are constructed of suitable materials and installed in ways that will minimize friction, heat and sparking.

5.2.2 High pressure fuel piping (greater than 100 bar, or 1450 psi) installed between fuel pumps and injectors, shall be double jacketed in order to reduce the risk of fuel spray coming in contact with hot surfaces.

5.2.3 Marine Engines and engine components shall be properly bonded and grounded to the hull.

5.2.4 The use of materials known to create, or store, static electricity shall be avoided.

5.2.5 Fans and fans blades shall be constructed of conductive, non-sparking materials.

5.2.6 Drive belts shall be conductive and the pulleys, shafts and driving equipment shall be grounded.

5.2.7 For sealed, purged or pressurized engine enclosures special considerations should be given to the use of lock outs that will prevent the engine from starting when protective guards, insulated covers, or other attachments necessary to maintain temperature control, are removed.

5.2.8 Sealed, purged or pressurized engine enclosures shall be designed to dampen the pressure of an internal explosion and shall be protected against over pressurization.

5.2.9 Air ducts and exhaust gas piping to and from non-hazardous locations shall be gas tight within the hazardous location. EN 1834-1 should be consulted.

5.2.10 Air ducts within the hazardous location shall be fitted with flame arrestors, or other equipment designed and tested to perform the functions of a flame arrestor. EN 1834-1 should be consulted.

5.2.11 Exhaust systems shall be fitted with a spark arrestor, or other equipment designed and tested to perform the functions of a spark arrestor. EN 1834-1 should be consulted.

5.2.12 To help prevent unsafe operation, warning signs and labels shall be used to indicate when necessary equipment guards, or protective covers, are removed from the engine.

5.2.13 The procedures outlined in EN 1834-1 should be consulted for additional hazard and risk reduction.

5.2.14 The procedures outlined in Practice F683 may be applied if necessary in order to limit the exposed surface temperatures of piping and machinery.

5.2.15 All electrical or electronic equipment associated with engine installations in hazardous locations shall be tested or approved and listed or certified by an independent laboratory for the Class and Group of the cargo carried or the hazardous location to the standards and protection techniques specified under NFPA 70 (NEC) Articles 500, 501 and 504; or NEC Articles 500 and 505; or IEC 60092-502 and acceptable to the authority having jurisdiction.

6. Procedure for Rating

6.1 The testing required in Section 7 shall be used to determine the highest temperature exposure of the engine application package. The highest temperature obtained, based on the most severe test operating and environmental (including high ambient air temperature) conditions, will be the temperature used for determining the rating of the engine.

6.2 The determination of an appropriate marine engine temperature rating for installation in a hazardous location is based upon the lowest ignition temperature of the cargo the vessel is authorized to carry, or the lowest ignition temperature of the engine fuel being used, whichever is lower, and the highest temperature exposure within the hazardous location of any part of the marine engine package as determined in 6.1. The temperature of engine surfaces, auxiliary components and exhaust system gases that may contact the cargo vapor must be maintained below the engine rating temperature and, specifically, more than 10°C (18°F) below the lowest ignition temperature of any cargo that the vessel is certified to transport.

6.3 Engines for hazardous locations shall be given a designated temperature rating from T1 through T6 based on Table 1. For example: a marine engine designated T3 shall have no exposed surfaces, components or exhaust piping with a temperature greater than 200°C (392°F) that may contact any ignitable mixture of gas and air within the hazardous area.

TABLE 1 Engine Temperature Classification and Rating

Engine Temperature Rating	Engine Rating Temperature
T1	≤ 450°C (842°F)
T2	≤ 300°C (572°F)
T3	≤ 200°C (392°F)
T4	≤ 135°C (278°F)
T5	≤ 100°C (212°F)
T6	≤ 85°C (185°F)

7. Testing and Certification

7.1 Manufacturers and modifiers of marine engines for use in hazardous locations shall certify, through testing, the ability of the engine and protective systems to maintain exposed temperatures below the marine certified temperature (T) rating.

7.2 Certification testing of the engine package and hazardous location protective systems shall be conducted for a minimum of two hours at 90 % of rated power. This test may be conducted as part of or in conjunction with other required operational tests or certifications.

7.3 Temperature measurements shall be taken using a reliable, calibrated means of measurement such as thermal imaging, or standard laboratory temperature measuring equipment.

7.4 Prior to taking measurements of the marine engine surface temperatures, the engine will be brought first to normal coolant operating temperature and then to a steady state load as specified in 7.2.

7.5 Temperature measurement shall be taken at a minimum of eight different locations on the engine, or engine enclosure, at the load specified in 7.2. When an enclosure is not utilized, at least half of the readings shall be taken from the turbo-charger and compressor discharge (if installed) and different points along the exhaust system. Readings shall be taken from the exhaust gas outlet if it is designed to discharge into the hazardous area. The location of other temperature reading locations shall be based on the engine design.

7.6 Temperature readings shall be recorded every 15 minutes in each location.

7.7 Any modification to the engine package that could result in an increase of temperature exposure within the hazardous area will require re-certification of the modified engine package.

7.8 Upon installation each engine package will be tested to assure the newly installed engine is in compliance with the marine engine's certified temperature (T) rating.

8. Hazards

8.1 Compliance with company-defined laboratory safety practices and applicable occupational safety standards shall be maintained.

9. Documentation

9.1 Marine engines manufactured, or modified, for installation in hazardous locations must be labeled with a nameplate or permanent marking to indicate their temperature rating in degrees as follows:

Meets ASTM F2876
Engine temperature rating _____ Maximum surface temperature _____
_____degrees (°C or °F).

9.2 An operations and maintenance manual shall be provided with each engine package manufactured, or modified, for installation in hazardous locations. The operations and maintenance manual shall include, but is not limited to the following:

9.2.1 Documentation that describes the tests used for determining the engine's temperature rating in accordance with this practice.

9.2.2 A periodic maintenance plan that includes the key maintenance and testing requirements for maintaining the engine's temperature rating during and following routine maintenance.

9.2.3 The required configuration to ensure the engine package meets the installation requirements as defined by the manufacturer, or modifier.

10. Post-Installation and Maintenance Testing Requirements

10.1 The engine shall be installed and maintained in the same configuration as it was tested and rated.

10.2 Each hazardous location engine package installation shall be checked periodically, in accordance with the operations and maintenance manual, but no less than annually, to ensure that temperatures are being maintained at or below limits. In particular, careful checks shall be made following significant maintenance or repair where critical insulation may have been removed or damaged.

11. Keywords

11.1 diesel engine; hazardous location; ships

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